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Western Scotian Shelf and Slope Strategic Environmental Assessment

Draft Report

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Executive Summary

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

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

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

The Project Area considered for this SEA encompasses the area within which exploration rights could be issued and petroleum-related activities could be authorized by the CNSOPB. To recognize a potential zone of influence of environmental effects from activities that could occur within the Project Area, a Study Area was established around the Project Area. The Study Area extends from the Emerald Basin to Georges Bank, and encompasses LaHave Bank and portions of Baccaro and Browns Banks, as well as the deeper water on the Scotian Slope.

There are several fish, marine mammal, sea turtle and bird species with special conservation status known to occur within the Study Area. These include, but are not limited to, the endangered blue whale, North Atlantic right whale, Northern bottlenose whale, leatherback and loggerhead turtles, and the roseate tern. Special Areas within the SEA Study Area include the Northeast Channel Coral Conservation Area, the Fundian Channel/Browns Bank Area Of Interest (AOI), Corsair and Georges Canyons Conservation Area, the Sambro Bank Sponge Conservation Area, the Western/Emerald Banks Conservation Area (including the Haddock Box), as well as several areas of importance for fish conservation, critical habitats for the North Atlantic right whale and leatherback turtle, and six Ecologically and Biologically Significant Areas (EBSAs). It is noted that leatherback turtle critical habitat has not yet been formally established and is currently considered as draft.

The Study Area encompasses portions of Northwest Atlantic Fisheries Organization (NAFO) Divisions 4W, 4X, and 5ZE. Shellfish fisheries (e.g., sea scallop, lobster, crab), pelagic (e.g., shark, swordfish, tuna, mackerel), and groundfish (cod, halibut, flatfish, haddock, hake) fisheries occur throughout the Study Area, with shellfish fisheries dominating the commercial catch value. Other ocean uses in and around the Study Area include commercial shipping, scientific research and military activity. There are currently two exploration licences in the SEA Study Area.

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

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

For each VC, the SEA explores potential effects of exploration activities drawing on existing knowledge and current literature, recommends mitigation and planning considerations, and discusses data gaps and uncertainties. Applicable regulatory requirements, which represent minimum standards in many cases, include, but are not limited to, the *Nova Scotia Offshore Petroleum Drilling and Production Regulations*, and the *Canada-Nova Scotia Offshore Petroleum Financial Requirements Regulations* (Federal/Provincial). Relevant guidance materials associated with these regulations as well as the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP), Offshore Waste Treatment Guidelines (OWTG), Offshore Chemical Selection Guidelines, and Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity provide advice to operators on how to meet regulatory requirements. Where required, enhanced mitigation is developed on a project-specific basis (e.g., enhanced mitigation for seismic surveys beyond the minimum requirements in the SOCP) to ensure safe and environmentally responsible operations.

Data gaps and uncertainties exist with respect to understanding potential environmental effects of exploration activities on marine species. Considering these gaps, any potential oil and gas exploration activities conducted in the vicinity of sensitive areas and/or in the presence of species of special status may require enhanced mitigation and monitoring, until understanding of potential interactions and effects can be improved and appropriate mitigation developed. Future exploration offers a potentially valuable opportunity to help address current knowledge gaps in the Study Area and understand environmental interactions and effects.

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

List of Acronyms and Abbreviations

2D	Two-dimensional
2DHR	2D high resolution
3D	Three-dimensional
AOI	Area of Interest
ASM	America Society for Microbiology
ATBA	Area to be Avoided
AZMP	Atlantic Zone Monitoring Program
BOP	Blowout preventer
BP	British Petroleum
CAC	Criteria air contaminant
CER	Canada Energy Regulator
CEA Agency	Canadian Environmental Assessment Agency
CEAA, 2012	*Canadian Environmental Assessment Act, 2012*
CEPA	*Canadian Environmental Protection Act*
CFA	Crab Fishing Area
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
COGOA	*Canada Oil and Gas Operations Act*
CoML	Census of Marine Life
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPT	Cone Penetrometer Technology
CRA	Commercial, Recreational, Aboriginal
cu.	Cubic
CUPE	Catch per unit effort
CWS	Canadian Wildlife Service
dB	Decibel
DFO	Fisheries and Oceans Canada
DND	Department of National Defence
E&P	Exploration and Production
EA	Environmental Assessment
EBSA	Ecologically and Biologically Significant Area
ECCC	Environment and Climate Change Canada
ECRC	Eastern Canada Response Corporation

ECSAS	Eastern Canadian Seabirds at Sea
EEM	Environmental Effects Monitoring
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EL	Exploration Licence
EPP	Environmental Protection Plan
ESRF	Environmental Studies Research Fund
FLO	Fisheries Liaison Officer
FPB	Fall Phytoplankton Bloom
GHG	Greenhouse Gas
H_s	Significant wave height
IA	Impact Assessment
IAA	*Impact Assessment Act*
IAAC	Impact Assessment Agency of Canada
ICCAT	International Commission for the Conservation of Atlantic Tuna
IUCN	International Union for Conservation of Nature
JIP	Joint Industry Programme
LFA	Lobster Fishing Area
MARLANT	Maritime Forces Atlantic
MBCA	*Migratory Birds Convention Act*
MBS	Migratory Bird Sanctuary
Mcf	Thousand cubic feet
MMcf	Million cubic feet
MMS	Minerals Management Service
MODU	Mobile Offshore Drilling Unit
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MSC	Meteorological Service of Canada
NAO	North Atlantic Oscillation
NAFO	Northwest Atlantic Fisheries Organization
NAVWARN	Navigational Warning
NEB	National Energy Board
NEBA	Net Environmental Benefit Analysis
NEFSC	Northeast Fisheries Science Center
NOTMAR	Notice to Mariners
NRCan	Natural Resources Canada
NSPD	Nova Scotia Petroleum Directorate

OBIS	Ocean Biodiversity Information System
OBM	Oil-based mud
OCSG	Offshore Chemical Selection Guidelines
OERA	Offshore Energy Research Association
OGP	Oil and Gas Producers Association
OSRL	Oil Spill Response Limited
OSV	Offshore supply vessel
OTN	Offshore Tracking Network
OWTG	Offshore Waste Treatment Guidelines
PAM	Passive acoustic monitoring
PIROP	Programme intégré de recherches sur les oiseaux pélagiques
ppt	Parts per thousand
PTS	Permanent threshold shift
rms	Root mean square
ROV	Remotely Operated Vehicle
SARA	*Species at Risk Act*
SBM	Synthetic-based mud
SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
SFA	Scallop Fishing Area
SFSC	Southeast Fisheries Science Center
SIMA	Spill Impact Mitigation Assessment
SOCP	Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment
SOEP	Sable Offshore Energy Project
SOLAS	International Convention for the Safety of Life at Sea
SSIP	Scotian Shelf Ichthyoplankton Program
T_p	Peak wave period
TPH	Total petroleum hydrocarbon
TTS	Temporary threshold shift
VC	Valued Component
VSP	Vertical Seismic Profiling
WAZ	Wide-azimuth seismic survey
WBM	Water-based mud
WWF	World Wildlife Fund

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1.0 INTRODUCTION

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

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

Notable features for environmental management consideration within or directly adjacent to the Project Area include the Western/Emerald Banks Conservation Area (*Fisheries Act,* Marine Refuge), Northeast Channel Coral Conservation Area, Sambro Bank and Emerald Basin Sponge Conservation Areas, North Atlantic Right Whale Critical Habitat, leatherback sea turtle critical habitat (draft), and Ecologically and Biologically Significant Areas (EBSAs). Figure 1.1 illustrates the spatial boundaries for the SEA, which includes the Project Area as defined by the CNSOPB and a larger Study Area that has been delineated in recognition of a potential zone of influence of the most substantive environmental effects that could occur (refer to Section 4.3).

The SEA:

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

The SEA highlights key potential environmental issues for the CNSOPB and for prospective future operators with interest in the SEA area. The SEA is not intended to replace project-specific EAs that would be required for any proposed exploration program; rather it is intended to support and facilitate future project-specific EAs. The scope of this SEA is based primarily on scoping conducted for previous SEA reports on the Scotian Shelf and Slope (e.g., Stantec 2012a, 2012b, 2013, 2014, 2017, 2019), knowledge of existing environmental conditions (refer to Section 3), applicable regulatory guidance (refer to Section 2.1), review of relevant publications, including project-specific EAs conducted for recent petroleum exploration projects offshore Nova Scotia (Shell 2014; BP Canada 2016), and experience of the study team and government reviewers. Additional information on the objectives and scope of the SEA is included in Section 4.

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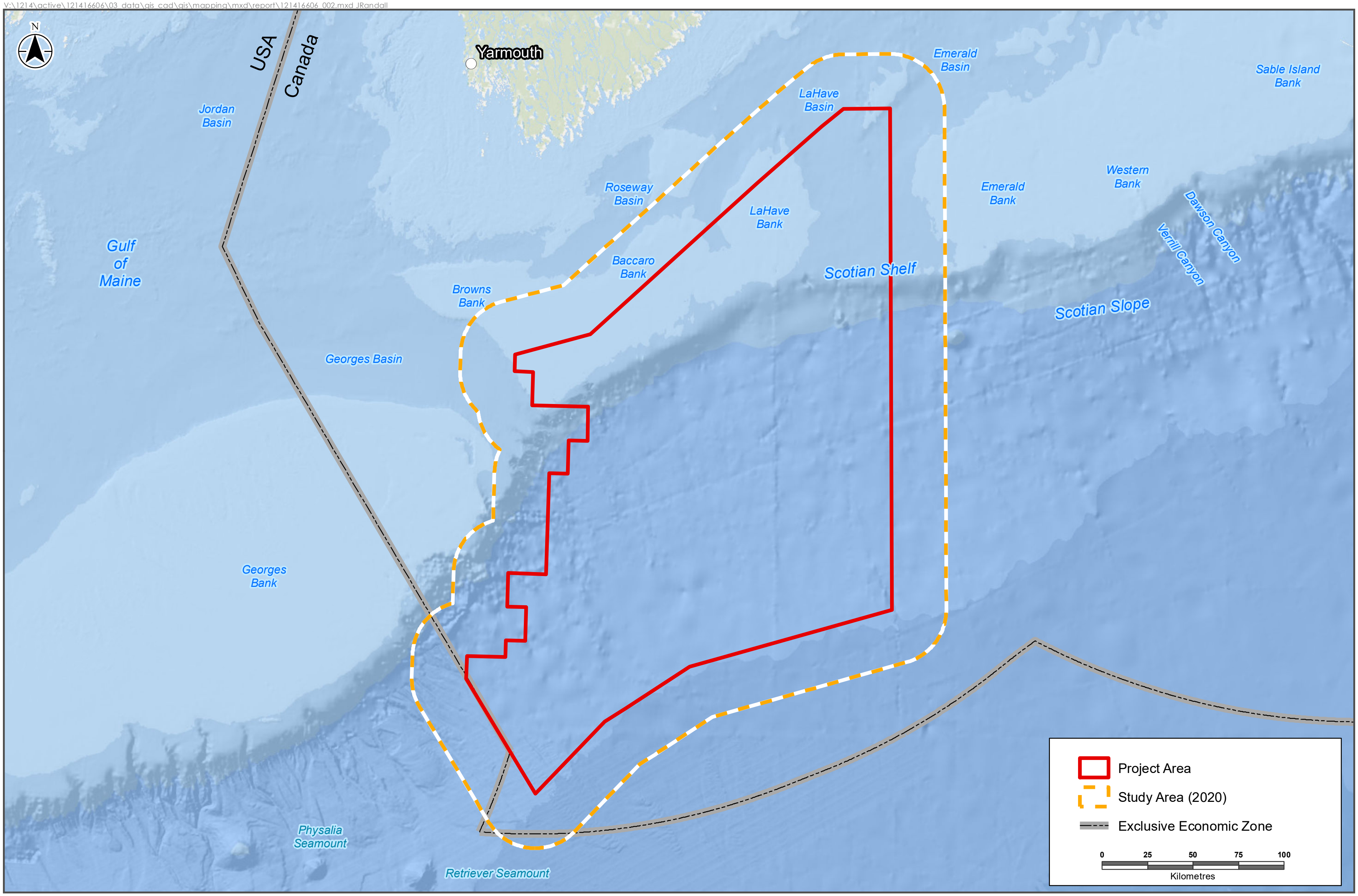

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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

NAD 1983 UTM Zone 20N

SEA Study Area

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

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Figure 1.1

2.0 EXPLORATION ACTIVITIES

Since 1960, there has been more than 401,650 line-kilometres of two-dimensional (2D) seismic survey work conducted in the Canada-Nova Scotia Offshore Area and over 43,375 km^2 of three-dimensional (3D) seismic coverage. Since the first exploratory well drilled in 1967 (Sable Island C-67), there have been a total of 210 wells drilled on the Nova Scotia shelf and slope (including exploratory, delineation and development wells), six of which are within the Western Scotian Shelf and Slope SEA Study Area (CNSOPB 2019a). This section provides an overview of regulatory issues and describes routine and accidental oil and gas exploration activities and events.

2.1 REGULATORY CONTEXT

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

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

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

In addition to the CNSOPB's environmental assessment requirements and processes, the Government of Canada has recently enacted new environmental assessment legislation. The new *Impact Assessment Act* (IAA), which repeals and replaces the *Canadian Environmental Assessment Act*, 2012 (CEAA 2012), came into force on August 28, 2019. The IAA established the Impact Assessment Agency of Canada (IAAC or the Agency) (replacing the Canadian Environmental Assessment Agency [CEA Agency]) to lead the review of major projects. The Government of Canada implemented new rules through the IAA that protect the environment and foster sustainability, recognize and respect Indigenous rights, and strengthen the economy. The new impact assessment process considers a range of environmental, health, social, and economic effects of projects, whereby decisions are based on public interest (as defined by IAA) rather than focused on the significance of adverse effects.

Like the previous legislation, this new federal legislation and its accompanying regulations (i.e., *Physical Activities Regulations*) apply to certain offshore oil and gas activities including the drilling, testing and abandonment of offshore exploratory wells in the first drilling program within a licenced area. Offshore operators that are proposing to undertake exploration drilling in newly acquired exploration licences must contact the IAAC and follow the five-step IA process described on their website (hyperlink here) and within the *Information and Management of Time Limits Regulations*. The IAA requires consultation and cooperation with the CNSOPB for designated projects under the IAA that are also regulated under the Accord Acts. The IAAC is working closely with the CNSOPB as well as Natural Resources Canada and the Nova Scotia Department of Energy and Mines to establish the roles and responsibilities of the IAAC and CNSOPB during future assessments.

Under the new IAA, it is understood that the Agency intends to make greater use of regional and strategic assessments. In June 2020, the Government of Canada completed its first regional assessment under the new IAA for the eastern portion of the Canada-Newfoundland and Labrador Offshore Area. The regional assessment aims to improve the effectiveness and efficiency of the impact assessment process as it applies to oil and gas exploration drilling in this region, while at the same time promoting high standards of environmental protection. The Government of Canada has developed a regulation under the IAA that sets out requirements for future exploratory drilling projects in the Regional Assessment Study Area. This was informed by the findings and recommendations outlined in a committee report, along with a public consultation process by government. If future exploratory drilling projects are able to demonstrate conformance with this regulation, they are not required to undergo a project-specific federal impact assessment. This regulation came into force on June 4, 2020. Information on the regulation, along with the government's response to the committee's recommendations is available (hyperlinked here), on the Agency's website.

Similar to the EAs conducted pursuant to the former legislation, assessments of offshore exploratory drilling conducted pursuant to IAA will also meet the environmental assessment requirements of the CNSOPB.

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

Table 2.1 Summary of Key Relevant Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance
Accord Acts	CNSOPB	This Act defines the mandate of the CNSOPB. It requires operators to obtain authorizations and approvals from the CNSOPB prior to conducting any offshore oil and gas exploration, development and production, and decommissioning activities. An environmental assessment (EA) is required as part of an operators application submission for such activities.
Nova Scotia Offshore Area Petroleum Geophysical Operations Regulations (and associated Guidelines)	CNSOPB	These Regulations pertain to the geophysical operations in relation to exploration for petroleum in the Canada-Nova Scotia Offshore Area and outline specific requirements for authorization applications and operations.
Nova Scotia Offshore Petroleum Drilling and Production Regulations (and associated Guidelines)	CNSOPB / C-NLOPB	The Regulations outline the various requirements that must be adhered to when drilling for petroleum in the Canada-Nova Scotia Offshore Area.
Offshore Waste Treatment Guidelines (OWTG)	National Energy Board (NEB; now the Canada Energy Regulator [CER]) / CNSOPB / Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB)	Guidelines to aid operators in the management of waste material associated with petroleum drilling and production operations in offshore areas regulated by the Boards. This document contains key mitigation to be adhered to by operators to allow streamlining of the environmental assessment process (NEB et al. 2010).
Canada-Nova Scotia Offshore Financial Requirements Regulations (and associated Guidelines)	CNSOPB	These Regulations pertain to an Applicant seeking an authorization with respect to each work or activity proposed to be carried on (Authorization) and the proof that should be provided to demonstrate how it meets the financial requirements set out in the *Canada Oil and Gas Operations Act* (COGOA) or the Accord Acts.
Offshore Chemical Selection Guidelines (NEB et al. 2009)	CER / CNSOPB / C-NLOPB	The Offshore Chemical Selection Guidelines (OCSG) provide a framework for chemical selection which minimizes the potential for environmental impacts from the discharge of chemicals used in offshore drilling and production operations.
Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017)	CNSOPB / C-NLOPB	These Guidelines describe the various compensation sources available to potential claimants for loss or damage related to petroleum activity offshore Canada-Nova Scotia and Canada-Newfoundland and Labrador. These Guidelines also outline the regulatory and administrative roles which the Boards exercise respecting compensation payments for actual loss or damage directly attributable to offshore operators.

Table 2.1 Summary of Key Relevant Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance
Environmental Protection Plan Guidelines (C-NLOPB et al. 2011)	CER / C-NLOPB / CNSOPB	Guidelines to assist an operator in the development of an environmental protection plan (EPP) that meets the requirements of the Acts and Regulations and the objective of protection of the environment from its proposed work or activity.
Statement of Canadian Practice (SOCP) with respect to the Mitigation of Seismic Sound in the Marine Environment (DFO 2007)	DFO / ECCC / CNSOPB / C-NLOPB / Natural Resources Canada (NRCan) / Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) / Provinces of British Columbia/ Newfoundland and Labrador/ Nova Scotia/Quebec	Specifies the minimum mitigation requirements that must be met during the planning and conduct of marine seismic surveys to avoid or reduce impacts on life in the oceans. This document contains key mitigation to be adhered to by operators of seismic programs. The SOCP is undergoing a detailed technical review led by DFO with support from the identified regulatory authorities. DFO has published papers suggesting potential new mitigation for inclusion in the SOCP. Any new mitigation included in an updated SOCP would be established collectively by the regulatory authority and may include enhanced mitigation for specific species at risk.
Impact Assessment Act (came into force August 2019)	Impact Assessment Agency of Canada (replaced the CEA Agency with coming into force of *Impact Assessment Act*)	The *Impact Assessment Act* (IAA) establishes the Impact Assessment Agency of Canada (IAAC) to lead the federal review of major projects, working with life-cycle regulators and in cooperation with provinces, territories and Indigenous jurisdictions. The list of projects (i.e., Regulations Designating Physical Activities) which are subject to IAA came into force with the legislation.
Fisheries Act	DFO ECCC (administers Section 36, specifically)	The *Fisheries Act* contains provisions for the protection of fish, shellfish, crustaceans, marine mammals and their habitats. Section 36 of the *Fisheries Act* pertains to the prohibition of the deposition of a deleterious substance into waters frequented by fish. On August 28, 2019, new provisions of the *Fisheries Act* came into force. The new *Fisheries Act* improves the protection of Canada's fisheries and their ecosystems. The revised Act reinstates previous protections for all fish and fish habitat. The newly revised Act also restores previous prohibitions against the harmful alteration, disruption, and destruction of fish habitat without DFO approval.
Canadian Environmental Protection Act, 1999	ECCC	The *Canadian Environmental Protection Act*, *1999* (CEPA) pertains to pollution prevention and the protection of the environment and human health in order to contribute to sustainable development. Among other things, CEPA provides a wide range of tools to manage toxic substances, and other pollution and wastes, including disposal at sea.
Migratory Birds Convention Act, 1994	ECCC	Under the *Migratory Birds Convention Act, 1994* (MBCA), it is illegal to kill migratory bird species not listed as game birds or destroy their eggs or young. (It is legal to kill game birds only during legislated hunting seasons). The Act also prohibits the deposit of oil, oil wastes or any other substance harmful to migratory birds in any waters or area frequented by migratory birds. The Act and the associated Migratory Bird Regulations also prohibits the disturbance of migratory birds.

Table 2.1 Summary of Key Relevant Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance
Species at Risk Act	DFO/ECCC/Parks Canada	The *Species at Risk Act* (SARA) is intended to protect species at risk in Canada and their "critical habitat" (as defined by SARA). The main provisions of the Act are scientific assessment and listing of species, protection of individuals, species recovery, protection of critical habitat, compensation, and permits and enforcement. The Act requires the development of recovery strategies and action plans for endangered and threatened species, and management plans for species of special concern. Under s.79 of the Act, proponents are required to complete an assessment of the environment and demonstrate that no harm will occur to listed species, their residences or critical habitat, or identify adverse effects on specific listed wildlife species and their critical habitat, followed by the identification of mitigation measures to avoid or minimize effects. Proponents are advised that all activities must be compliant with Section 32 of SARA which states "No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, endangered species or threatened species". In some cases, a SARA permit may be issued for activities that would otherwise be prohibited under the Act, provided certain conditions are met.
Oceans Act	DFO	The *Oceans Act* provides for the integrated planning and management of ocean activities and legislates the marine protected areas program, integrated management program, and marine ecosystem health program. Marine protected areas are designated under the authority of the *Oceans Act*.
Navigation Protection Act/Canadian Navigable Waters Act	Transport Canada	The *Navigation Protection Act* is intended to protect inland and nearshore navigable waters by regulating the construction of works on those waters (as identified on the list of "Scheduled Waters") by regulating construction of works on these waters and providing the Minister of Transport with the power to remove obstructions to navigation. In 2016, the Minister of Transport announced a review of the *Navigation Protection Act.* The review was conducted concurrently with the review of the environmental assessment process and other federal legislation. Amendments to the *Navigation Protection Act* were proposed in Bill C-69 which received Royal Assent in June 2019.

2.2 CONSULTATION AND ENGAGEMENT

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

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

As the regulator of the Canada-Nova Scotia Offshore Area, the CNSOPB recognizes that in carrying out the regulatory processes, it is important to engage with Indigenous groups and the public. Prior to conducting this SEA, a Scoping Document was prepared and made publicly available. An opportunity to submit written comments on the draft SEA scoping document was provided from January 27 to February 25, 2020. Once the draft SEA is completed, the draft document will be made available to the public for a 30-day period. Both engagement opportunities aer advertised to the public on the CNSOPB website and the @CNSOPB Twitter account. These opportunities were also communicated to:

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

SEAs are based on the information gathered as a result of public comment periods and engagement with Indigenous groups and key stakeholder groups. This helps the CNSOPB better understand perspectives and concerns and assisting in making informed decisions. The CNSOPB will review all comments submitted. A summary of the issues and concerns raised along with the CNSOPB's responses will be provided in Appendix A of the Final Report. The online SEA Public Registry and comments submitted specific for the SEA for the Western Scotian Shelf and Slope can be viewed on the Public Registry (hyperlink here) when available.

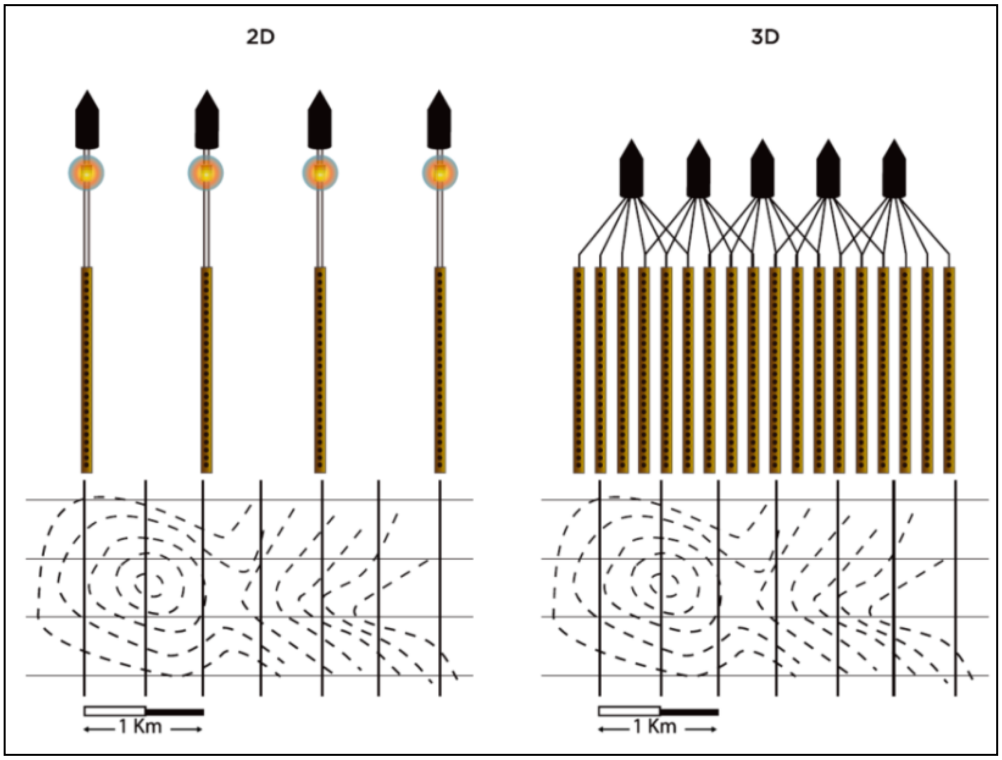
2.3 DESCRIPTION OF ROUTINE OIL AND GAS EXPLORATION ACTIVITIES

Generic descriptions of potential exploration activities to be considered in the SEA are presented in Tables 2.2, 2.3, 2.4 and 2.5. Consideration of routine emissions and discharges have been guided by applicable regulations and guidelines including: the OWTG (NEB et al. 2010), Nova Scotia Offshore Petroleum Drilling and Production Regulations (and associated guidelines), Offshore Chemical Selection Guidelines (NEB et al. 2009), Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017), and Environmental Protection Plan Guidelines (C-NLOPB et al. 2011).

Table 2.2 Generic Description of Exploration Activities - Geophysical Surveys

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

Table 2.2 Generic Description of Exploration Activities - Geophysical Surveys



Source: International Association of Oil and Gas Producers (OGP) 2011

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

Table 2.2 Generic Description of Exploration Activities - Geophysical Surveys

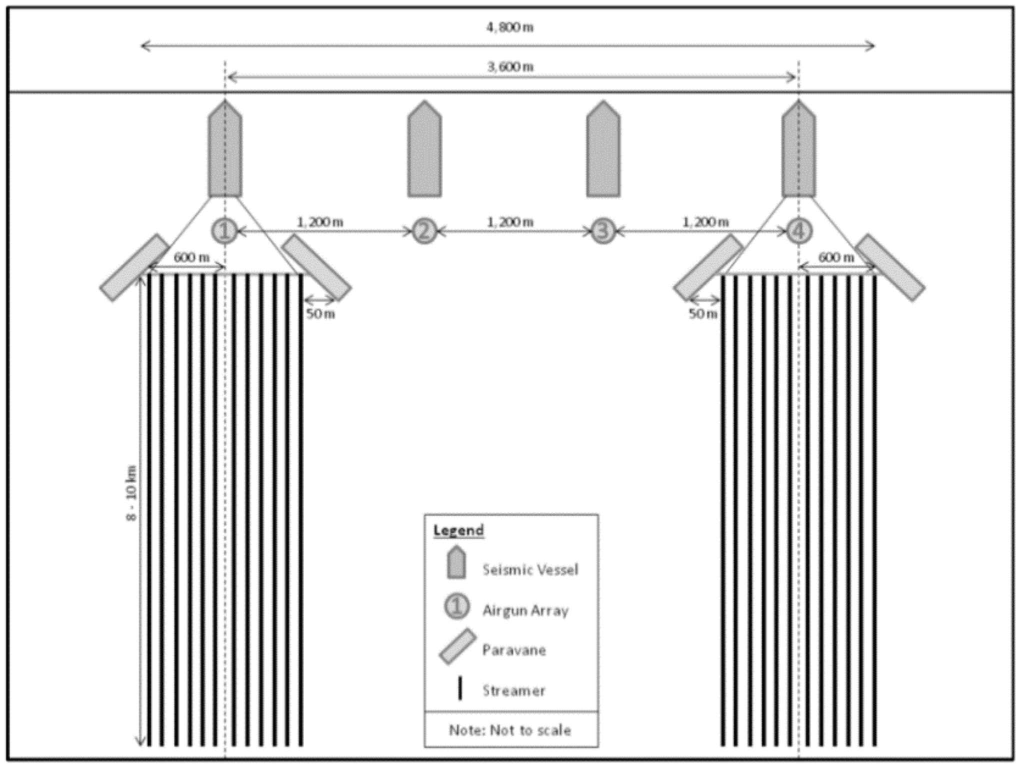
Equipment and Methods	 Source: Shell 2012 **Figure 2.2 Typical 3D WAZ Survey Vessel Configuration**
Spatial Extent	• 2D data acquisition lines are typically spaced several kilometres apart over a large area (up to thousands of kilometres). • 3D data sail line separation is typically in the order of 400 to 800 m depending on the number of streamers deployed and their cross-line separation. A small 3D survey is approximately 300 km^2, with larger surveys covering approximately 1,000 to 3,000 km^2. • WAZ surveys have a larger footprint than conventional seismic surveys (up to 10,000 km^2) given the multi-vessel configuration that is used, although the overall survey area is generally more focused and in the range of 3D surveys. • Propagation of underwater sound increases the spatial extent beyond the physical footprint of the seismic equipment by hundreds of kilometres.
Timing/ Duration	• Conventional seismic surveys (2D and 3D) typically take a few weeks to a month to complete. • 3D WAZ seismic surveys may occur over a few (up to four) months, depending on the area being surveyed. 3D WAZ seismic surveys take longer to change survey lines (turn), usually 5-7 hours, compared to 2-3 hours for typical 3D seismic surveys.

Table 2.2 Generic Description of Exploration Activities - Geophysical Surveys

Routine Emissions	• Emissions associated with geophysical surveys include routine vessel emissions (e.g., exhaust emissions, lights, sewage/ food wastes, bilge water/ballast water) and underwater sound. • Most of the emitted seismic energy lies within the 10–120 Hz range, with energy also in the 500–1000 Hz range. In shallow waters (25-50 m) air guns can be audible at distances up to 75 km, while in deeper waters they can be audible at distances well over 100 km. Airgun sounds have been recorded almost 4,000 km from the survey vessel at levels audible to fin whales. Typical zero-to-peak source levels for exploration seismic arrays are 245-260 decibels (dB) relative to 1 µPa at 1 m**.**
Key Environmental Issues	• Effects of seismic noise on marine wildlife • Spills and unauthorized discharges • Interactions with other ocean users, particularly the fishing industry • Interactions between seismic ship and gear with marine mammals and sea turtles

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

Alternative technologies such as seismic airguns with controlled bandwidth sources which enable suppression of high frequency energy, may also be considered on a project-specific basis. Operators may be asked to consider the use of such alternatives subject to any limitations related to data acquisition. The assessment of suitable alternative technology would be considered in the EA/IA for specific projects.

Table 2.3 Generic Description of Exploration Activities - Seabed Surveys

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

Table 2.3 Generic Description of Exploration Activities - Seabed Surveys

Seabed Surveys (Geophysical Surveys, Geotechnical Sampling, Environmental Surveys)	
Spatial Extent	• Seabed surveys are typically focused on targeted drilling locations and do not generally extend more than 1 km from the proposed well site.
Timing/Duration	• The duration of each survey program would be in the order of days, with a total survey program taking a few weeks to a couple of months including port calls and downtime. Reprocessing 3D seismic data can take several weeks to months, depending on the area of coverage being considered.
Routine Emissions	• Routine emissions include emissions from survey vessels (e.g., exhaust, lights, noise, deck drainage, sewage/food wastes, bilge/ ballast water) and limited noise associated with geophysical and geotechnical sampling.
Key Environmental Issues	• Effects of underwater sound on marine wildlife • Spills and unauthorized discharges from survey vessels • Interactions with other ocean users, particularly the fishing industry

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

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

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

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)	
	100 m), a jack-up rig is typically used (Figure 2.3); in deeper waters a drill ship (Figure 2.4, Photo 1) or semi-submersible rig (Figure 2.4, Photo 2) is used. o A jack-up rig is towed to the drill site. Once on site, the rig's retractable legs are lowered until they rest on the sea floor, at which point the platform is elevated up the legs until it reaches the desired height above the sea surface (refer to Figure 2.3). o A drill ship is a self-propelled drilling unit that can stay on location using anchors (in waters less than 1,000 m) or a dynamic positioning system (satellite navigation system transmits position to a computer, which controls thruster direction and power to keep the rig on station). Drill ships generally can carry greater loads (e.g., supplies), making them better suited for remote locations where re-supply is more difficult (refer to Figure 2.4 for example). o A semi-submersible rig can be towed or move under its own power to the site and is designed to operate in rough seas. Semi-submersibles can be moored using anchors (in shallower waters) or a dynamic positioning system (refer to Figure 2.4 for example).
Equipment and Methods	• Drilling fluids (also referred to as drilling muds) are used to lubricate the drill bit and flush drilled rock cuttings from the bit, carrying them up to the surface. There are three basic types of drilling muds: water-based muds (WBM), synthetic-based muds (SBM), and oil-based muds (OBM). OBMs are no longer used in the Canada-Nova Scotia Offshore Area. • Offshore wells are drilled in stages (sections), with a typical well depth ranging from 2,000 to 6,000 m below the seafloor. • The first section of the well is a large diameter conductor hole (approximately 900 mm) drilled several hundred metres into the seafloor. As there is no way to return the drilling muds and cuttings to the MODU before the riser is installed, these muds and rock cuttings are released onto the seafloor. Therefore, WBM is used to drill this portion of the well. • The drill string is then removed, and a steel casing is run and cemented into place to prevent the wall of the hole from caving in and to prevent the seepage of muds and other fluids. • The drill bit and string are then lowered through the BOP and into the surface hole. The bit begins drilling at the bottom of the hole, and extra joints are added to the drill string as the drill bit cuts the hole. • When a section of the well is complete, the drill string is pulled out and the sections of the casing are joined together, lowered into the well and cemented into place. • The casing also ensures that there is adequate pressure integrity to allow a blowout preventer (BOP) and the drilling riser to be installed. The BOP is a system of high-pressure valves that prevent water or hydrocarbons from escaping into the environment in the event of an emergency or equipment failure. • For this portion of the well, the drilling riser connects the casing set at the seafloor up to the drilling unit, which allows the return of cuttings and drilling muds to the surface drilling unit where processing takes place. • SBM is often used in drilling lower well sections, particularly if the use of WBM is technically impractical (e.g., due to formation structure, well orientation). • SBM is transported with the cuttings up the riser to the drilling rig for recovery and reuse. Once onboard, the cuttings are removed from the drilling muds in successive separation stages, with most fluids being reconditioned and reused, and spent fluids returned to shore for disposal. • Cuttings (both WBM and SBM) may be discharged at the drill site provided they are treated (SBM) prior to discharge to meet the OWTG (NEB et al. 2010) specified limit of oil on cuttings. Otherwise, cuttings are collected and returned to shore for disposal. • Once the well has been completed, VSP may be conducted to obtain accurate "time-to-depth ties". This is necessary as seismic data are recorded in time and wells are drilled in metres. VSP involves placing a string of geophones down the well, with a seismic source (e.g., air guns) suspended from the drilling unit (zero-offset VSP) or another vessel (offset VSP). The seismic source is similar to a seismic survey array but is considerably smaller with a peak

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

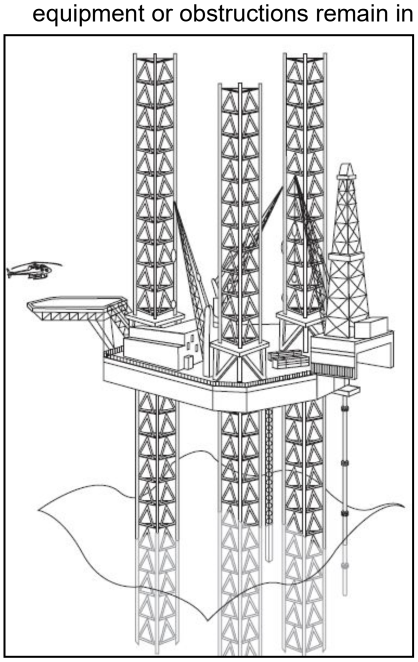
Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)	
	output pressure of 240-250 dB (refer to Figure 2.5 for example). There are several forms of VSP surveys and equipment, with varying source sizes, duration of activity analysis and sound propagation characteristics. Project-specific EAs should specify the VSP program intensity and highlight the differences between regular seismic programs and VSP. • Once wells have been drilled and evaluation programs completed (if applicable), wells are typically plugged and abandoned. Cement or mechanical devices are used to plug the well and isolate hydrocarbon-bearing intervals within the wellbore, preventing the release of wellbore fluids to the marine environment. • The decision to remove or abandon the wellhead in place is based on safety considerations and the potential for the abandoned wellhead to interfere with other ocean uses (e.g., fishing). Recent deepwater wells drilled offshore Nova Scotia have received approval from the CNSOPB to abandon the wellhead on the seafloor given deep water depths and lack of potential interaction with other ocean users.
Equipment and Methods	• Where approval is obtained to abandon the wellhead in place, the only infrastructure that remains on the seafloor is the wellhead. All other infrastructure (including the blowout preventor) is removed. Leaving the wellhead in place does not alter the number, type or placement of barriers within the wellbore. The permanent footprint of the wellhead on the seafloor is representative of the casing size of the conductor section of the well (typically 900 mm). The wellhead would extend approximately 1.5 m to 3.7 m above the seafloor. • In cases where the wellhead is removed, this is done primarily using a mechanical casing/wellhead cutting device. Alternatively, if mechanical separation is unsuccessful, a chemical/directed explosive method is used to detach the wellhead (with the charge set a minimum of 1 m below the sea substrate). An ROV is used to inspect the seabed to confirm no equipment or obstructions remain in place.  Source: Petroleum Support 2011 **Figure 2.3 Schematic of Typical Jack-up Rig**

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

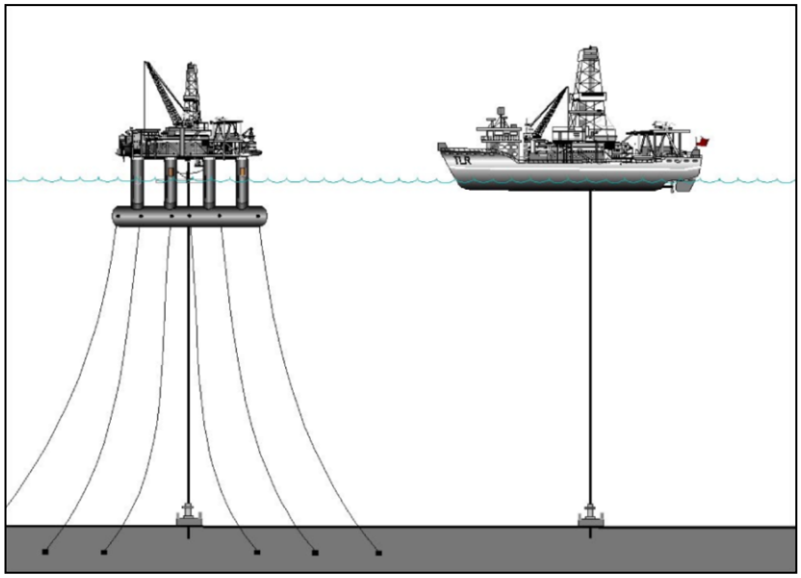
Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)	
Equipment and Methods	 Source: Minerals Management Service (MMS) 2000 **Figure 2.4 Schematic of Typical Semi-submersible Drilling Rig and Drill Ship, with Photo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

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

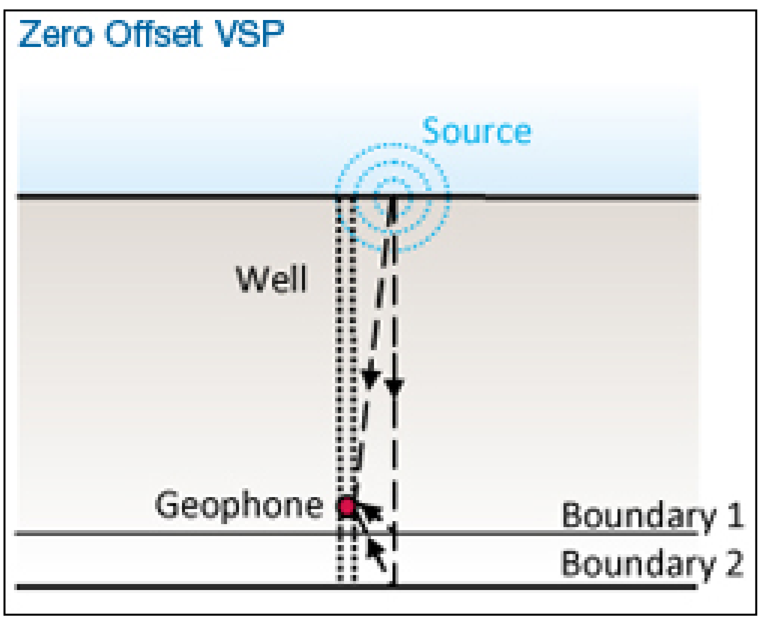
Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)	
Equipment and Methods	 Source: CNSOPB **Photo 2 Semi-submersible MODU**  Source: CO2CRC 2011 **Figure 2.5 Schematic of VSP**

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

<table>
<tr><th colspan="2">Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)</th></tr>
<tr><td>Spatial Extent</td><td>• A safety zone of 500 m from the MODU (or 50 m beyond the edge of an anchor pattern if applicable) is established while a drilling rig is on location. Only ships supporting the drilling program (e.g., supply vessels) are permitted to enter this zone.
• Propagation of underwater sound, atmospheric emissions, and routine discharges (including drill wastes) during drilling operations increase the spatial extent beyond the physical footprint of the drilling rig and can extend over 150 km from the drill site in the case of underwater sound from dynamic positioning thrusters.</td></tr>
<tr><td>Timing/ Duration</td><td>• The typical duration of an exploratory drilling program ranges from 60-120 days, including drilling, and plugging and abandonment, but can be longer depending on the complexity of the well and operational circumstances.
• The duration of VSP operations and well testing (if performed) is in the order of hours to days within this time frame.</td></tr>
<tr><td>Routine Emissions</td><td>• Routine emissions include:
  o Atmospheric emissions such as exhaust and flare emissions (during testing), heat/light emissions from navigation, deck and underwater lights
  o Drill waste including drilling muds and associated cuttings, provided the cuttings do not exceed 6.9 g/100 g oil on wet solids as per the OWTG (release of whole SBM is not authorized for discharge offshore)
  o Potentially oily water associated with deck drainage, bilge water, and ballast water
  o Macerated sewage and food wastes
  o Noise from standby/supply vessels, MODU, and VSP
• Levels of radiated drilling noise are dependent on rig type. Jack-up rigs tend to be relatively quiet compared to other rig types. Semi-submersibles are relatively quiet themselves although dynamic positioning thrusters are a source of noise. Drill ships are noisier than jack-up rigs or semi-submersibles, since heavy machinery is situated close to the hull, thereby radiating more noise into the marine environment.
• Miscellaneous solid waste (e.g., paper, domestic waste, scrap metal) is transferred to shore for sorting, recycling, and disposal according to the Nova Scotia Solid Waste-Resource Management Regulations and municipal requirements as applicable.
• Whole SBM is not permitted to be discharged offshore and rock cuttings associated with SBM use that do not meet the OWTG minimum requirements after treatment, are shipped to shore for appropriate treatment and disposal.</td></tr>
<tr><td>Key Environmental Issues</td><td>• Discharges and emissions resulting in a reduction of water and sediment quality
• Attraction and potential stranding/mortality of marine and migratory birds to artificial lighting/flares
• Change in benthic habitat due to drilling dischanges and well abandonment (if wellhead left in place)
• Behavioral and/or physical effects on marine wildlife due to underwater noise
• Temporary loss of access for fishing and other ocean uses within designated safety zone around the MODU for the duration of the drilling campaign.
• Spills and unauthorized discharges (including loss of drill muds, blowouts, or exceedances of OWTG)</td></tr>
</table>

Sources: Canadian Association of Petroleum Producers (CAPP) 2006; Jacques Whitford Environment Limited (JWEL) 2003; Hurley 2009; Encana 2005

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

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

Sources: Thomson et al. 2000, Husky Energy 2010

2.4 POTENTIAL ACCIDENTAL EVENTS

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

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

As of August 2020, there have been 210 wells drilled in the Canada-Nova Scotia Offshore Area and as of July 31, 2020, there have been 495 wells drilled in the Canada-Newfoundland and Labrador offshore area (CNSOPB 2020a, C-NLOPB 2020).

Since the first well was drilled offshore Nova Scotia in 1967, there have been two blowouts. In February 1984, a surface blowout occurred at Shell's Uniacke G-72 exploratory gas well, approximately 16 km from Sable Island. Over the course of the blowout, the well released approximately 70 million cubic feet (MMcf) of gas and 1.7 thousand cubic feet (Mcf) of condensate a day (Angus and Mitchell 2010). Environmental monitoring toward the end of the 10-day blowout revealed a condensate slick that covered 50-90 percent of the water's surface within a radius of several hundred metres of the rig; patches of slick were observed up to 10 km from the rig. Slick trajectory modelling run during the event predicted the slick would affect Sable Island, although monitoring patrols on the Sable Island beach never detected any condensate. While some oiled birds and seals were sighted, the incidence of oiling was not considered exceptional for this area of navigable waters. Monitoring of fish stocks revealed no evidence of tainting and the likelihood of adverse effects on fish stocks was considered to be low (Gill et al. 1985).

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

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

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

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

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

Table 2.6 presents CNSOPB spill statistics (exploration and development) from 1999 to 2020 (as of June 30, 2020) for spills (including chemical spills) offshore Nova Scotia (CNSOPB 2020b). Note that this database does not include releases associated with the 1984 Uniacke Blowout as this database commenced in 1999.

Table 2.6 CNSOPB Statistics for Spills to the Marine Environment (1999-2020)

Year	Less Than 1L	1-10L	11-150L	Greater Than 150L	Total Incidents[a]
1999-2000	0	8	3	2	13
2000-2001	11	8	11	2	32
2001-2002	11	9	4	0	24
2002-2003	10	3	4	3	20
2003-2004	6	5	9	5	25
2004-2005	6	0	2	2	10
2005-2006	7	2	3	1	13
2006-2007	4	2	4	2	12
2007-2008	1	3	1	0	5
2008-2009	3	4	0	0	7
2009-2010	9	1	2	1	13

Table 2.6 CNSOPB Statistics for Spills to the Marine Environment (1999-2020)

Year	Less Than 1L	1-10L	11-150L	Greater Than 150L	Total Incidents[a]
2010-2011	5	2	0	1	8
2011-2012	3	0	2	1	6
2012-2013[b]	6	0	1	0	7
2013-2014	6	1	1	2	10
2014-2015	3	2	1	2	8
2015-2016	5	0	1	0	6
2016-2017	4	1	0	0	5
2017-2018	6	0	1	0	7
2018-2019	6	3	1	0	10
2019-2020	5	0	0	0	5
TOTAL	112	54	51	24	241

Notes:
[a]Does not include exceedances to authorized discharge limits (e.g., oil in produced water) or gas releases.
[b]Current to March 31, 2019
Source: CNSOPB 2020b

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

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

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

Also in 2004, 3,528 liters of diesel fuel spilled into the ocean over a period of 36 hours. On August 22, ExxonMobil reported a spill of diesel fuel into the ocean from the North Triumph Platform, located 25 km South of Sable Island. A cracked fuel filter on the diesel engine of an electrical generator caused a leak which eventually spilled into the ocean. ExxonMobil was issued a penalty of $60,000: as a $10,000 fine and $50,000 to be paid into the Environmental Damages Fund (Stantec 2013).

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

On June 22, 2018, BP Canada Energy Group reported an unauthorized discharge of approximately 136 m^3 of SBM from the Seadrill *West Aquarius* semi-submersible drilling rig during drilling operations at the Aspy D-11 wellhead located at a water depth of 2,771 m. The source of the release was part of the piping which forms the drilling mud system, approximately 30 m below the water surface. The review and investigation of this incident was completed in 2019 which concluded that the incident occurred as a result of a failed connection in the mud boost line that is fastened to the marine riser, and that the discharge did not result in significant adverse environmental effects (CNSOPB 2019b).

2.4.2 Oil Spill Prevention and Response

The CNSOPB holds operators fully accountable and responsible for protection of the environment, ensuring that operators and drilling contractors have the necessary competencies to carry out their work, that they exercise due diligence in incident prevention, and that they demonstrate the capability and capacity to respond to any incidents that may occur.

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

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

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

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

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

Spill response can include any combination of the following methods:

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

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

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

Spill response also includes surveillance and monitoring (including a spill-specific Environmental Effects Monitoring [EEM] program) as well as wildlife protection and/or recovery and rehabilitation measures. An operator's Spill Response Contingency Plan shall include a wildlife response plan, consistent with local species expected to be encountered/affected and in line with local practices. Operators are encouraged to consult with local area experts in emergency management and wildlife response when preparing the wildlife response plan.

Compensation of affected parties for associated loss or damage attributed to a spill by the offshore petroleum industry is described within by the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017).

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

3.0 KEY CHARACTERISTICS OF THE ENVIRONMENT

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

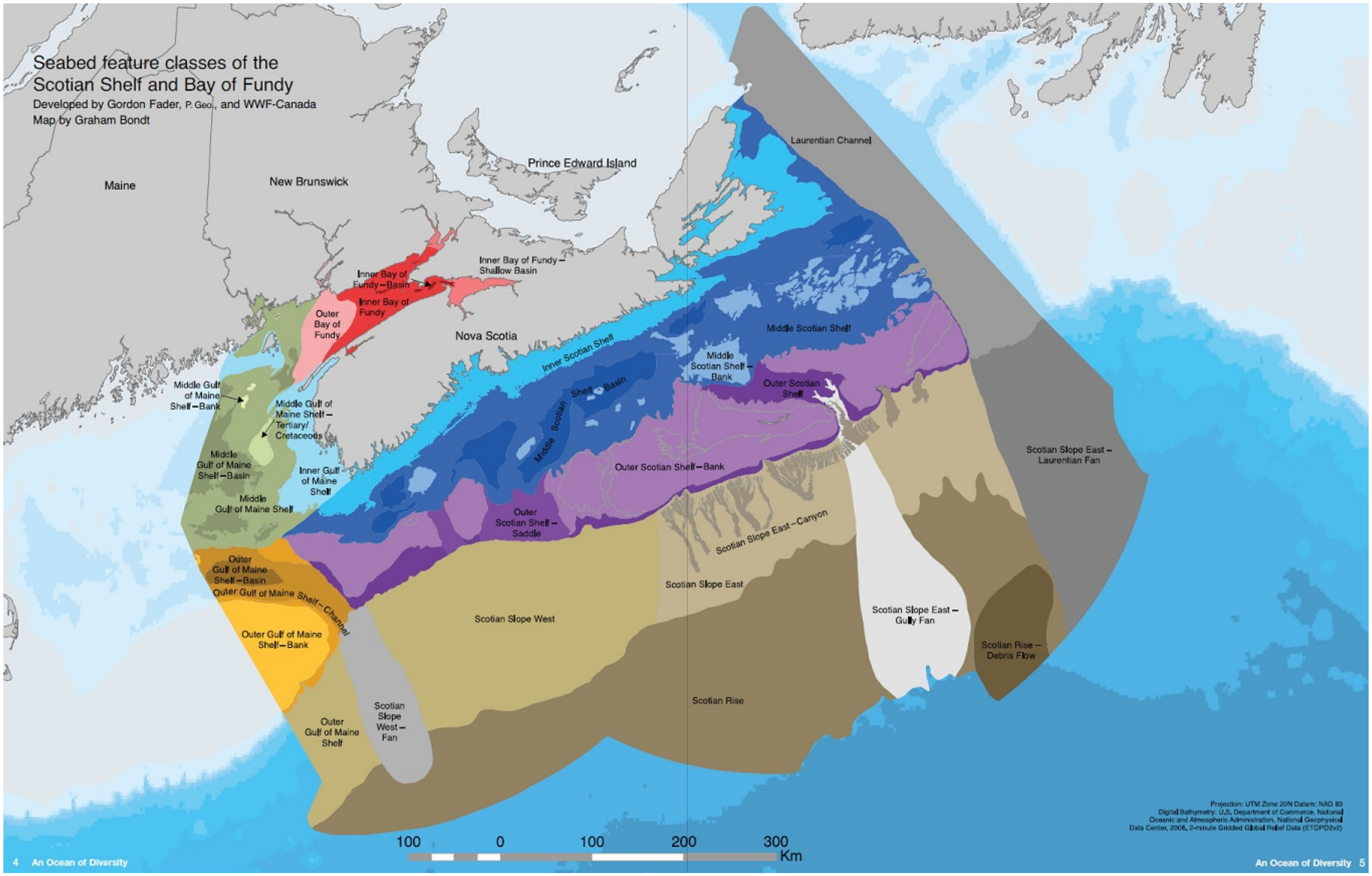
3.1 PHYSICAL CHARACTERISTICS

3.1.1 Oceanography

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

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

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



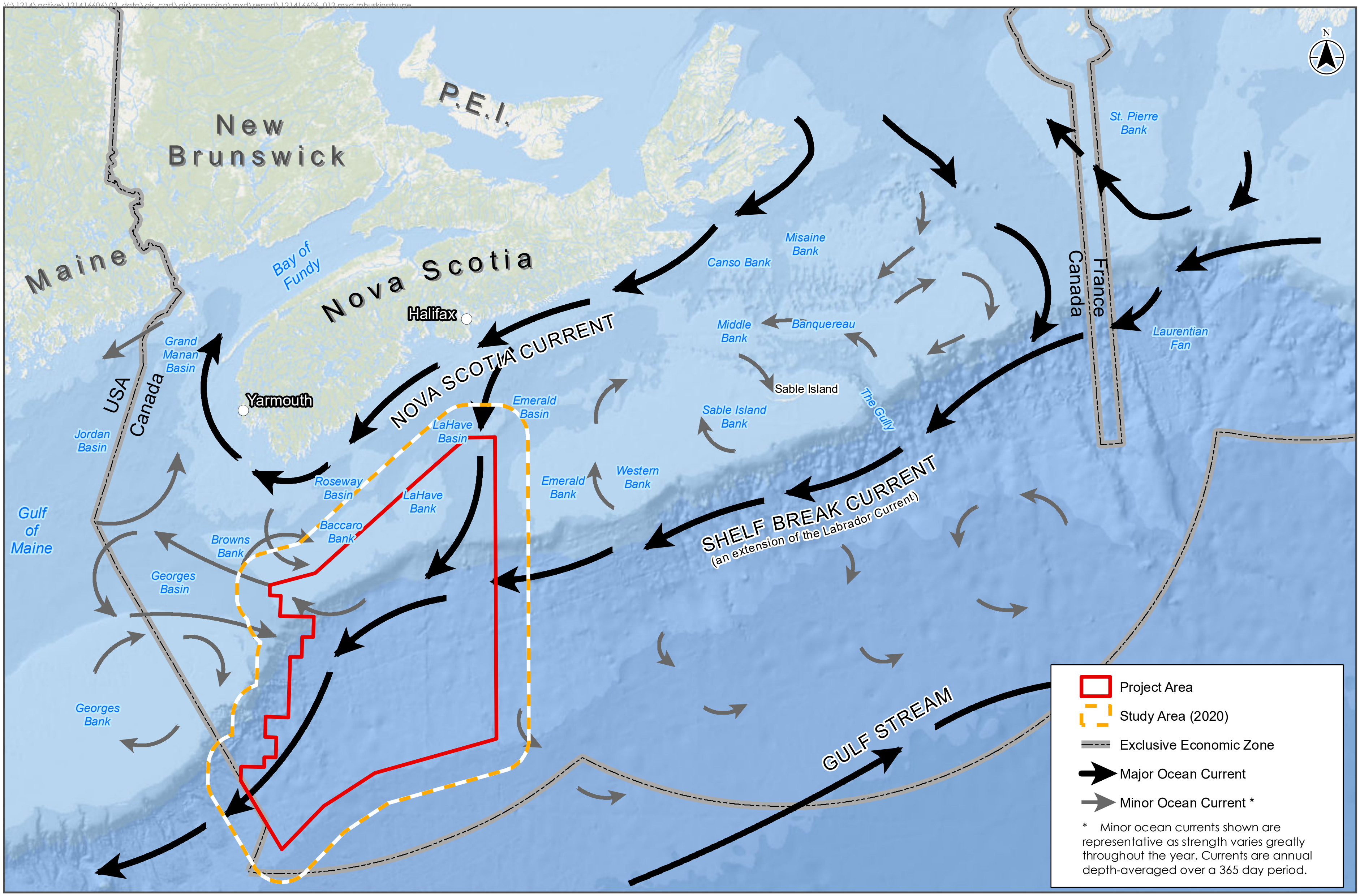
Source: WWF 2009

Figure 3.1 Seabed Features Offshore Nova Scotia and Bay of Fundy

The physical environment on the Scotian Shelf and Slope is governed by its proximity to the meeting place of major currents of the northwest Atlantic and its complex bathymetry. The three major currents influencing the movement of water on the Scotian Shelf and Slope are the Nova Scotia Current; the Shelf Break Current (an extension of the Labrador Current); and the Gulf Stream (Zwanenburg et al. 2006; Figure 3.2). Relatively cool, fresh waters flow from the Gulf of St. Lawrence through the Cabot Strait. A portion of this water turns at Cape Breton to flow southwest along Nova Scotia's Atlantic coast, while the rest of the flow continues through the Laurentian Channel to the shelf break. At the shelf break it turns and joins the Shelf Break Current to flow southwest along the shelf edge. The Shelf Break Current has the largest transport along the Eastern Scotian Shelf (Han and Loder 2003). The Gulf Stream flows northeastwards, and its warmer, more saline waters mix with the cool Labrador Current waters over the Scotian Slope, forming a mass of water known as slope water (DFO 2011a). This slope water periodically leaks onto the shelf through channels and canyons. The shelf bottom consists of a series of submarine banks and cross-shelf channels along the outer shelf and basins and troughs along the central shelf which limit and guide the near-bottom flow. The predominant flow of cold, fresh water from the northeast to the southwest results in temperature and salinity generally increasing to the southwest (Zwanenburg et al. 2006). This flow is strongest in the winter and weakest in the summer. For an overview of currents on the Scotian Shelf and Slope refer to Figure 3.2.

On the Western Scotian Shelf, the Nova Scotia Current flows in a southwesterly direction close to the coastline. As it reaches the Halifax area it branches in an offshore direction, where it joins the Shelf Break Current and continues to flow southwesterly along the shelf break (Breeze et al. 2002). On the shelf, the influence of the warm waters from the Gulf Stream is felt primarily within the deep channels and basins. The depression between Emerald and LaHave Banks, known as the Scotian Gulf, is a well-known area of warm water infiltration. Significant differences in circulation patterns exist between the western and central Scotian Shelf. The water masses of the central and Western Scotian Shelf are more like one another than to those found on the Eastern Scotian Shelf (Breeze et al. 2002).

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



Sources: Canada-Nova Scotia Offshore Petroleum Board, Government of Canada, Brickman and Drozdowski 2012 Miller et al. 1998
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

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

An Overview of Currents on the Scotian Shelf and Slope

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STRATEGIC ENVIRONMENTAL ASSESSMENT

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Figure 3.2

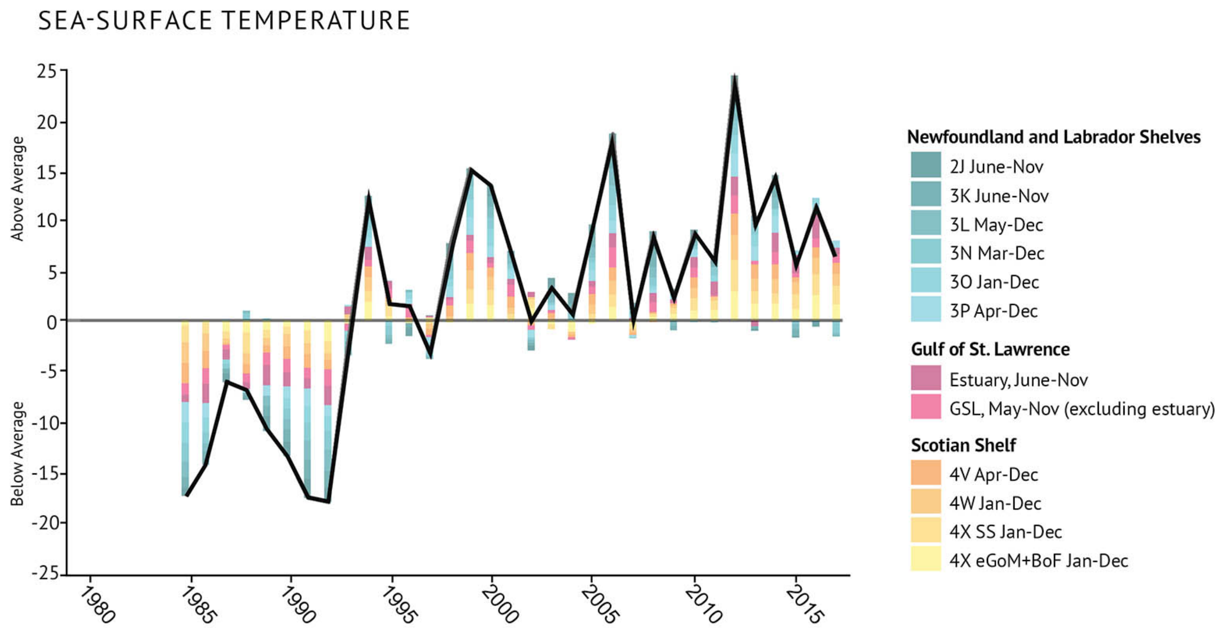
On the edge of the Scotian Shelf, deep-water lowlands can be found that feed canyons and the Scotian Slope with sediments. At the outer margins, water masses collide to form a “frontal zone” which shifts year to year, in which warm-water masses occasionally spill onto the shelf through the lowlands and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

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

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

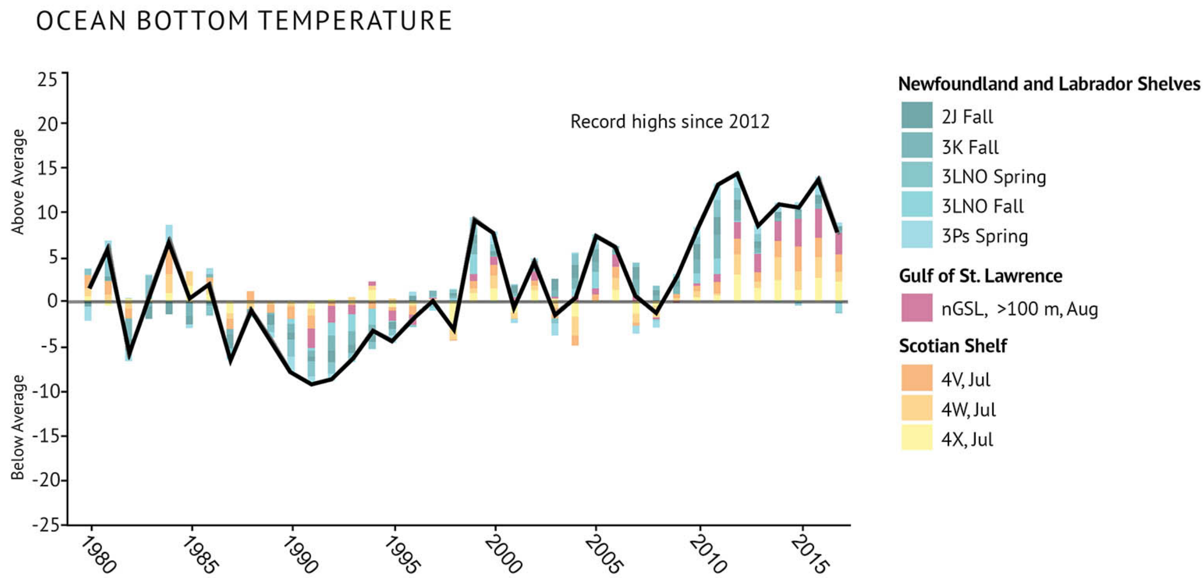
The water temperatures on the Scotian Shelf and in the Gulf of Maine are among the most variable in the North Atlantic (Worcester and Parker 2010). The Western Scotian Shelf is generally warmer than the Eastern Scotian Shelf. This is due to the infiltration of warm Gulf Stream water entering in between Browns and Western Banks. The normal temperatures on the Western Scotian Shelf is both seasonally and spatially more dynamic than those found on the Eastern Scotian Shelf. This is also due to the impact of warm water from the Gulf Stream and increased vertical mixing (Breeze et al. 2002). Surface temperatures typically show a large variation over the Scotian Shelf. Hebert et al. (2018) reviewed observations and model results for air temperature trends, ice cover, sea surface temperatures and physical oceanographic variability during 2016 on the Scotian Shelf, Bay of Fundy and the Gulf of Maine. They note that, due primarily to half freshening and half warming of surface waters, stratification has slowly been increasing on the Scotian Shelf.

Figure 3.3 presents an index of sea surface temperatures from 1985-2017 across several North Atlantic Fisheries Organization (NAFO) regions the location of which can be viewed at (hyperlink here). Values are shown relative to the average from this 25-year period. These data indicate that from 1985 until the early 1990s, surface water temperatures were typically below the 25-years average. After the early 1990s, surface water temperatures have been consistently above the average and indicate an overall warming trend. Sea surface temperature is closely associated with air temperature, which has been rising by approximately 1ºC per century since the 1870s. For the time period for which satellite records are available, (1985-present), 2012 had the warmest recorded sea-surface temperature on the Scotian Shelf (DFO 2019a, Bernier et al. 2018). Ocean bottom temperatures show a similar trend to the ocean surface temperatures (Figure 3.4) across the same NAFO regions. Like surface temperatures, the bottom temperatures are warming, with record highs occurring since 2012. The warming deep-sea temperatures are related to the increasing influence of the Gulf Stream relative to the Labrador Current (DFO 2019a, Bernier et al. 2018). illustrates the warming water trend from the 1970s to 2017.



Source: DFO 2019a

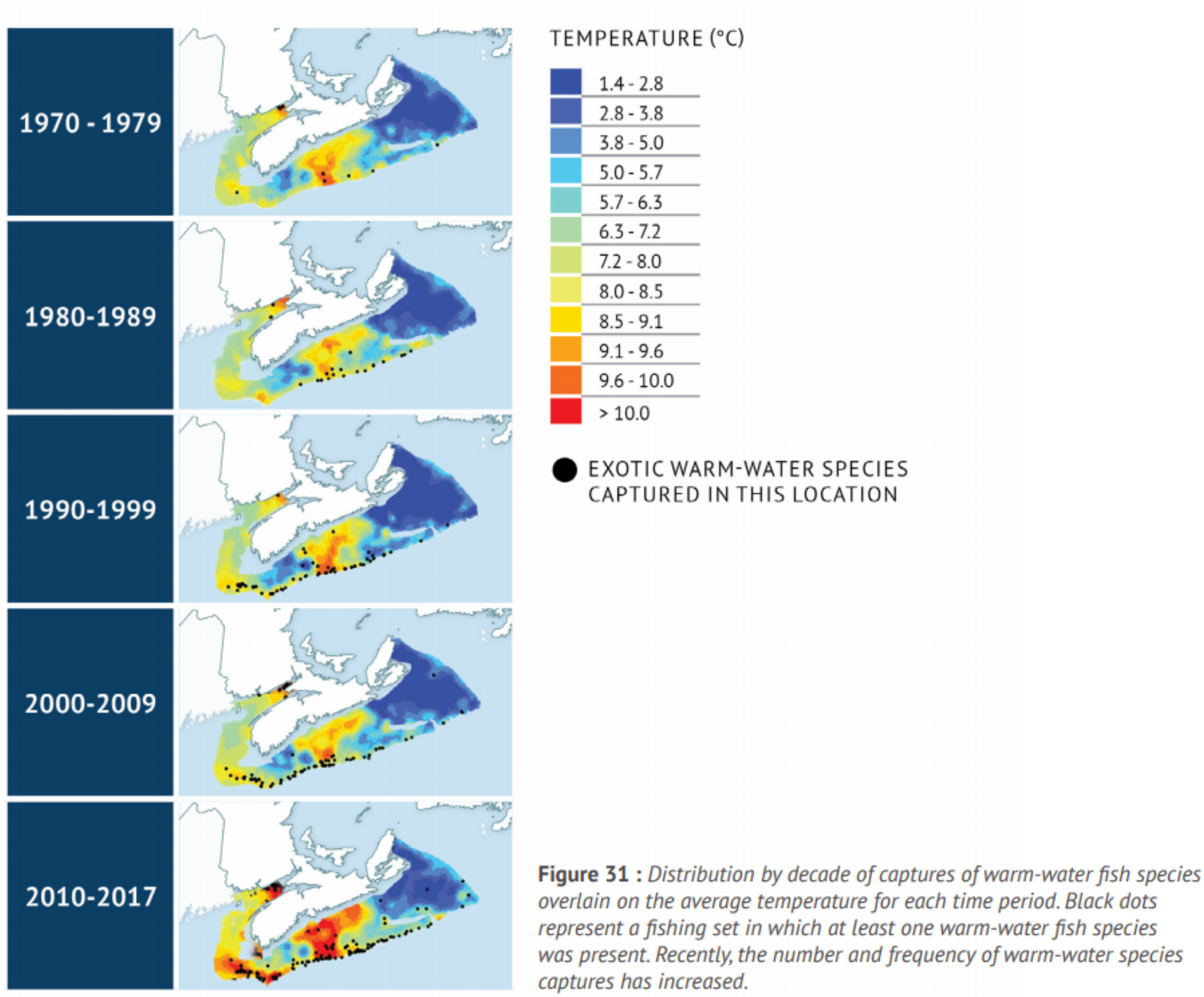
Figure 3.3 Sea-surface Temperature Relative to Average (1985-2017), measured during Ice-free Times of the Year



Note: Black trend line represents the combined anomalies for all areas

Source: DFO 2019a

Figure 3.4 Ocean Bottom Temperature Relative to Average (1981-2017)



Source: Bernier et al. 2018

Figure 3.5 Average Water Temperature on the Scotian Shelf and Slope by Decade

Ice cover and sea ice are very rare in the Nova Scotia offshore environment (Worcester and Parker 2010). Hebert et al. (2018) note that following above-average conditions in 2015, sea ice coverage returned to that of the 2010-2013 period, which had extremely low coverage and volume. Sea ice is generally transported out of the Gulf of St. Lawrence through the Laurentian Channel and pushed out to the Scotian Shelf via northwesterly winds and ocean currents. Generally, sea ice will only make it as far as the Eastern Scotian Shelf and melt before reaching the Central and Western sections of the shelf. Localized sea ice may also form along the coastline of Nova Scotia but would melt and dissipate after break-up before it has any chance of entering the Study Area.

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

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

Strong stratification has the potential to inhibit the vertical mixing of water to a degree to cause dissolved oxygen levels in the deeper layers to become depressed. The waters in the Study Area do stratify, but not to a degree where low dissolved oxygen levels become an issue for the species inhabiting the area. The lowest dissolved oxygen levels can be found within the deepest basins in the area (Worcester and Parker 2010).

3.1.2 Climatology

The climate of the Scotian Shelf and Slope varies between Atlantic, boreal, and sub-arctic climates. The warm Gulf Stream and the cold Labrador Current influence the climate in the area. Air temperatures in the region are measured on Sable Island and have shown an increase of 1°C over the last century (Worcester and Parker 2010). In 2016, mean annual air temperature anomalies were positive at all sites examined, with values ranging from +0.8°C (+0.9 SD) to +1.2°C (+1.9 SD) (Hebert et al. 2018).

The North Atlantic Oscillation (NAO) is the dominant atmospheric pattern in the North Atlantic Ocean, which is the significant large-scale abiotic driver of the Scotian Shelf ecozone (Drinkwater et al. 1998; Petrie 2007; Worcester and Parker 2010). The Scotian Shelf is primarily affected by advection. The NAO is a back and forth pattern between a high-pressure cell over the Azores in the southeast Atlantic and a low-pressure cell over Iceland. The NAO index is a measure in the difference in sea level pressure between the two locations in winter. A high index brings increased westerly winds, precipitation, and warmer waters to the Scotian Shelf. The opposite forcing occurs with a low NAO index bringing drier conditions, a decrease in storm conditions, and cooler water temperatures as a result of an increase in influence from the Labrador Current. Hebert et al. (2018) noted that the largest value in the NAO index 121-year record occurred in 2015, and this value remained positive in 2016 (+4.6 mb, +0.5 SD from the 1981-2010 mean).

Wind climate is an important physical force in the generation of currents and waves, which can affect exploration vessels and marine operations. Wind speed and direction are common parameters to describe wind characteristics. Data on percent wind speed by wind direction were acquired from Environment Canada's Meteorological Service of Canada (MSC).

The MSC50 hindcast data set has wind and wave data available from 1954-2018. The grid point 6001526 (located at 41.8°N, 64.3°W; water depth 2,722 m), which is located approximately in the center of the Study Area on the Scotian Slope, was used for the analysis presented in this report. Table 3.1 presents the mean, maximum and most frequent wind direction observed at this grid point, organizing the wind data by each season (winter, spring, summer and fall). Wind roses depicting these data, also seasonal, are presented in Figure 3.6.

The mean wind speed is higher during the winter, similar during spring and fall, and lower during the summer. Analyzing the probability of exceedance, it is expected that wind speeds over 10 m/s will occur approximately 52%, 30%, 29% and 5% of the time during winter, spring, fall and summer, respectively. This only provides one example of the probability of exceedance; other values can be obtained from Figure 3.7. Winds are most commonly from the west-northwest (especially during winter), except during the summer (June to August) when they are typically from the southwest. The probability of exceedance for the winds at grid point 6001526 are shown in Figure 3.7.

Table 3.1 Seasonal Wind Statistics for Grid Point 6001526 (1954-2018)

Season	Mean Wind Speed (m/s)	Most Frequent Direction	Maximum Hourly Wind Speed (m/s)
Winter (Dec. – Feb.)	10.5	West-Northwest	31.4
Spring (Mar. – May)	8.3	West-Northwest	27.5
Summer (June – Aug.)	5.6	Southwest	30.9
Fall (Sep. – Nov.)	8.2	West-Northwest	29.0

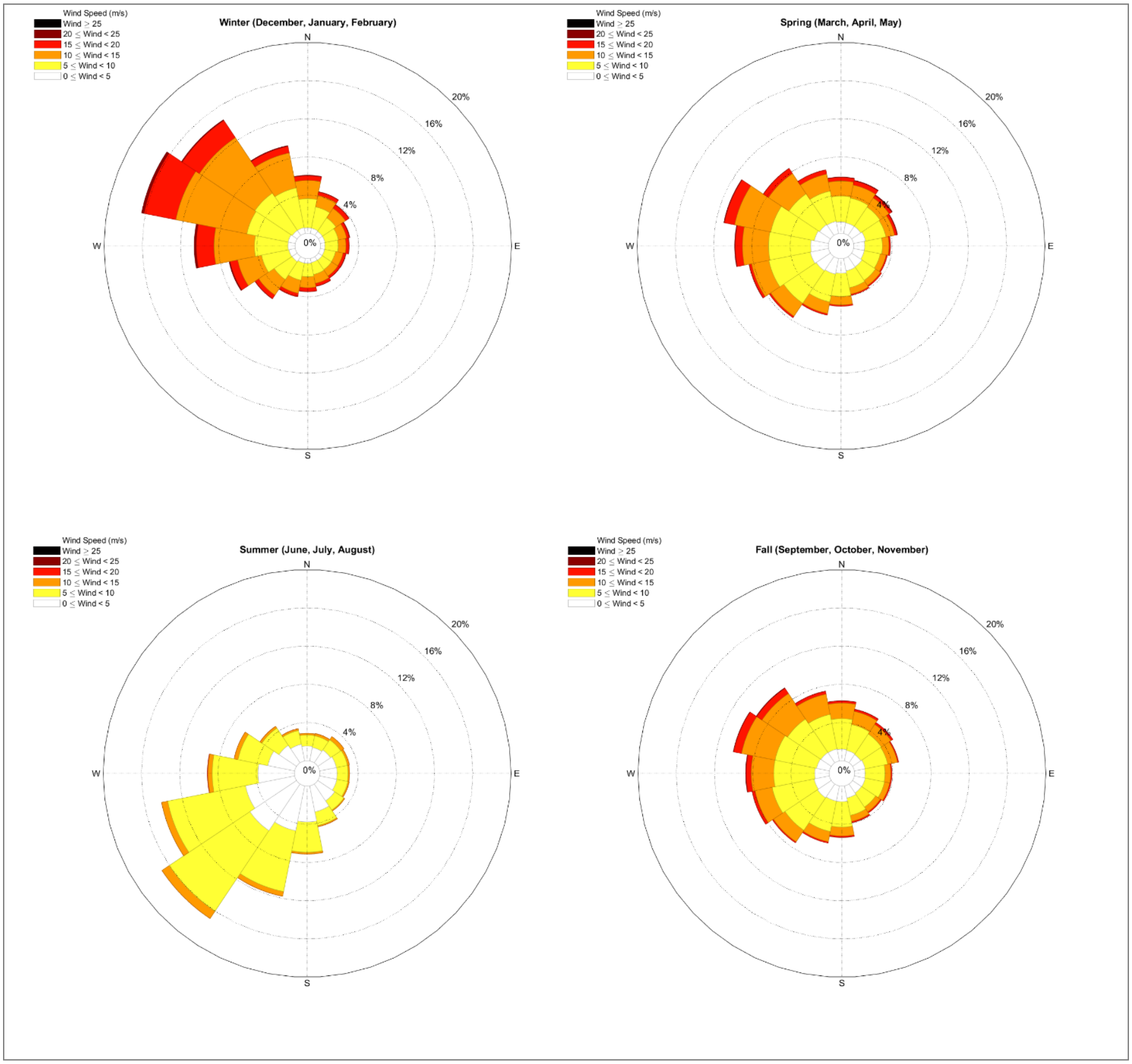


Figure 3.6 Seasonal Wind Roses for Grid Point 6001526 (1954-2018)

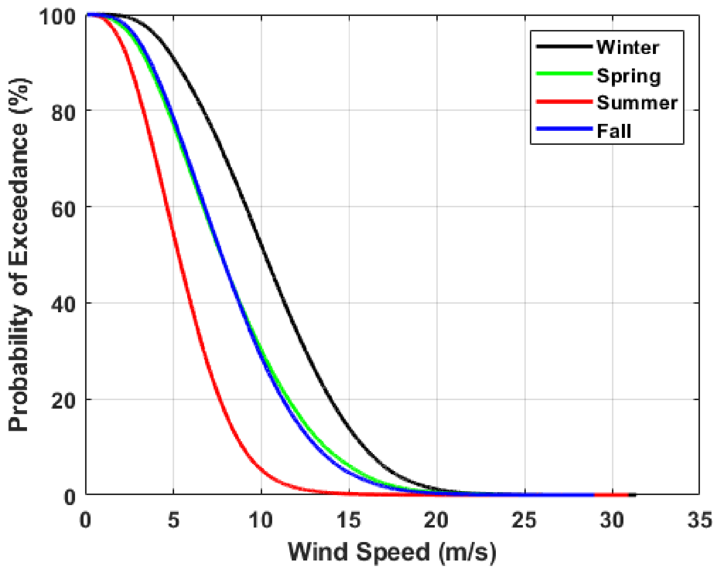


Figure 3.7 Probability of Exceedance for the Winds at Grid Point 6001526 (1954-2018)

The wave climate in the Study Area was also assessed by means of the MSC50 data set (1954-2018) for grid point 6001526 (41.8°N, 64.3°W; water depth 2,722 m). The minimum, maximum, mean and standard deviations of significant wave heights for each season are presented in Table 3.2. Significant wave height (H_s) is the mean wave height of the highest 1/3 of all individual waves from trough to crest (National Oceanic and Atmospheric Administration [NOAA] 2011). The percent occurrence of peak wave period (T_p) against significant wave heights for grid point 6001526 for each season is presented in Tables 3.3 to 3.6. Peak wave period (Tp) refers to the period associated with most energetic waves in the nondirectional wave spectrum at a specific point.

Maximum significant wave heights were greatest in the spring, with the highest mean significant wave height occurring in the winter (refer to Table 3.2). Most of the significant wave heights occurred at 1 to 2 m during the spring, summer, and fall (refer to Tables 3.4 to 3.6). In the winter, most significant wave heights occurred between 2 and 3 m (refer to Table 3.3). The typical peak period was between 6 and 8 seconds for spring, summer and fall, and between 8 and 10 seconds during winter.

Table 3.2 Minimum, Maximum, Mean and Standard Deviation of Significant Wave Height at Grid Point 6001526 by Season(1954-2018)

Season	Minimum Wave Height (m)	Maximum Wave Height (m)	Mean Wave Height (m)	Standard Deviation (m)
Winter (Dec – Feb)	0.54	12.79	3.09	1.46
Spring (Mar – May)	0.370	15.28	2.37	1.31
Summer (Jun – Aug)	0.45	14.93	1.46	0.62
Fall (Sep – Nov)	0.45	14.54	2.72	1.19

Table 3.3 Percent Occurrence of Peak Wave Period against Significant Wave Height for Grid Point 6001526: December, January, February(1954-2018)

Significant Wave Height (m)	Peak Wave Period(s)										Total
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	>18	
0 - 1	<0.01	0.02	0.54	0.18	0.18	0.05	0.05	<0.01	<0.01	<0.01	**1.01**
1 - 2	<0.01	0.16	6.12	11.34	4.53	1.21	0.60	0.20	<0.01	<0.01	**24.16**
2 - 3	<0.01	<0.01	1.27	17.57	8.48	3.03	0.51	0.23	<0.01	<0.01	**31.08**
3 - 4	<0.01	<0.01	<0.01	4.87	12.34	3.04	0.58	0.09	<0.01	<0.01	**20.93**
4 - 5	<0.01	<0.01	<0.01	0.13	8.48	2.89	0.59	0.04	<0.01	<0.01	**12.13**
5 - 6	<0.01	<0.01	<0.01	<0.01	2.03	3.60	0.59	0.04	<0.01	<0.01	**6.27**
6 - 7	<0.01	<0.01	<0.01	<0.01	0.13	2.12	0.37	0.03	<0.01	<0.01	**2.65**
7 - 8	<0.01	<0.01	<0.01	<0.01	<0.01	0.69	0.29	0.01	<0.01	<0.01	**1.00**
8 - 9	<0.01	<0.01	<0.01	<0.01	<0.01	0.29	0.18	<0.01	<0.01	<0.01	**0.47**
9 - 10	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.16	0.01	<0.01	<0.01	**0.20**
10 - 11	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	<0.01	<0.01	<0.01	**0.08**
11 - 12	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	**0.03**
12 - 13	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
13 - 14	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
14 - 15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
>15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
Total	**0.00**	**0.19**	**7.93**	**34.09**	**36.15**	**16.94**	**4.01**	**0.69**	**0.01**	**0.00**	**100.00**

Table 3.4 Percent Occurrence of Peak Wave Period against Significant Wave Height for Grid Point 6001523: March, April, May

Significant Wave Height (m)	Peak Wave Period(s)										Total
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	>18	
0 - 1	<0.01	0.12	2.20	2.71	0.84	0.34	0.23	0.03	0.03	<0.01	**6.50**
1 - 2	<0.01	0.19	10.28	19.29	10.10	1.69	0.92	0.15	0.02	<0.01	**42.64**
2 - 3	<0.01	<0.01	0.72	13.64	9.24	2.62	0.44	0.13	<0.01	<0.01	**26.78**
3 - 4	<0.01	<0.01	<0.01	2.77	7.85	2.50	0.32	0.02	<0.01	<0.01	**13.47**
4 - 5	<0.01	<0.01	<0.01	0.03	4.07	1.83	0.21	0.02	<0.01	<0.01	**6.17**
5 - 6	<0.01	<0.01	<0.01	<0.01	0.84	1.52	0.17	0.03	<0.01	<0.01	**2.56**
6 - 7	<0.01	<0.01	<0.01	<0.01	0.04	0.84	0.13	0.02	<0.01	<0.01	**1.03**

Table 3.4 Percent Occurrence of Peak Wave Period against Significant Wave Height for Grid Point 6001523: March, April, May

Significant Wave Height (m)	Peak Wave Period(s)										Total
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	>18	
7 - 8	<0.01	<0.01	<0.01	<0.01	<0.01	0.23	0.08	0.02	<0.01	<0.01	**0.33**
8 - 9	<0.01	<0.01	<0.01	<0.01	<0.01	0.09	0.12	0.02	<0.01	<0.01	**0.23**
9 - 10	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.09	0.03	<0.01	<0.01	**0.14**
10 - 11	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	0.03	<0.01	<0.01	**0.10**
11 - 12	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	**0.03**
12 - 13	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
13 - 14	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.01**
14 - 15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
>15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
Total	**0.00**	**0.32**	**13.20**	**38.44**	**32.98**	**11.67**	**2.80**	**0.54**	**0.06**	**0.00**	**100.00**

Table 3.5 Percent Occurrence of Peak Wave Period against Significant Wave Height for Grid Point 6001523: June, July, August

Significant Wave Height (m)	Peak Wave Period (s)										Total
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	>18	
0 - 1	<0.01	0.16	4.96	12.27	2.05	0.59	0.24	0.10	0.12	0.02	**20.50**
1 - 2	<0.01	0.12	14.38	36.46	10.87	1.57	0.91	0.51	0.21	0.02	**65.05**
2 - 3	<0.01	<0.01	0.20	6.36	4.13	0.76	0.27	0.14	0.04	<0.01	**11.90**
3 - 4	<0.01	<0.01	<0.01	0.35	1.13	0.30	0.05	0.07	<0.01	<0.01	**1.90**
4 - 5	<0.01	<0.01	<0.01	<0.01	0.24	0.15	0.05	0.02	<0.01	<0.01	**0.46**
5 - 6	<0.01	<0.01	<0.01	<0.01	0.02	0.05	0.03	<0.01	<0.01	<0.01	**0.11**
6 - 7	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	**0.04**
7 - 8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	**0.02**
8 - 9	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	**0.01**
9 - 10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
10 - 11	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
11 - 12	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
12 - 13	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
13 - 14	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**

Table 3.5 Percent Occurrence of Peak Wave Period against Significant Wave Height for Grid Point 6001523: June, July, August

Significant Wave Height (m)	Peak Wave Period (s)										Total
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	>18	
14 - 15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
>15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
Total	**0.00**	**0.28**	**19.53**	**55.44**	**18.44**	**3.45**	**1.59**	**0.86**	**0.38**	**0.04**	**100.00**

Table 3.6 Percent Occurrence of Peak Wave Period against Significant Wave Height for Grid Point 6001526: September, October, November

Significant Wave Height (m)	Peak Wave Period (s)										Total
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	>18	
0 - 1	<0.01	0.08	2.08	1.65	1.65	0.53	0.32	0.03	<0.01	<0.01	**6.35**
1 - 2	<0.01	0.20	11.78	18.28	8.24	3.59	1.76	0.25	0.01	<0.01	**44.12**
2 - 3	<0.01	<0.01	0.75	16.11	7.45	2.71	1.15	0.48	0.02	<0.01	**28.65**
3 - 4	<0.01	<0.01	<0.01	2.84	7.20	1.78	0.41	0.22	<0.01	<0.01	**12.44**
4 - 5	<0.01	<0.01	<0.01	0.04	3.47	1.19	0.36	0.10	<0.01	<0.01	**5.15**
5 - 6	<0.01	<0.01	<0.01	<0.01	0.64	0.94	0.21	0.08	<0.01	<0.01	**1.89**
6 - 7	<0.01	<0.01	<0.01	<0.01	0.03	0.62	0.16	0.03	<0.01	<0.01	**0.83**
7 - 8	<0.01	<0.01	<0.01	<0.01	<0.01	0.21	0.10	0.01	<0.01	<0.01	**0.32**
8 - 9	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.06	<0.01	<0.01	<0.01	**0.12**
9 - 10	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.05	<0.01	<0.01	<0.01	**0.06**
10 - 11	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	**0.03**
11 - 12	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	**0.01**
12 - 13	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	**0.01**
13 - 14	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.01**
14 - 15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
>15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.00**
Total	**0.00**	**0.28**	**14.61**	**38.91**	**28.67**	**11.62**	**4.60**	**1.25**	**0.05**	**0.00**	**100.00**

Table 3.7 provides extreme wave conditions for the grid point 6001526 for various return periods. The methodology proposed by Goda (2000) based on the peak-over-threshold method was used to calculate the extreme event with different return periods. The results from extreme event analysis are presented in Table 3.7 using Weibull (k=1.4) distribution and 95% confidence level. Other distributions (Fisher-

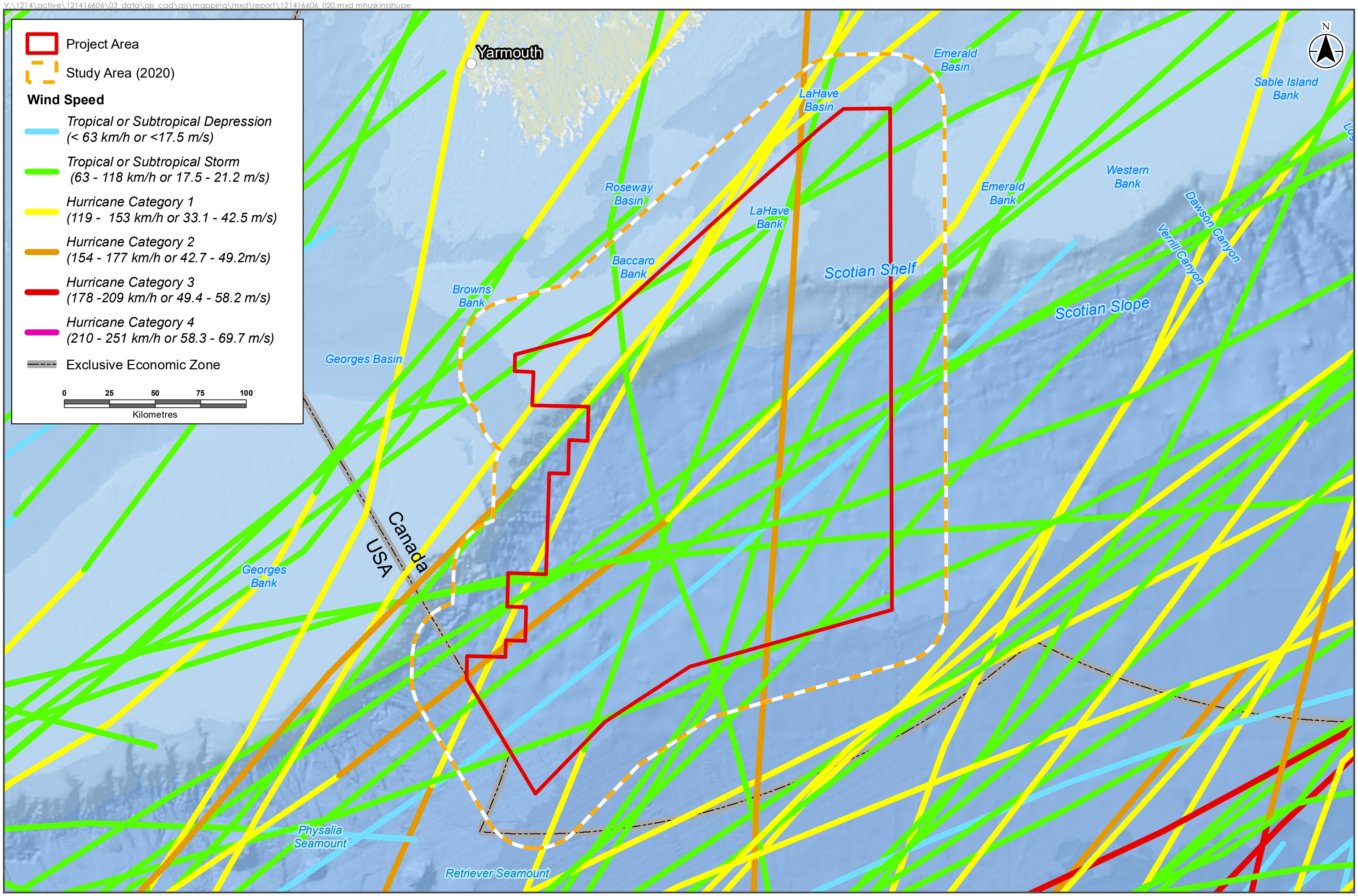
Tippett—I, Weibull with k=0.75, k=1 and k=2) were also checked presenting lower correlation overall. The analysis was conducted for waves coming from the west and southwest, as those were the most common wave directions observed at the site. The H_s was transformed to the maximum wave height (H_{max}) using a 1.6 factor.

Table 3.7 Extreme Wave conditions at the Grid Point 6001526

Direction	SW			W		
Return Period (year)	H_s (m)	T_p (s)	H_{max} (m)	H_s (m)	T_p (s)	H_{max} (m)
1	6.8	11.5	10.8	7.3	11.5	11.7
5	11.4	14.4	18.2	10.2	12.9	16.3
10	12.9	15.4	20.6	11.1	13.4	17.8
25	14.3	16.2	22.8	12.0	13.9	19.1
50	16.0	17.3	25.6	13.0	14.4	20.8
100	17.2	18.1	27.6	13.8	14.8	22.0
5	6.8	11.5	10.8	7.3	11.5	11.7

[1]Based on 65 years of MSC50 hourly wave data from 1954 to 2018

In the North Atlantic, hurricane season occurs from June 1st to November 30th, and peaks in late August and September. Hurricanes and tropical storms occurring on the Scotian Shelf and Slope typically form in the warmer, more southern water of the tropics, and move northward along the coast. Storms tend to decrease in intensity as they move into the colder waters of the North Atlantic. Hurricane and tropical or subtropical storm tracks from 1980 to 2020 are shown in Figure 3.8. Some of the most recent hurricanes include Dorian (Sept 2019), Dolly (June 2020) and Kyle (Aug 2020), with only hurricane Dorian passing through the Study Area. During 1980 to 2020, a total of 19 storms passed through the Study Area, which included two Category 2 hurricanes (categorized by wind speeds of 154-177 km/h), three Category 1 hurricanes (categorized by wind speeds of 119-153 km/h), 13 tropical or subtropical storms (categorized by wind speeds of 63-118 km/h), and one tropical or subtropical depression (categorized by wind speeds <63 km/h). The Category 2 hurricanes included hurricane Juan (Sept 2003) and hurricane Gustav (Sept 2002), and the Category 1 hurricanes included hurricane Hortense (Sept 1996), hurricane Bill (Aug 2009) and hurricane Dorian (Sept 2019). Of the 19 storms occurring in the Study Area, five occurred in the 1980s, five occurred in the 1990s, eight occurred in the 2000s and one occurred in the 2010s.



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

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

NAD 1983 UTM Zone 20N

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

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Hurricanes and Tropical or Subtropical Depressions/Storms between 1980 and 2020

Figure 3.8

3.1.3 Overview of Physical characteristics of Study Area

Table 3.8 summarizes physical characteristics of the Study Area.

Table 3.8 Overview of Physical Characteristics

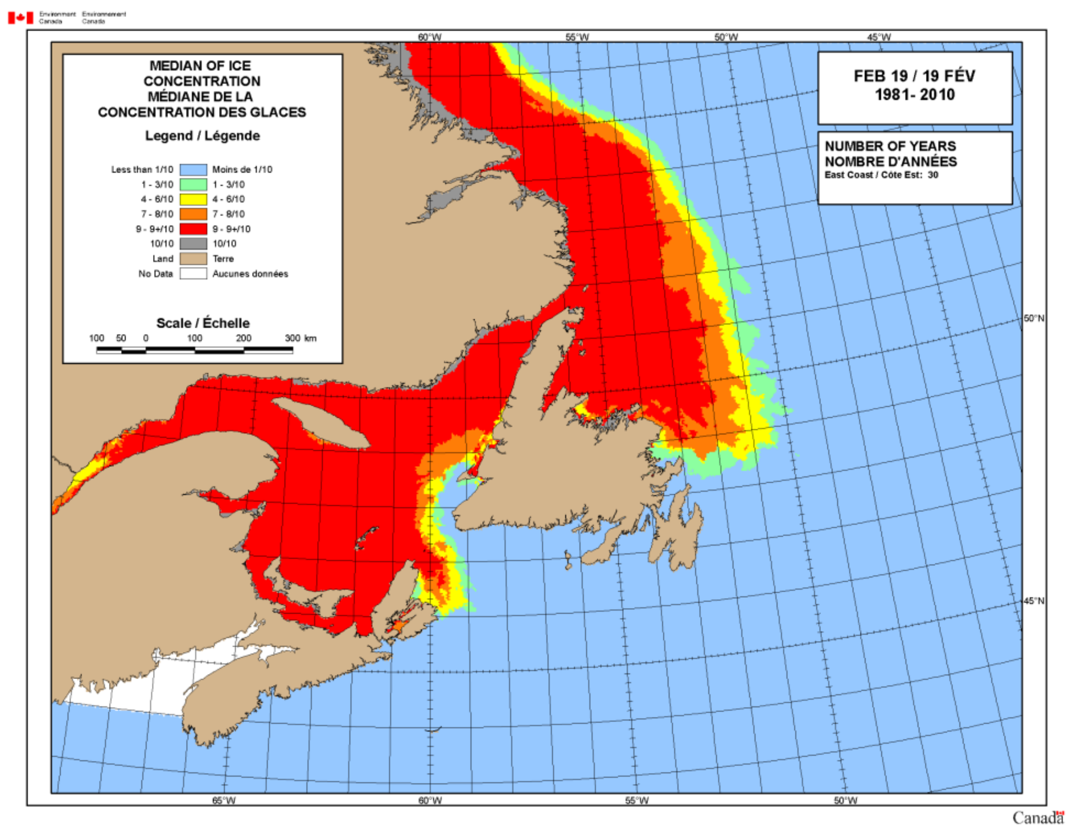
Physical Characteristics	
Seabed Characteristics (refer to Figure 3.1)	• The western shelf is characterized by a wide and complex network of valleys, ridges, and small gravel covered banks. • Basins have been smoothed by glaciers and recently filled with the deposition of silt. These basins span across the middle of the Scotian Shelf. In certain areas, boulder-covered till ridges protrude through the mud, silt, and pockmarks. • There are several large and shallow banks that are the defining features of western shelf and outer banks. These include the Sable Island, Western, Emerald, LaHave, Baccaro, Browns, and Georges banks. Of these, portions of Emerald, Browns, LaHave and Georges banks are located within the Study Area. • The shallow outer banks tend to have sand and/or gravel benthic structure, with some areas having an extensive shell bed cover. Storms and currents constantly shape the tops of the banks forming sand into a wide variety of ridges, waves and ripples. • The deeper basins are covered in fine silt and clay interspersed with coarse glacial material. • Saddles are areas of slightly deeper water that occur between the banks on the outer Scotian Shelf. Saddles are present between Emerald Bank, LaHave Bank, and Browns Bank on the western Scotian Shelf. They occur at depths less than 200 m and are covered by sand which contains minor amounts of clay, silt and gravel. The saddles form an entrance to the basins of the middle Scotian Shelf for deep warmer slope water masses. • The Western Scotian Slope has a gentle gradient with a relatively smooth seabed. It is an area of low, gentle hills and valleys, sloping towards the Scotian Rise and abyssal plain. Compared to the Eastern Scotian Slope, the western slope has a less dynamic seabed, with fewer canyons. There are a few shallow gullies which reach depths of up to 500 m. The area is extremely productive, hosting many marine mammals and large fish during important life history periods, including feeding and migration. • Between the canyons the seabed is crisscrossed by furrows and pits created by icebergs in the past. This area continues to erode creating a natural disturbance, which may enhance biological productivity. • The Northeast Channel is the largest and deepest channel connecting the open Atlantic Ocean to the Gulf of Maine. It crosses the outer continental shelf between Georges and Browns Banks, connecting the basins of the Gulf of Maine at depths between 200 m to 300 m. Glacial till, a mixture of clay, silt, sand, gravel, and boulders covers large areas of the floor of the Northeast channel. The Northeast Channel is located outside the Study Area. Source: DFO 2011b; Worcester and Parker 2010; Zwanenburg et al. 2006; WWF 2009; Li and King 2007
Climatology	• Climate is strongly influenced by the warm Gulf Stream and the cold Labrador Current • Daily Air Temperature Range: -1.4°C (February) to 17.8°C (August) • Extreme Minimum Air Temperatures: -19.4°C (January) to 4.4°C (August) • Extreme Maximum Air Temperatures: 12.8°C (February) to 29.6°C (July) • Average Monthly Precipitation: 95.2 mm (July) to 147.0 mm (November) • Extreme Daily Precipitation: 66.00 mm (April) to 166.1 mm (November) • Average days per year with fog: 127 days Source: Environment Canada 2012a

Table 3.8 Overview of Physical Characteristics

<table>
<tr><th colspan="2">Physical Characteristics</th></tr>
<tr><td>Sea Ice and Icebergs
(Figure 3.9)</td><td>

- Ice cover is rare in the offshore of the Scotian Shelf and Slope.
- Sea ice is generally transported out of the Gulf of St. Lawrence through the Cabot Strait.
- Ice can be transported from the Cabot Strait by northwesterly winds and ocean currents onto the Eastern Scotian Shelf, although this is very rare.
- Sea ice which travels onto the Scotian Shelf from the Gulf of St. Lawrence will dissipate and melt before reaching the Central and Western sections of the shelf.
- Localized sea ice can form in coastal areas but will dissipate before entering the Study Area.

Source: DFO 2011b



Source: Environment Canada 2012b

Figure 3.9 Maximum Extent of Median Sea Ice Concentration (1981-2010)
</td></tr>
<tr><td>Wind</td><td>

- Average Wind Speeds: 5.6 m/s (20.2 km/h) (Summer) to 10.5 m/s (37.8 km/h)(Winter)
- Most Common Wind Direction (from): West-Northwest (Winter, Spring, Fall) and Southwest (Summer)
- Maximum Hourly Wind Speed: 30.9 m/s 111.2 km/h) (Summer) to 30.96 m/s (113 km/h)(Winter)

MSC50 Grid Point 6001526 (1954-2018) Source: Meteorological Service of Canada (MSC) 2020
</td></tr>
</table>

Table 3.8 Overview of Physical Characteristics

Physical Characteristics	
Waves	• Mean significant wave height, Hs (m): 1.46 in summer to 3.09 in winter • Maximum Hs (m): 12.79 in winter to 15.28 in spring MSC50 Grid Point 6001526 (1954-2018) Source: Meteorological Service of Canada (MSC) 2020
Ocean Currents	• Circulation patterns are governed by the complex seafloor topography and by the influence of three major currents: o Cool, relatively fresh (less saline) Nova Scotian Current derived from the outflow of the Gulf of St. Lawrence flowing along the inner, middle, and outer portions of the shelf o Cold Shelf Break Current (Influenced by Labrador Current from the north) flowing along the shelf edge o Warm, higher saline Gulf Stream flowing northeast over the Scotian Slope and mixing with the Labrador Current, creating “slope water”. • The Nova Scotia Current flows in a southwesterly direction close to the coastline. As it reaches the Halifax area it branches in an offshore direction, where it joins the Shelf Break Current and continues to flow southwesterly along the shelf break. • Overall flow is from the Northeast to southwest, with speeds ranging from 0.055–0.3 m/s. Currents are stronger in the winter and weaker in the summer. Sources: Worcester and Parker 2010; Zwanenberg et al. 2006; Brickman and Drozdowski 2012; Kennedy et al. 2011

Table 3.8 Overview of Physical Characteristics

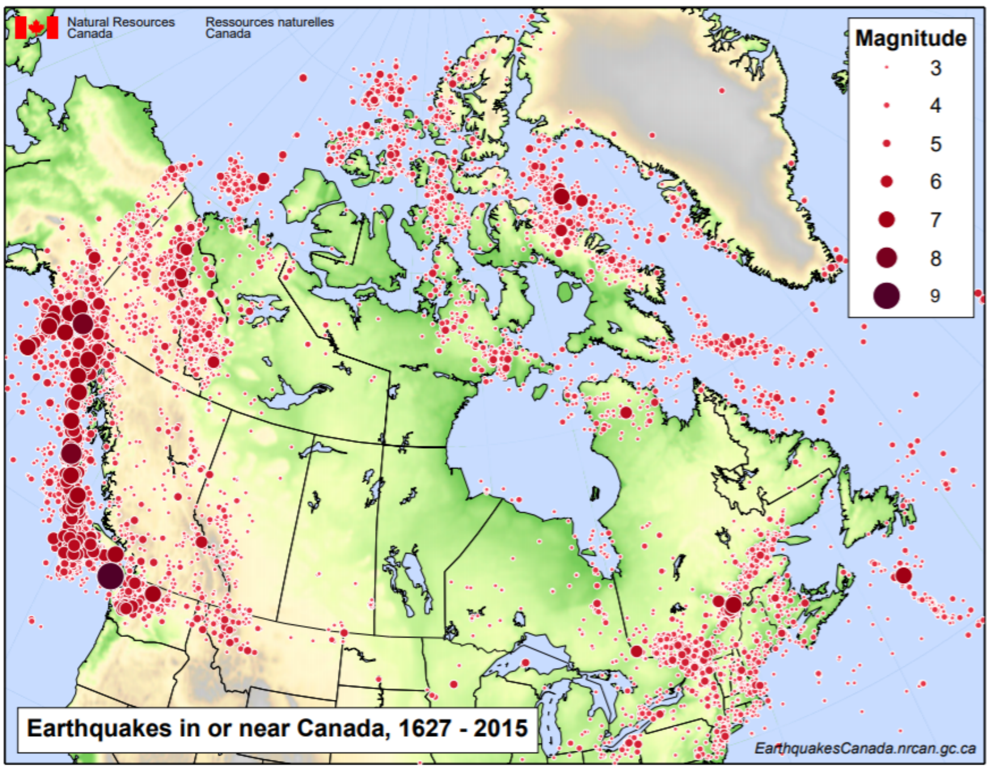
Physical Characteristics	
Water Temperature	• The water temperatures found in the Western Scotian Shelf and the Gulf of Maine are among the most variable in the North Atlantic Ocean. • The Western Scotian Shelf is generally warmer than the Eastern Scotian Shelf. • Warm water from the Gulf Stream enters the Western Scotian Shelf between Browns Bank and Western Bank. Warm water can also be found entering the shelf via Verill and Dawson Canyons. • As a result of the influence from the Gulf Stream and from increased vertical mixing in the area, the Western Scotian Shelf has a more dynamic temperature regime than that found in the Eastern Scotian Shelf. • Upper 50 m of water warms in the summer months. • The large variability in the coastal waters of the Scotian Shelf has a significant influence on sound propagation. A strong surface layer condition occurs in many areas during July-October when solar heating has a high effect on surface temperatures. The higher temperature near the surface is often associated with lower salinity produced by runoff that floats on top of the dense ocean water. Sound travels faster in warm water than cold resulting in a net downward refraction of horizontally travelling sound waves. This produces more bottom reflections per kilometre and higher transmission loss. • From November to May, the surface waters are normally colder than the water at depth, resulting in an upward refraction or neutral direction. During these conditions when sound waves are not refracted or are refracted upwards, the effect of the bottom on transmission loss is reduced. • Surface water temperatures correlate to air temperatures and have therefore exhibited a general warming trend in recent years. Between 2010 and 2017, surface and deep-water temperatures were above normal for the Scotian Shelf, with 2012 being the warmest on record. • Both surface water temperature and ocean bottom temperatures have showed a general warming trend between the mid-1980s to 2017. • In 2016-2017, sea surface temperatures in the Study Area ranged from approximately 0°C in February and March, to more than 20°C in August. Sources: Worcester and Parker 2010; DFO 2011b; Davis et al. 1998; Johnson et al. 2018; DFO 2019a
Salinity	• Coastal waters: 30-32 parts per thousand (ppt) • Nova Scotian Current: 31-33 ppt • Labrador Current: 34-36 ppt • Gulf Stream 34-36 ppt • Salinity is lower near-coast than off-shelf and increases from east to west. Sources: Worcester and Parker 2010; Li 2014
Stratification	• There have been increases in stratification in recent years on the Scotian Shelf. • Strong stratification can inhibit vertical mixing and cause depleted dissolved oxygen levels at depth. Increases in stratification can also concentrate phytoplankton, increasing primary productivity. • Stratification is weaker in the spring than in the fall. • Bottom dissolved oxygen concentration is relatively high within the Study Area on the LaHave Bank, and on the adjacent Emerald, and Western Banks. Lower dissolved oxygen concentrations can be found at deeper depths in the LaHave and Emerald Basins. Sources: Worcester and Parker 2010; Zwanenburg et al. 2006; DFO 2011b; Li 2014

Table 3.8 Overview of Physical Characteristics

<table>
<tr><th colspan="2">Physical Characteristics</th></tr>
<tr><td rowspan="2">Seismic Activity
(Figure 3.10)</td><td>

Significant Earthquakes are a rare occurrence in southeastern Canada with five zones of high earthquake activity, with the closest zone being the Laurentian slope zone.
The area is located off Canada’s east coast approximately 250 km south of Newfoundland.
In 1929, a 7.2 magnitude earthquake triggered a large underwater landslide in the Atlantic Ocean, triggering a tsunami that killed 27 people on the Burin Peninsula.
Other earthquakes as large as magnitude 5.3 have been recorded in the area.
Earthquakes in this area are generally associated with fault movement in the ocean floor.

Source: NRCan 2013</td></tr>
<tr><td>



Source: NRCan 2018

Figure 3.10 Earthquakes in or near Canada (1627-2015)</td></tr>
</table>

3.2 BIOLOGICAL CHARACTERISTICS

3.2.1 Plankton

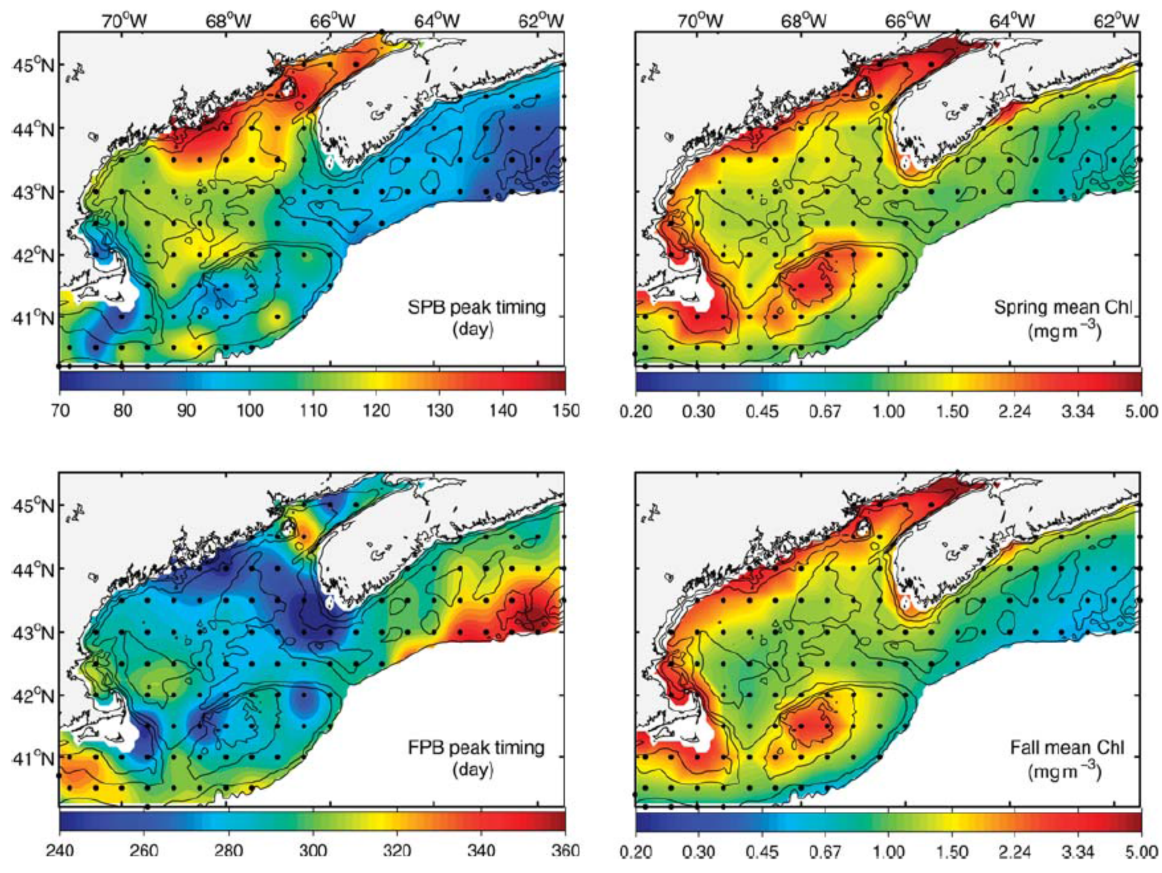
3.2.1.1 Phytoplankton

Phytoplankton are the base of the marine food web and as a result, their production sets an upper limit on the production of all higher trophic levels (Worcester and Parker 2010). Phytoplankton are distinctive among ocean biota in that they derive their energy from sunlight and structural requirements from nutrients in the surrounding water (DFO 2011a), and they play an important role in drawing carbon dioxide out of the atmosphere (Ross et al. 2017). On the Scotian Shelf, diatoms and dinoflagellates are generally the forms with the largest cell size and most recognized types of phytoplankton. Their abundance is based on the balance between growth and mortality, which may be strongly influenced by the complex physical oceanographic features of the shelf. There is a distinctive cycle to their abundance characterized by widespread spring and fall blooms related to a high concentration of nutrients, increased wind speeds, and sunlight in the water column.

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

Blooms can vary in temporal and spatial scales. Recent trends in the magnitude and duration of the spring bloom on the Scotian Shelf indicate that blooms are beginning earlier now than they did in the 1960s and 1970s and are more intense and longer in duration (Worcester and Parker 2010). The structure and composition of the phytoplankton community in the Gulf of Maine area, including the Western Scotian Shelf, has been described by Li et al. (2011a). Diatoms (which have silica shells) and dinoflagellates (which can swim with flagella) are the most taxon rich groups in these waters (Li et al. 2011a; DFO 2013a). Cyanobacteria as well as 18 classes of other microalgae also occur in the waters of the Western Scotian Shelf. The spring bloom is typically dominated by diatoms, with dinoflagellates contributing significantly to blooms later in the season.

Specifically, on the Western Scotian Shelf and in the Gulf of Maine regions, changes in the intensity of low-salinity Scotian Shelf Current inflows can significantly affect the spring blooms in these areas (Song et al. 2010). Other environmental factors such as surface winds can influence the spring bloom dynamics by changing the strength and depth of vertical mixing. Figure 3.11 depicts the peak timing and mean chlorophyll levels associated with the spring and fall blooms on the Western Scotian Shelf and Gulf of Maine areas. In general, the spring bloom occurs earlier in the eastern regions of the shelf and later on the Western Scotian Shelf and Gulf of Maine (Johnson et al. 2018). The opposite is true for the fall bloom, with the Western Scotian Shelf peak bloom occurring earlier than the Eastern Scotian Shelf bloom (Song et al. 2010). On the Western Scotian Shelf the average peak bloom occurs from mid-March to mid-April. The spring bloom on the Western Scotian Shelf is strong and short-lived, with a late and weak fall bloom counterpart (Song et al. 2010).



Source: Song et al. 2010.

Notes: SPB = spring phytoplankton bloom; FPB = fall phytoplankton bloom.

Figure 3.11 Spatial Distribution of the Spring Bloom (top panel) and Fall Bloom (lower panel) by Day of Year (left panel) and Concentration of Chlorophyll during Blooms (right panel)

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

3.2.1.2 Zooplankton

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

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

Zooplankton biomass on the Scotian Shelf and in the eastern Gulf of Maine is normally dominated by large, energy-rich copepods, mainly *Calanus finmarchicus*, which are important prey for planktivorous fish such as herring and mackerel, North Atlantic right whales, and other pelagic species (Johnson et al. 2018). There is a linkage between the endangered North Atlantic right whale and *Calanus* spp. as right whales mainly feed on lipid-rich, late copepodite stages of *Calanus* spp. in areas where prey densities are sufficient to support their energetic needs (Plourde et al. 2019). For example, Roseway Basin, which is located in the Study Area, is a foraging area for right whales feeding on *Calanus* (Davies et al. 2015). Further, recent shifts in right whale habitat in the region, for example, have been linked to climate-related shifts in copepod distribution, and resulted in large additional whale mortality due to emerging new threats in their new feeding habitat (Record et al. 2019). There is also a linkage between jellyfish and leatherback sea turtles (*Dermochelys coriacea*) as this species migrates to temperate Atlantic Canadian waters every summer to feed on gelatinous zooplankton (Nordstrom et al. 2020).

Calanus species require deep water to overwinter and can be found in dense aggregations at depths >400 m along the Scotian Slope (Head and Pepin 2007). The seasonal life cycle of *C. finmarchicus* involves reproduction and development in surface waters before overwintering at depth (Sören Häfker et al. 2018). *C. finmarchicus* are most abundant in surface waters during the spring and summer of each year. During late summer and fall it undergoes a period of diapause at depth, usually during the C5 stage (Durbin and Casas 2006).

Deep basins found on the Scotian Shelf contain high concentrations of *C. finmarchicus*, *C. glacialis*, and *C. hyperboreus* at water depths below 200 m (Sameoto and Herman 1990). These high concentrations of *Calanus* spp. suggest that the basins have higher levels of *C. finmarchicus* production than the adjacent shelf with mean depths less than 100 m (Sameoto and Herman 1990). Further sampling by Herman et al. (1990) also indicated that the deep Scotian Shelf basins harbor large populations of zooplankton during fall and winter which consist mainly of stages IV and V of *C. finmarchicus*, *C. hyperboreus*, and *C. glacialis*. This winter storage mechanism is also a dominant source of young copepedite stages in surface waters during the spring (Herman et al. 1990).

At the Halifax-2 sampling station, located on the Scotian Shelf, zooplankton biomass and total abundance are typically lowest in January-February and increase to maximum values in April, similar to the spring phytoplankton bloom peak timing, before declining to low levels again in the fall (Johnson et al. 2018).

The structure of the zooplankton community of the Scotian Shelf was investigated during eight cruises between August 1978 and September 1980 (Tremblay and Roff 1983). Zooplankton taxa were grouped as inshore (characterized by Arctic species), intermediate (the dominant shelf species), or offshore (expatriate species). Inshore species included *Temora longicornis*, *Sagitta elegans*, *C. glacialis*, *Aglantha digitale*, *Metridia longa*, *Parathemisto gaudichaudii*, *Pseudocalanus minutus* and *C. hyperboreus*. Intermediate species included *Centropages typicus*, *Limacina retroversa*, *C. finmarchicus*, *Fritillaria borealis*, *Oithona similis* and *Metridia lucens*. Offshore species included *Nanomia/Physophora*, *Paracalanus parvus*, *Microsetella norvegica*, *Euchaeta norvegica*, *Oithona atlantica*, *Sagitta tasmanica*, *Clausocalanus* sp., *Scolecithricella minor*, *Microcalanus pusillus*, siphonophores, ostracods, *Euchirella rostrata*, *Candacia armata*, *Mecynocera clausi*, *Rhincalanus nasutus*, *Pleuromamma borealis*, *Nannocalanus minor* and *Calocalanus* sp.

Durbin and Casas (2006) assessed the abundance and distribution of copepods on Georges Bank during the winter/spring period (January to June) from 1995 to 1999. The most abundant species were *C. finmarchicus*, *Metridia* spp. (primarily *M. lucens*), *Pseudocalanus* spp., *Oithona* spp. (primarily *O. similis*), *Temora longicornis*, *Centropages typicus*, and *C. hamatus*. The first four of these taxa had off-bank sources while the last three had on-bank sources (Durbin and Casas 2006).

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

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

3.2.1.3 Ichthyoplankton

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

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

3.2.2 Bacterial Communities

Bacterial communities consist of prokaryotes (single-celled organisms including bacteria and archaea) which make up the smallest free-living cells in any pelagic ecosystem. Bacteria can have a variety of energy sources with some using light as their primary energy source (photoautotrophs), or as an auxiliary source (photoheterotrophs), with most bacteria using organic material as an energy source (heterotrophs) (DFO 2011a). Since most bacteria are secondary producers (rely on organic material for energy) their abundance can be correlated to the abundance of phytoplankton communities. Most bacteria rely on material derived from phytoplankton, including waste exuded from plankton cells, cell autolysis, viral lysis, and organic material released from grazers feeding on phytoplankton (DFO 2011a). Bacteria, specifically heterotrophic bacteria, are natural microbial agents which can remediate hydrocarbon contamination in the marine environment. Crude oil can be found naturally in the marine environment from natural seeps in the ocean floor (America Society for Microbiology [ASM] 2011).

3.2.3 Algal Communities

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

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

Table 3.9 Marine Algae

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

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

3.2.4 Corals and Sponges

Corals and sponges provide marine fish and invertebrates with protection from strong currents and predators and can serve as nurseries for larval and juvenile life stages, feeding areas, breeding and spawning areas, and resting areas (Campbell and Simms 2009). They also offer protection by locally enhancing biodiversity (e.g., Hawkes et al. 2019). Generally, they are long-lived with episodic recruitment making recovery over 10 to 15-year time frames unlikely or impossible (FAO 2009).

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

The Scotian Shelf and Slope, including the Study Area, support a high diversity of corals and sponges (Cogswell et al. 2009). The Northeast Channel Coral Conservation Area is located within the Study Area on the southeast corner of Georges Bank, in between Georges and Browns Banks (Deller 2012) (refer to Section 3.2.8). In June of 2002, following successive video surveys conducted by DFO and Dalhousie University, the Northeast Channel Coral Conservation Area was established by DFO (Cogswell et al. 2009). The surface area for conservation is 424 km^2 and consists of a restricted bottom fishing zone (90% of the area) and a limited bottom fishing zone (10% of the area). The area was chosen based on having the highest density of octocorals, specifically the bubblegum coral, *Paragoria arborea*, and the seacorn coral, *Primnoa resedaeformis*, in the Maritimes. In addition to having the highest concentrations of these corals, there was also evidence of recent disturbances to corals in the area from bottom fishing activities (Cogswell et al. 2009). It is acknowledged that complete surveys of the canyons have not yet been completed in the region and there may be areas with higher densities.

Corsair and Georges Canyons Conservation Area (see Section 3.2.8) contains undersea canyons located south of Georges Bank. High densities of gorgonial corals, including bubblegum coral (*Paragoria arborea)* and sea corn coral *(Primnoa resedaeformis*) have been documented in these canyons (Metaxas et al. 2019). In 2016, this area was established as a Conservation area, and all bottom contact fishing is restricted, except for two small areas that allow red crab fishing (DFO 2018a). Recently, Metaxas et al. (2019) found the locally densest aggregations of *P. arborea* that have been detected on the continental slope off Nova Scotia. *P. arborea* was very abundant at depths of 484-856 m in Corsair Canyon and some colonies were > 2 m high (Metaxas et al. 2019). *P. resedaeformis* was also recorded in Corsair Canyon at similar depths (Metaxas et al. 2019). Georges Canyon was also surveyed; however, only a few *P. arborea* and *P. resedaeformis* colonies were observed, and most of these were found around a single location (Metaxas et al. 2019). Continued scientific surveys and monitoring is planned for this area (DFO 2018a).Using primarily multispecies trawl survey data and *in situ* benthic imagery observations, DFO has conducted species distribution modelling (Beazley et al. 2016, 2018) and kernel density analysis to delineate significant benthic areas for corals and sponges for the Maritimes Region, focusing on the Scotian Shelf and Slope (see Kenchington et al. 2016; Beazley et al, 2016, 2018; and Figure 3.15). Table 3.10 summarizes characteristics of corals in the Study Area.

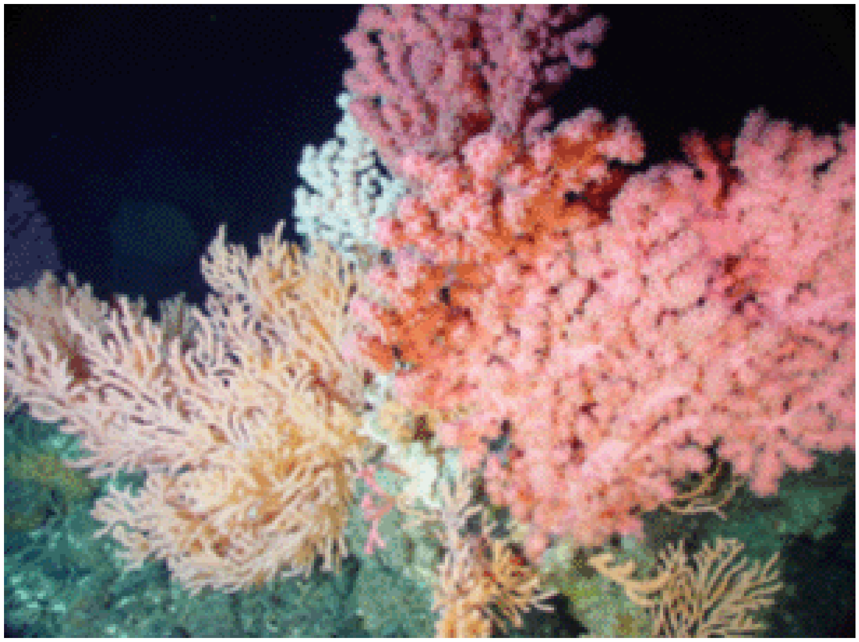
Table 3.10 Cold-Water Corals

General Characteristics	• Suspension-feeding invertebrates with delicate appendages that capture food particles from the water column. • Do not contain symbiotic algae and can live at depths without the influence of sunlight. • Most require a hard substrate for attachment; sea pens and some gorgonian corals can anchor into soft sediment, where they provide shelter and oxygenate the sediments. • Occur in many sizes and shapes, with some species forming reef structures. • Slow-growing, some may be over 100 years old. • Two major groups occur on the Scotian Shelf: hard/stony corals (*Scleractinia*) and octocorals, some of which are solitary while others form reefs. • Octocorals include sea pens, sea whips, sea fans, and “soft corals”. • The largest octocorals on the Scotian Shelf are the gorgonian corals, which include bubblegum (*Paragorgia arborea*) and seacorn corals (*Primnoa resedaeformis*) (Figure 3.12).
Locations within the Study Area	• In general, corals are most likely to occur in areas with complex topography and strong currents, although different families of coral can exhibit different habitat preferences. • Depth and slope are important predictors for the presence of sea pen and large and small gorgonian corals (Figures 3.12 and 3.13). • Large concentrations of large and small Gorgonacea can be found along the edges of the shelf, including the Baccaro and Brown’s Banks, within the Study Area (Kenchington et al. 2010; Kenchington et al. 2016). • Large gorgonian corals are primarily found in areas containing cobble, boulder, or large rocky outcrops.

Table 3.10 Cold-Water Corals

	• Cup corals (*Flabellum* spp.) can be found on the soft sediments in the basins of the Scotian Shelf and Gulf of Maine. The Scotian Slope contains many areas where cup corals have been collected and observed (DFO 2006). • Soft corals (dead man's fingers, *Alcyonium digitatum,* and red soft coral, *Gersemia rubiformis*) are widespread on the Scotian Shelf where there is a suitable rock substrate for attachment (DFO 2006). • Sea pens and small gorgonians have been found on soft sediments (Figure 3.12). • Significant benthic area for large gorgornians has been identified in the north and western portions of the Study Area on the Scotian shelf break and Slope, and in the Northeast Channel (Figure 3.15) (Kenchington et al. 2010; Kenchington et al. 2016). • Significant benthic area for sea pens has been identified in the central portion of the Study Area on the Scotian shelf break and Slope, and on the LaHave Bank and in the LaHave Basin (Figure 3.15) (Kenchington et al. 2010; Kenchington et al. 2016). • Significant benthic area for small gorgonians has been identified on the shelf break and slope in the central portion of the Study Area (Figure 3.15) (Kenchington et al. 2010; Kenchginton et al. 2016).

Table 3.10 Cold-Water Corals

Locations within the Study Area	 Source: DFO 2007b **Figure 3.12 Sea corn (*Primnoa resedaeformis*; at left of photograph) and Bubblegum coral (*Paragoria arborea*; at right of photograph) 900 m below surface in Northeast Channel**  Source: DFO 2011c **Figure 3.13 Sea pens (*Pennatula* sp.) in Emerald Basin**

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

At least 34 species of sponge have been identified off the Atlantic coast. Table 3.11 summarizes the general characteristics of Scotian Shelf sponges and potential distribution in the Study Area. Figure 3.15 displays significant benthic areas for corals and sponges on the Scotian Shelf (data courtesy of DFO).

Table 3.11 Sponges

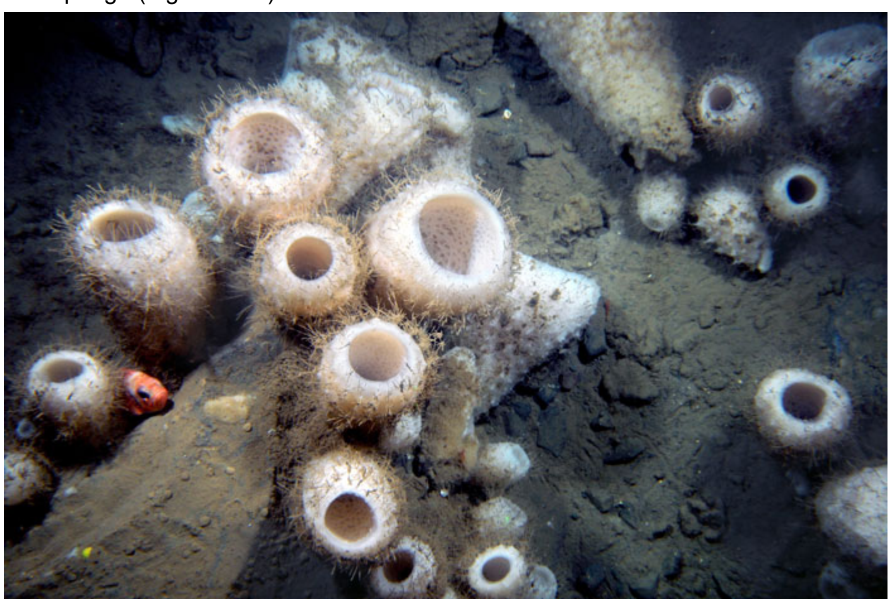
General Characteristics	• Marine invertebrates that attach themselves to bottom substrates. • Filter feeders, which are found at all water depths from coastal waters to the abyssal plain. • Sponges provide substrate, shelter, and food for many other species, locally enhancing biodiversity. Dense aggregations (sponge grounds) are key in nutrient cycling and benthic-pelagic coupling. • Sponges host a rich and diverse microbial fauna and are an important source of marine natural products. • Russian hat glass sponge *(Vazella pourtalesi)*, one of the larger sponges present on the Scotian Shelf, is a rare, fragile and barrel-shaped structure forming species of glass sponge (Figure 3.14).  Source: DFO 2013b **Figure 3.14 *Vazella pourtalesi* (Russian Hats) on the Scotian Shelf**
Locations within Study Area	• Sponge species (Phylum Porifera) are found throughout the Study Area. • Concentrations of *Vazella pourtalesi* are found in Emerald and LaHave Basins on the central Scotian Shelf and in deepwater between Emerald and LaHave Banks near the edge of the Scotian Shelf. Globally unique sponge grounds containing large aggregations of *Vazella pourtalesi* are found on Sambro Bank and Emerald Basin. This species is otherwise only known to exist in the Gulf of Mexico adjacent to Florida, and along the eastern seaboard of the USA but those populations only contain individuals or small aggregations.

Table 3.11 Sponges

	• In 2013, DFO closed areas of Sambro Bank and Emerald Basin to bottom–contact fishing to help protect the densest concentrations of *Vazella pourtalesi*. Together these conservation areas encompass 259 km^2. However, over 99% of the sponge's predicted distribution remains unprotected. • Significant benthic areas for sponges are located northeastern and northwestern portions of the Study Area.

Sources: DFO 2017a; DFO 2011b; Kenchington et al. 2010; DFO 2013b; Beazley et al. 2016, 2018

It is also noted that these invertebrates have been a focus of research on marine natural products (MNPs) namely drug discovery and tissue engineering, with > 198 antifouling compounds obtained from sponges, gorgonians and soft corals (Qi and Ma 2017). Sponges and their associated microorganisms are the richest and most prolific source of MNPs, comprising more than 30% of those described to date with > 2,400 sponge-derived natural products from 671 species of sponges reported between 2001 and 2010 alone (Mehbub et al. 2014). *Vazella pourtalesi* (Russian Hat sponge) has a rich and unique reservoir of microbial biodiversity (Busch et al. 2020).

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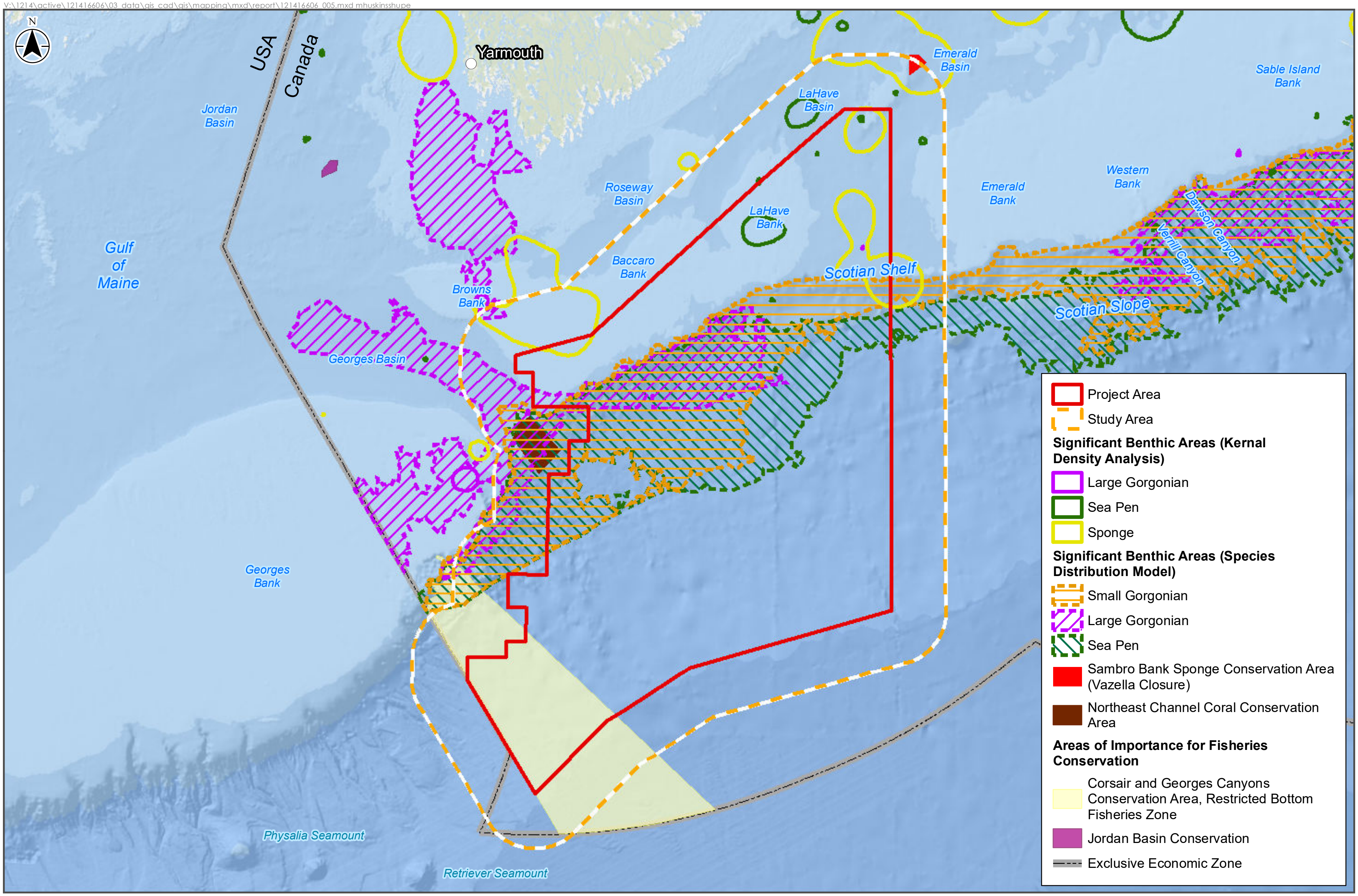

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Coral and Sponge Significant Benthic Areas

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

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Figure 3.15

3.2.5 Fish and Invertebrates

Key fisheries species on the Scotian Shelf and Slope are described in three categories: pelagic fish, groundfish, and invertebrates (e.g., shellfish). Pelagic organisms live in the water column and at the surface and include highly migratory species such as tuna, swordfish, and sharks. Groundfish spend most of their life near the bottom of the ocean and include the gadids (cod, pollock, and haddock), skates, and flatfishes. Groundfish are a major component of Scotian Shelf fisheries. The Project Area is a significant spawning and nursery area for haddock and is also an important spawning area for other groundfish including cod, plaice and yellowtail flounder. The Western/Emerald Banks Conservation Area (Haddock box) is a significant spawning and nursery ground for haddock. It is also an important habitat for American cod, American plaice and winter skate, which are species that are considered to be depleted fisheries (DFO 2019b). Invertebrates play an important role in Scotian Shelf fisheries with over 28 species that have commercial value including crustaceans, bivalves, snails, squid, and echinoderms. A designated lobster broodstock area occurs in the northwestern portion of the Study Area, on and around Browns Bank.

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

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

Common Name	Scientific Name	Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Species at Risk (SARA Schedule 1 listed and / or COSEWIC assessed)														
American plaice	*Hippoglossoides platessoides*	Nearshore: Halifax to Liverpool Georges to Banquereau Banks and Edge, Roseway Basin												
Atlantic cod	*Gadus morhua*	Nearshore: Halifax to Yarmouth Georges Bank and scattered throughout the Western Scotian Shelf, with higher concentration in Eastern Scotian Shelf												
Atlantic wolffish	*Anarhichas lupus*	Nearshore: south of Bridewater and southwest NS Roseway and LaHave Basins												
Cusk	*Brosme brosme*	Georges Basin, Roseway Basin, Browns to Western Sable Island Bank and edges												
Redfish (acadian and deepwater)	*Sebates fasciatus* *Sebastes mentalla*	Scattered over entire Scotian Shelf and Slope												
Porbeagle	*Lamna nasus*	Outside of Study Area												
Roundnose grenadier	*Coryphaenoides rupestris*	Scotian Slope with the highest abundance on LaHave Bank												
Shortfin Mako	*Isurus oxyrinchus*	Lack of data has prevented any identification of habitats necessary for critical life functions (e.g., mating, pupping)												
Smooth skate	*Malacoraja senta*	Roseway Basin												
Spiny dogfish	*Squalus acanthias*	Roseway, LaHave, and Emerald Basins												

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

Common Name	Scientific Name	Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Spotted wolffish	*Anarchias minor*	Outside of Study Area												
Thorny skate	*Amblyraja radiate*	Roseway and LaHave Basins Emerald to Banquereau Banks												
White hake	*Urophycis tenuis*	Georges Bank, Roseway Basin, Baccaro Bank and edge, Western to Sable Island Bank and edge. It spawns in offshore deep water and shelf break												
Winter skate	*Leucoraja ocellata*	West of Sable Island: Browns Bank, Western to Banquereau Banks												
Pelagic Species														
Atlantic herring	*Clupea harengus*	Nearshore: Halifax to southwest NS Browns to Banquereau Banks, with a few along the shelf edge												
Atlantic mackerel	*Scomber scombrus*	Emerald to Banquereau Banks and few along shelf edge												
Black dogfish	*Centroscyllium fabricii*	Eggs and larvae not present in the area, gives birth to pups												
Blue shark	*Priomace glauca*	Not on shelf or slope												
Capelin	*Mallotus villosus*	Nearshore: Halifax Eastern Scotian Shelf outside of the Study Area												
Roughhead grenadier	*Macrourus berglax*	Outside of the Study Area, Potentially Scotian Slope												

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

Common Name	Scientific Name	Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Groundfish Species														
Atlantic halibut	*Hippoglossus hippoglossus*	Browns to Banquereau Banks and shelf edge												
Haddock	*Melanogrammus aeglefinus*	Nearshore: Halifax to Liverpool Georges Bank, Browns Bank to Western Sable Island Bank and shelf edge, Roseway Basin												
Hagfish	*Myxine glutinosa*	Georges Bank												
Monkfish	*Lophius spp.*	Georges to Banquereau Banks and shelf edge												
Pollock	*Pollachius virens*	Nearshore: Halifax to Yarmouth Georges Bank, Browns to Western Bank												
Red hake	*Urophycis chuss*	Browns to Sable Island Bank and shelf edge												
Sandlance	*Ammodytes dubius*	Banquereau												
Silver hake	*Merluccius bilinearis*	Browns Bank and Slope, Emerald to Banquereau Banks and shelf edge												
Turbot-Greenland halibut	*Reinhardtius hippoglossoides*	Potentially Scotian Slope												
Witch flounder	*Glyptocephalus cynoglossus*	Nearshore: Halifax to southwest NS Georges to Banquereau Banks and the shelf edge and slope												
Yellowtail flounder	*Limanda ferruginea*	Nearshore: south of Halifax Georges Bank, Browns Bank, Emerald to Banquereau Banks												

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

Common Name	Scientific Name	Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Invertebrate Species														
Lobster*	*Homarus americanus*	Nearshore Waters with larvae and late stage berried females also found in offshore waters												
Jonah crab**	*Cancer borealis*	N/A												
Scallop	Potential for multiple species	Nearshore southwest NS Georges Bank, Browns Bank, Western to Banquereau Banks												
Northern shrimp	*Pandalus borealis*	Nearshore waters												
Sea cucumber**	*Class Holothuroidea*	N/A												
Shortfin squid	*Illex illecebrosus*	Not completely known – Possibly continental shelf south of Cape Hatteras and in the Gulf Stream												
Snow crab	*Chinoecetes opilio*	Nearshore Waters												
*Note: Lobster eggs are extruded by the female from June to September and held until they hatch approximately 9-12 months later.														
**Note: Very little biological information exists for this species on the Scotian Shelf and Slope.														
	Mating Period													
	Potential Spawning and Hatching Periods													
	Anticipated Peak Spawning Period													

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

3.2.5.1 Pelagic Fish

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

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

Common Name	Scientific Name	Distribution
Albacore tuna	*Thunnys alalunga*	• Albacore tuna enter Canadian waters in late April and remain until November feeding on forage species. Migration routes are still uncertain. Albacore tuna are distributed sparsely along the Scotian Shelf edge (particularly the Hell Hole), with higher numbers further offshore above the abyssal plain. Spawning takes place in subtropical waters of the Atlantic Ocean and the Mediterranean Sea. Larvae remain in the spawning grounds until the second year when during the spring, they begin their migration to the North American coast.
Atlantic herring	*Clupea harengus*	• Atlantic herring are a small schooling fish and are common along the coast of Nova Scotia and offshore banks. Known to be present in the Roseway, LaHave, and Emerald Basins feeding primarily on zooplankton, krill and fish larvae. • Atlantic herring travel from spawning grounds to feeding sites in a seasonal migratory cycle, with spawning locations found in both coastal waters and on offshore banks. Coastal spawning grounds include areas off southwest Nova Scotia, Bay of Fundy, and off Grand Manan Island. Offshore spawning occurs on areas of Georges Bank. Spawning begins in August in the Nova Scotia and eastern Maine regions and in October/November in the southern Gulf of Maine and Georges Bank.
Atlantic mackerel	*Scomber scombrus*	• The Atlantic mackerel is a pelagic species found on both sides of the Northern Atlantic Ocean. On the western side of the Atlantic Ocean, they can be found from Cape Hatteras, North Carolina to Newfoundland and Labrador. During the spring and summer months, mackerel can be found in coastal waters. During the fall and winter the species moves offshore to the warmer waters along the continental shelf. • Atlantic mackerel feed primarily on crustaceans including copepods, krill, and shrimp. They will also feed on squid and small fish species. The species has two major spawning areas which include the Mid-Atlantic Bight from April to May and the Gulf of St. Lawrence in June and July.
Bigeye tuna	*Thunnus obesis*	• Bigeye tuna are a tropical tuna species which can be found in temperate to tropical waters from Nova Scotia to Brazil. Spawning takes place in tropical waters throughout the year with a peak during the summer months. Young individuals typically inhabit tropical waters with mature individuals migrating to northern latitudes. Mature bigeye tuna enter Canadian waters including the Scotian Shelf in late April and remain until November to feed. Bigeye tuna have a similar distribution as the albacore with a few fish inhabiting waters along the Scotian Shelf edge (particularly the Hell Hole), with higher numbers further offshore.

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

Common Name	Scientific Name	Distribution
Black dogfish	*Centroscyllium fabricii*	• The black dogfish is a deepwater species found in temperate to boreal waters over the outer continental shelves and slopes of the North Atlantic Ocean. The black dogfish has been observed at depths of up to 1,500 m but are more common from 550-1,000 m. This species has been found along the banks and basins within the Study Area. Reproduction occurs year-round. Females are ovoviviparous and give birth to up to 40 pups which measure 12-19 cm in length. In Canadian waters they have been observed giving birth in parts of the Laurentian Channel.
Swordfish	*Xiphias gladuis*	• Swordfish migrate into Canadian waters in the summer as part of their annual seasonal movement, following spawning in subtropical and tropical areas; however, landing data shows they are present in the area longer than just the summer months. Swordfish can be found along the Scotian Shelf edge and slope as well as on the northeast corner of the Emerald Basin. They can be commonly found feeding on the slopes of the banks in cooler, more productive waters. Swordfish feed on a variety of fish species as well as invertebrates including squid.
White marlin	*Tetrapturus albidus*	• In the western Atlantic waters, marlin can be found in warm temperate waters and tropical waters. During the summer months, marlin migrate into Canadian waters off Nova Scotia; however, landing data shows they are present in late spring and early fall. Marlin can be found along the Scotian Shelf edge and slope. They can often be found in areas with upwelling and distinct geographic features including shoals, drop-offs, and canyons. White marlin feed on squid, mahi-mahi, mackerel, herring, flying fish and bonito.
Yellowfin tuna	*Thunnus albacares*	• Yellowfin tuna migrate into Canadian waters, including the Scotian Shelf to feed during the summer months; however, landing data shows they are present from April to November. The highest concentration of yellowfin tuna is in the vicinity of Hell Hole and as well as further offshore and south to 40 degree latitude. The species spawns from May to August in the Gulf of Mexico and from July to November in the Southeastern Caribbean.
Bluefin tuna	*Thunnus thynnus*	• Bluefin tuna is distributed throughout the North Atlantic, generally occupying waters up to a depth of 200 m, but are known to dive 500 m to 1000 m (Wilson and Block 2009). Adult bluefin tuna enter Canadian waters, including the Scotian Shelf from June to December; however, tagging data and reports from fishers indicate that they are present in every month of the year. Bluefin can be found distributed along the edges and slopes of the Study Area.
Blue shark	*Prionace glauce*	• The blue shark is a highly migratory species, with its western Atlantic range from Newfoundland to Argentina. The blue shark has been recorded in Canadian waters including the Scotian Shelf most commonly during the summer months. The blue shark mates on the continental shelf during the spring and early summer, moving further offshore afterwards. Blue sharks can be found along the Scotian Shelf edge and slope.
Porbeagle shark	*Lamna nasus*	• Porbeagle sharks move onto the Scotian Shelf in the early spring. The primary factor affecting distribution is thought to be temperature, with the species typically inhabiting waters between 5-10°C. Porbeagles can be found in a similar distribution as the blue shark inhabiting the Scotian Shelf edge and slope. Porbeagles are caught incidentally through other commercial fisheries (DFO 2018f).

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

Common Name	Scientific Name	Distribution

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

3.2.5.2 Groundfish

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

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

Common Name	Scientific Name	Distribution
Acadian redfish	*Sebastes fasciatus*	• Closely associated with the seafloor and commonly found inhabiting waters 150 to 300 m in depth along the Scotian Shelf edge and slope. Mature individuals expected in to occur in the Study Area from May to October. Spawning occurs in fall. Larvae may be present in water column May to August
American plaice	*Hippoglossoides platessoides*	• Closely associated with the seafloor and commonly found in water depths of 100 to 200 m where soft/sandy sediments are present. The Maritimes population is common to the Scotian Shelf. Within the Study Area, American plaice can be found along the banks and basins as well as along the shelf edge. The Study Area is an important American plaice spawning area.
Atlantic cod	*Gadus morhua*	• A demersal gadoid species usually found within 2 m of the seafloor. Atlantic cod can be found from Greenland to Cape Hatteras and is common in the Study Area on the Scotian Shelf. In 1993 a moratorium on cod fishing on the eastern Scotian Shelf (4VW) was put in place and remains in effect today. Cod remains an important commercial species on the southwest Scotian Shelf and is caught as bycatch as part of a multispecies groundfish fishery.
Atlantic halibut	*Hippoglossus hippoglossus*	• Atlantic halibut are distributed from north of Labrador to Virginia. Halibut can be found on the banks and basins of the continental shelf and are present within the Study Area, particularly near Georges bank. On the Scotian Shelf, halibut are most abundant between 200 and 500 m. They prefer sand, gravel or clay substrates. The Atlantic halibut is a very important groundfish species within the Study Area. The species preys on benthic organisms which range from invertebrates to fish as they increase in size. • Females mature at 10 to 14 years and spawn from December to June in deep water ranging from 300 to 700 m. Females can spawn several million eggs which are pelagic.

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

Common Name	Scientific Name	Distribution
Haddock	*Melanogrammus aeglefinus*	• Haddock are a demersal gadoid species usually closely associated with the seafloor, preferring broken ground, gravel, pebbles, clay, smooth hard sand, sticky sand of gritty consistency, and shell beds. Haddock can be found from Greenland to Cape Hatteras and are common in the Study Area on all of the banks and basins. They are most common at depths ranging from 50 to 250 m. • Haddock feed on a variety of benthic organisms including mollusks, polychaetes, crustaceans, echinoderms, fish eggs, and small fish. They are a species which grows at a fast rate and mature from one to four years of age. Spawning takes place from January to July over rock, sand, gravel and mud bottoms on areas of Georges Bank and eastward to Sable Island Bank and shelf edge. Eggs and larvae are pelagic. The haddock box, located in the Northeast corner of the Study Area, is a significant haddock spawning and nursery area.
Hagfish	*Myxine glutinosa*	• Hagfish can be found from the coast of Florida to the Davis Strait and Greenland. They can be found in depths up to 1200 m at temperatures less than 14°C and salinities less than 32 ppt. The species prefers soft substrates and areas with low current velocity. As a new fishery in the area, hagfish are becoming an important source of income within the groundfish fishery. • Hagfish spawn year-round with each female carrying 1 to 30 horny-shelled large eggs. Females deposit eggs in burrows with newly hatched hagfish resembling adults and measure 6 to 7 cm in length. They feed on a variety of infaunal and epifaunal invertebrates.
Monkfish	*Lophius americanus*	• Monkfish can be found from the Northern Gulf of St. Lawrence to Cape Hatteras. They have been found inhabiting areas up to 800 m in depth but are most commonly found from 70 to 190 m. Concentrations of monkfish can be found on the banks and basins and the edge of the Scotian Shelf. Monkfish typically inhabit areas with benthic substrates consisting of sand, mud and shell hash. They are opportunistic feeders and prey on a wide variety of fish and invertebrates. • Monkfish reach sexual maturity between three and four years of age. Spawning typically occurs during the summer months from Georges to Sable Island Bank and shelf edge. The eggs are spawned in a thin ribbon-like mucous veil which is pelagic in nature.
Pollock	*Pollachius virens*	• Pollock is a gadoid species found from southern Labrador to Cape Hatteras, with major concentrations on the Scotian Shelf, including the banks and basins of the Study Area. Pollock is a semi-pelagic species that can be found inhabiting areas with sand, mud, rock, and various types of vegetation. Pollock travel in schools between the Scotian Shelf and Georges Bank with some fish traveling into the Gulf of Maine. Pollock mature from four to seven years of age with spawning taking place from September to March. Spawning occurs from Georges Bank to Western Bank. Eggs and larvae are pelagic and float in the surface layers.

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

Common Name	Scientific Name	Distribution
Red hake	*Urophycis chuss*	• Red hake can be found from the Gulf of St. Lawrence to North Carolina from depths of 10 to 500 m at temperatures of 5 to 12°C. Within the study area red hake can be found in the LaHave and Emerald Basins as well as along the shelf edge. During the spring and summer red hake migrate to shallower waters to spawn, returning to the deeper waters of the shelf edge and slope during the winter months.
Sand lance	*Ammodytes dubius*	• In the northwest Atlantic, sand lance can be found from Cape Hatteras to Greenland and are generally found in water depths of less than 90 m. They are generally found along coastal zones and on the shallow waters of offshore banks on sand or small gravel benthic substrates. Sand lance do not make extensive migrations, but will travel between resting and feeding grounds • Sand lance mature at two years of age and spawn on sand in shallow water depths during the winter months. The eggs stick to the substrate and remain there until they hatch. Upon hatching, the larvae become pelagic and remain in the surface waters for a few weeks and are an important food source for predators.
Silver hake	*Merluccius bilinearis*	• The silver hake can be found from southern Newfoundland to South Carolina. Within the Study Area, this species can be found in the LaHave and Emerald Basins as well as along the shelf edge. The species can be most commonly found at depths from 150 to 200 m feeding primarily on shrimp, krill, and sand lance. • Silver hake mature at two years of age. Seasonal migrations occur during the spawning period, from June to September. Spawning occurs from Browns Bank to Sable Island Bank and along the shelf edge. During this time, they move from the deeper waters of the LaHave and Emerald Basins up onto the banks. The eggs and larvae are buoyant for a period of three to five months.
Turbot – Greenland halibut	*Reinhardtius hippoglossoides*	• The Greenland halibut can be found in water depths ranging from 90 to 1600 m from western Greenland to the southern edge of the Scotian Slope. Within the Study Area, this species is most common along the shelf edge and slope. Females mature at approximately nine years of age with spawning taking place during the winter and early spring.
White hake	*Urophycis tenuis*	• White hake can be found on the continental slopes, ranging from southern Labrador and the Grand banks to the Gulf of Maine. Within the Study Area white hake can be found in the LaHave and Emerald Basins as well as along the shelf edge. Larger fish generally occur in deeper waters whereas juveniles typically occupy shallow areas close to shore or over shallow offshore banks. Individuals of all sizes tend to move shoreward in summer and disperse to deeper water in winter.
Witch flounder	*Glyptocephalus cynoglossus*	• Witch flounder is a deep-water, boreal flatfish that can be found from Labrador to Georges Bank at depths from 100 to 400 m, and can occasionally be found at depths up to 1600 m. They occur most commonly in deep holes and channels and along the shelf edge on muddy bottoms. Spawning occurs from May to October with a peak in July and August. Spawning occurs on the shelf from Georges Bank to Sable Island Bank. Eggs and larvae are pelagic and drift in the currents until settling to the benthos.

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

Common Name	Scientific Name	Distribution
Yellowtail founder	*Limanda ferruginea*	• Yellowtail flounder is a small-mouthed Atlantic flatfish that inhabits relatively shallow waters of the continental shelf from southern Labrador to Chesapeake Bay. A major concentration of yellowtail flounder occurs on Georges Bank from the Northeast Peak to the Great South Channel. This species prefers sand or sand-mud sediments in water depths ranging from 40 to 80 m. The species feeds on a variety of invertebrates as well as small fish species. • Maturity is reached from two to three years of age. Spawning takes place near the substrate on Georges, Browns, Emerald, Western and Sable Island Banks from May to July. The eggs drift to the surface following fertilization and drift during development.

Sources: Scott and Scott 1988; Cargnelli et al. 1999a, 1999b; COSEWIC 2013; DFO 2001, 2009b, 2009c, 2012a. NOAA 2013h, 2013i; 2013j; 2013k

Note: For an in-depth overview of important areas for fish, particularly larval distribution maps, refer to Horsman and Shackell (2009).

3.2.5.3 Invertebrates

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

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

Common Name	Scientific Name	Distribution
American lobster	*Homarus americanus*	• Lobster can be found along the Atlantic coastline and on the continental shelf from Northern Newfoundland to South Carolina. Within the Study Area there are two classifications of lobster; inshore and offshore. The inshore component of the population can be found in LaHave Basin as well as in most locations of the nearshore shelf. The offshore component of the population is present along the edges of the shelf and there are also high concentrations of lobsters in many areas on banks. Their offshore habitat is less tied to rock and boulder shelter and seasonal migrations have been documented and are largely tied to thermal regimes. Adult lobsters are typically found in water depths of less than 300 m but have been found up to 750 m. They prefer substrate with rock and boulder shelter as they use these surfaces as protection from predators as well as sunlight. They have also been found in areas with sand, gravel and mud substrates. During the summer months lobsters migrate to shallower waters to take advantage of warm water temperatures. In the winter they retreat to deeper water to avoid winter storms, ice, and extreme cold-water temperatures. • Lobster reproduction takes two years. Immediately after molting, females mate with males and store sperm in the undersides of their bodies in a sperm plug. During this time females are developing eggs internally for 12 months. The next summer eggs are extruded and fertilized with the stored sperm. Females carry the fertilized eggs for 9 to 12 months before hatching. Egg bearing females will move inshore to hatch their eggs during the late spring to early summer. • A designated lobster broodstock area is in the northwest corner of the Study Area, on Browns and Baccaro Banks.
Snow crab	*Chionoecetes opilio*	• Snow crabs can be found from the Gulf of Maine to Greenland at depths from 50 m to 1300 m. Snow crab prefer water temperatures of 1 to 4 °C but can occur outside this range, particularly in the Western Scotian Shelf. For the majority of the Scotian Shelf, snow crab are located midshore/offshore. In the Western Scotian Shelf, snow crab are located more nearshore, occurring in cold water provided by the Nova Scotia current. Snow crab landings are low in the Study Area as compared to the rest of the Scotian Shelf.
Jonah crab	*Cancer borealis*	• Jonah crab are found from Newfoundland to South Carolina and in the Bermuda Islands at water depths ranging from intertidal to 800 m. Offshore Nova Scotia they are generally found at water depths of 50 to 300 m. Jonah crab feed primarily on benthic invertebrates including mussels, snails, barnacles, as well as dead fish.
Atlantic sea scallop	*Placopecten magellanicus*	• Atlantic sea scallop can be found from the Gulf of St. Lawrence to Cape Hatteras, North Carolina and are prevalent on Browns and Georges Banks. Females can reproduce beginning at two years of age, but do not produce many eggs until four years of age.
Iceland sea scallop	*Chlamys islandica*	• Iceland Sea Scallop can be found from the Gulf of St. Lawrence to Cape Hatteras, North Carolina. Within the Study Area, they can be found on Browns Bank.

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

Common Name	Scientific Name	Distribution
Northern shrimp	*Panadalus borealis*	• This species can be found from Massachusetts to Greenland at water depths from 10 to 350 m. The species prefers soft mud benthic substrates. Northern shrimp are important in marine food chains as they are an important prey item for many species of fish and marine mammals. Although a benthic species, northern shrimp will migrate vertically through the water column at night (diel vertical migration) to feed on small crustaceans in the pelagic zone. They also prey on phytoplankton and zooplankton as well as benthic invertebrates. • The northern shrimp is a hermaphroditic species (possesses the reproductive organs of both sexes). The species first reaches maturity as a male at the age of 2 to 3 years and by the age of 4 to 5 years they transform into a female, spending the rest of their lives in this state. Juveniles will remain in coastal waters for over a year before migrating to deeper offshore waters and mature as males. Northern shrimp migrate with seasonal changes in water temperature spending the fall and winters in nearshore waters when the water is the coolest and migrating offshore during the spring and summer. Shrimp landings from commercial fisheries tend to be low in the Study Area.
Striped shrimp	*Panadalus montagui*	• The striped shrimp can be found from New England to Greenland and Baffin Bay at depths from 20 to 100 m. The species prefers hard substrates including rock, gravel, sand and mud. The species can be found in abundance within the valleys and basins separating Sable Island, Banquereau, and Middle Banks. Shrimp landings from commercial fishers tend to be low in the Study Area.
Shortfin squid	*Illex illecebrosus*	• The life cycle of the shortfin squid is approximately one year in length. The shortfin squid may reproduce during any part of the year although most reproduction occurs during the winter months over the continental shelf south of Cape Hatteras, North Carolina. Females then expel their eggs through jets in their abdomen while at the same time creating one or multiple jelly masses which contains up to 100,000 eggs and measures up to a metre in diameter. The fertilized mass of eggs is pelagic and travels north in the Gulf Stream. • When the squid first hatch after 8 to 16 days they are known as paralarvae. Paralarvae are abundant in the convergence zone of Gulf Stream water and slope water where there is an area of high productivity. Once reaching a size of 5 cm the paralarvae become juveniles and feed mainly on crustaceans (euphausiids) at night near the surface waters; they also feed on nematodes and fish. At this stage juveniles grow at a rate of 1.5 mm per day. Once reaching a size of 10 cm juveniles are at the adult stage and can reach sizes of up to 35 cm. During the spring juveniles and adults migrate onto the Scotian Shelf area from the slope frontal zone and feed on fish including cod, mackerel, redfish, sand lance, herring, and capelin. Adults will also cannibalize smaller squid. Juvenile and adult squid have diel vertical migrations in which they rise vertically in the water column to feed at night and migrate to deeper depths during the day. During the fall months the shortfin squid will migrate off the shelf to spawn presumably in the Gulf Stream and south of Cape Hatteras. Spawning is believed to occur from December to March.

Sources: DFO 2002, 2004, 2012a

3.2.5.4 Fish Species of Special Status

Table 3.16 lists fish species of special status which may be present in the Study Area. Species of special status are those listed on Schedule 1 of the SARA, or species assessed as endangered, threatened, or of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The International Union for Conservation of Nature (IUCN) red list designation is also provided. Note that the IUCN designations may vary from SARA and COSEWIC status as it considers and refers to global populations rather than specific populations found in Canadian waters. Populations that are highly unlikely to occur in the Study Area have been excluded (e.g., Atlantic cod Laurentian North population).

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

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Northern wolffish *Anarhichas denticulatus*	Threatened	Threatened	Not Assessed	• Main range is off northeast Newfoundland and across the North Atlantic Ocean with some occurrence on the Eastern Scotian Shelf off Cape Breton. Mostly found at depths of 500-1000 m. Most common at water temperatures between 2 and 5 ˚C. Non-migratory spawning occurs in the fall. The eggs are probably deposited on the bottom, and the larvae and juveniles are thought to occupy the upper layers of the water column before subsequently settling to the bottom. Larvae may be present on the seafloor in fall to early winter.
Spotted wolffish *Anarhichas minor*	Threatened	Threatened	Not Assessed	• Main range is west of Greenland to the Grand Banks with some occurrence on the Eastern Scotian Shelf off Cape Breton. Typically occupies depths between 200 and 750 m on the continental shelf or in deep trenches. On the Scotian Shelf it is found in temperatures ranging from 2 to 8 ˚C. Non-migratory spawning occurs in the summer. Eggs are deposited on the seafloor, but larvae are pelagic before settling in the benthic environment. Juveniles and adults then occupy the bottom. Eggs/larvae may be present on the seafloor in summer to fall.
Atlantic/striped wolffish *Anarhichas lupus*	Special Concern	Special Concern	Not Assessed	• Occurs along the Scotian Shelf with a higher concentration around Browns Bank, along the edge of the Laurentian Channel and into the Gulf of Maine. Most commonly found inhabiting the seafloor in water depths between 100 and 350 m. Tolerates a broad temperature range (from -1.5 to 13 ˚C), although they concentrate in a narrower range and water temperature is thought to be a major factor determining habitat selection. Short migrations to spawning grounds in shallow waters during the fall. Eggs/larvae may be present on the seafloor in fall to early winter in the Roseway and LaHave Basins.

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

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
White shark *Carcharodon carcharias*	Endangered	Endangered	Vulnerable	• Increased research and identification effort in recent years have revealed that white sharks use Atlantic Canadian waters more frequently than previously thought. In total there have been 67 confirmed and 18 unconfirmed records of white sharks since 1873. Of these, 45 records (33 confirmed, 12 unconfirmed) occurred between 2009 and 2020. The overall population size in the Northwest Atlantic is unknown, though 649 verified records (excluding tagged detections) were collected over a 210-year period (1800 to 2010), 94% of which occurred after 1950 (Curtis et al. 2014). • Preliminary and published results indicate that white sharks occur seasonally in Atlantic Canadian waters, ranging widely throughout the region, representing a mix of sub-adults and mature adults, males and females (Skomal et al. 2017; OCEARCH 2019). Recorded sightings range from the Grand Banks of Newfoundland to as far west as the Portneuf River Estuary in the Saint Lawrence River and from the Strait of Belle Isle off the northern tip of Newfoundland to south of Sable Island Bank. • Can range in depth from the surface to 1,300 m, are highly mobile and seasonally migrant. OCEARCH is an organization that conducted expeditions to collect scientific data in the Western Atlantic Ocean. OCEARCH has a white shark tagging program that is providing data on white shark movement. Sharks of multiple ages and of both sexes have been encountered and tagged off Nova Scotia, which may indicate that there is a sub-population of white sharks that aggregate in Candian waters. Five of the six white sharks tagged in Nova Scotia in 2018 returned in 2019, further supporting the importance of this area for white sharks (OCEARCH 2019). Also, the Massachusetts Division of Marine Fisheries (MDMF), in collaboration with the Ocean Tracking Network (OTN) at Dalhousie University, and DFO, have tagged sharks in US waters that have similarly tracked into Atlantic Canadian waters. Over 30 acoustic-tagged sharks have been detected in Atlantic Canadian waters.

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

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Acadian redfish (Atlantic pop.) *Sebastes fasciatus*	Not Listed	Threatened	Not Assessed	• The Acadian redfish is closely associated with the seafloor commonly found inhabiting waters 150 to 300 m in depth along the Scotian Shelf edge and slope. They can be found over a wide range of habitats and are known to use rocks and anemones as protection from predators. Mature individuals expected to occur in the Study Area from year-round. Migratory information for the species is lacking because they cannot be tagged. Mating occurs in fall. Larvae may be present in the water column May to August.
American eel *Anguilla rostrata*	Not Listed	Threatened	Endangered	• Adult American eels migrating from freshwater streams to the Sargasso Sea may pass through the Study Area. Mature silver eels spawn in the Sargasso Sea with hatching occurring from March to October, peaking in August. The larvae are transparent and willow-shaped and are transported to North American coastal waters via the Gulf Stream. After approximately 7 to 12 months, larvae enter the Continental Shelf area and become glass eels taking on an eel shape while remaining transparent. As glass eels migrate towards freshwater coastal streams they are known as elvers. Elvers will run into the freshwater streams with runs peaking from April to June in Nova Scotia. Elvers eventually transform into yellow eels, which is the major growth phase for the species. Yellow eels will spend years maturing in freshwater streams and coastal areas before making a major transformation to return to the Sargasso Sea to spawn. On average, yellow eels will remain in coastal areas or freshwater for 9 to 22 years before metamorphosing both morphologically and physiologically into silver eels. Nova Scotian silver eels will begin their outmigration to the Sargasso Sea in November travelling over 2000 km to spawn for the only time during their life.
American plaice (Maritime pop.) *Hippoglossus platessoides*	Not Listed	Threatened	Not Assessed	• The American plaice is closely associated with the seafloor and commonly found in water depths of 100 to 300 m where soft/sandy sediments are present. The Maritime population is common to the Scotian Shelf. Within the Study Area, American plaice can be found along the banks and basins as well as along the shelf edge year-round. Females are batch spawners, spawning batches of eggs for up to one month. Spawning occurs in April/May. Eggs and larvae are pelagic and may be present in the water column between May and June. Major spawning areas include Banquereau, Western and Browns Banks.

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

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Atlantic bluefin tuna *Thunnus thynnus*	Not Listed	Endangered	Endangered	• The Bluefin tuna is a highly migratory species which travels over long and varied routes. The species is distributed throughout the North Atlantic Ocean, occupying waters up to a depth of 200 m, but are known to dive 500 m to 1000 m (Wilson and Block 2009). Adult bluefin tuna enter Canadian waters, including the Scotian Shelf from June to December; however, tagging data and reports from fisherman indicate that they are present in every month of the year. The bluefin can be found distributed in high concentrations along the shelf edge and the Northeast Channel (Hell Hole). The species forages on herring, mackerel, capelin, silver hake, white hake, and squid. Spawning takes place in the Gulf of Mexico and the Mediterranean Sea with females producing upwards of 10 million eggs per year. The eggs are buoyant and are fertilized by males in the water column.
Atlantic cod (Southern pop.) *Gadus morhua*	Not Listed	Endangered	Vulnerable	• Atlantic cod can generally be found in coastal, nearshore and offshore areas from depths of a few metres to 500 metres. In 1993 a moratorium on northern cod fishing (Newfoundland and Labrador, Gulf of St. Lawrence, and Eastern Scotian Shelf [4VW]) was put in place on all directed fishing and remains in effect today. Cod remains an important commercial by-catch fishery on the southwest Scotian Shelf. Atlantic cod from the Southern Population inhabit waters from the Bay of Fundy and southern Nova Scotia including the Scotian Shelf to the southern extent of the Grand Banks. This population overwinters in the deeper waters of Browns and LaHave Banks as well as inshore waters near Nantucket. Atlantic cod have been observed spawning in both offshore and inshore waters year-round. Peak spawning has been observed during the spring with pelagic eggs and larvae. Juvenile cod prefer habitats which provide protection and cover such as nearshore waters with eelgrass or areas with rock and coral.

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

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

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

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Atlantic salmon (Nova Scotia Southern Upland pop.) *Salmo salar*	Not Listed	Endangered	Least Concern	• This population extends from northeastern Nova Scotia (mainland) along the Atlantic and Fundy coasts up to Cape Split. Migration between freshwater rivers and the North Atlantic means the population may pass through the Study Area with a presence being transient in nature.
Atlantic sturgeon (Maritimes pop.) *Ancipenser oxyrinchus*	Not Listed	Threatened	Not Assessed	• This population is found throughout the coastal waters of the Maritimes and extends out onto the shelf. Concentrated in water depths less than 50 m and highly migratory in nature so any presence in the Study Area is likely transient. Adults migrate into estuaries and rivers in the autumn (August- October) or in the spring (May-June) prior to reproduction. Adults will often overwinter in deep channels and pools in rivers and estuaries downstream of the spawning sites. Adults and large juveniles move both inwards and seawards in response to season and salinity. They can be found in the Bay of Fundy, along the coast of Nova Scotia and offshore as far as Banquereau and Sable Island banks. There is a known spawning population of Atlantic Sturgeon in the Saint John River which empties into the Bay of Fundy.
Basking shark (Atlantic pop.) *Cetorhinus maximus*	Not Listed	Special Concern	Endangered	• Found throughout the North Atlantic with concentrations in coastal waters of Newfoundland and near the mouth of the Bay of Fundy. They have also been observed on Georges Bank, Northwest Channel, and the LaHave and Emerald Banks. During the summer months they can be found in surface waters, particularly the LaHave and Emerald Basins, where they may mate. During the winter months they are believed to be found on the Scotian Slope in deeper waters. It is believed that the basking shark lives primarily in oceanic front locations where their main food source, zooplankton, is found. They have been shown to be sensitive to low frequency (25 to 200 Hz) pulses.

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

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

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

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Porbeagle shark *Lamna nasus*	Not Listed	Endangered	Vulnerable	• Porbeagle sharks are a pelagic shark species commonly inhabiting continental shelves and ocean basins at depths from 1 to 2800 m. Immature porbeagle sharks inhabit the Scotian Shelf with mature individuals migrating along the shelf waters to mating grounds located on the Grand Banks, off the mouth of the Gulf of St. Lawrence, and on Georges Bank during September to November. Females leave the continental shelf in December, travelling to the Sargasso Sea to give birth in March and April. Young of the year porbeagles begin to show up in Atlantic Canadian waters in June and July. There is a population which undertakes extensive migrations; from January to February they can be found in the Gulf of Maine, Georges Bank and the Southern Scotian Shelf. During the spring they can be found on the edge of the Scotian Shelf and in offshore basins. They migrate northeasterly and can be found off the southern coast of Newfoundland and in the Gulf of St. Lawrence in summer and fall.
Roundnose grenadier *Coryphaenoides rupestris*	Not Listed	Endangered	Critically Endangered	• The roundnose grenadier is a continental slope species with the deeper part of its geographic range not well surveyed. It is closely associated with the seafloor and commonly found inhabiting waters 400 to 1,200 m in depth but has been found in water depths of up to 2,600 m. The species prefers areas absent of currents and can be found in aggregations in troughs, gorges, and lower parts of the Scotian Slope. Aggregations have been found around the North Atlantic Seamounts. Spawning is believed to occur year-round with peaks at different times for different areas. Females will spawn 12,000 to 25,000 pelagic eggs. Roundnose grenadier have been observed moving up and down continental slopes, moving to deeper water in the winter and shallower water in the summer. They have also been observed to carry out diurnal vertical migrations of 1,000 m off the bottom. The species feeds in the water column on a variety of prey items including copepods, amphipods, squid, and small fish.
Shortfin mako *Isurus oxyrinchus*	Not Listed	Endangered	Endangered	• Canadian landings data for shortfin mako shark indicate this species is present from April to November; however, the majority of catches occur in the summer and early fall as they generally migrate into Canadian waters with the warm waters of the Gulf Stream. Shortfin makos inhabit the Scotian Shelf edge and slope, as well as the banks and basins within the Study Area. They are reported throughout the EEZ.

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

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

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

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
White hake (Atlantic & Northern Gulf of St. Lawrence pop.) *Urophycis tenuis*	Not Listed	Threatened	Not Assessed	• White hake can be found on the continental slopes, ranging from southern Labrador and the Grand Banks to the Gulf of Maine. Within the Study Area, white hake can be found in the LaHave and Emerald Basins as well as along the Shelf edge. Larger fish generally occur in deeper waters whereas juveniles typically occupy shallow areas close to shore or over shallow offshore banks. On the Scotian Shelf, individuals of all sizes tend to move shoreward in summer and disperse to deeper water in winter. Maturity is reached from two to five years of age. Spawning occurs during the summer months.
Winter skate (Eastern Scotian Shelf-Newfoundland pop.) *Leucoraja ocellata*	Not Listed	Endangered	Endangered	• High concentrations have been found on Georges Bank and the offshore banks of the Scotian Shelf. Non-migratory spawning has been observed in the fall. Eggs / larvae may be present up to 22 months after spawning and are attached to the seafloor. Female Winter Skate have been captured extruding egg cases in the late summer-early fall west of Sable Island, suggesting a spawning area.

[1] Note that the IUCN designations refer to global populations rather than specific populations found in Canadian waters.

Sources: Acero et al. 2010; Campana et al. 2003; Collette et al. 2011; COSEWIC 2006a, 2006b, 2008a, 2009a, 2009b, 2009c, 2010a, 2010b, 2010c, 2010d, 2011, 2012a, 2012b, 2012c, 2012d; DFO 2011a, 2012a, 2013a, 2013f, 2013g, 2013h, 2013i, 2013j, 2013l, 2013m; Fordham et al. 2016; Iwamoto 2015; Jacoby et al. 2017; Kulka et al. 2009a, 2009b; Maguire and Lester 2012; NOAA 2013l; SARA 2012, 2013a, 2013b; Rigby et al. 2019a, 2019b, 2019c, 2019d; Scott and Scott 1988; Simon and Frank 2000; Sobel 1996; Sulikowski et al. 2009; World Conservation Monitoring Centre 1996

3.2.6 Marine Mammals and Sea Turtles

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

The Ocean Biodiversity Information System (OBIS) is an online database with information on distribution and abundance of marine species. It was developed as a component of the Census of Marine Life (CoML) but is not limited to CoML data. Species records in OBIS come from a variety of sources, including government (including the Canadian Wildlife Service [CWS] and the US National Oceanic and Atmospheric Administration [NOAA]), universities, and non-profit organizations.

Figure 3.16 to Figure 3.21 have been prepared using sightings from OBIS and data provided by DFO Maritimes Region Whale Sightings Database.These data have been collected from various sources over the years, including sightings from fishing and whaling in the 1960s and 1970s and more recently from observer programs on fishing vessels. The database also includes data from scientific expeditions by DFO, non-governmental organizations, and Dalhousie University research teams. Much of the data were collected on an opportunistic basis from vessels in the area, with survey effort not consistent across the Study Area (e.g., lack of sightings does not necessarily represent lack of species presence in a given area) (DFO, pers. comm. 2013).. DFO's cetacean aerial surveillance efforts have substantially increased in eastern Canada in recent years, and additional cetacean sightings data are available for the Scotian Shelf region that are not necessarily included in the Maritimes Region database.

3.2.6.1 Mysticetes and Odontocetes

Table 3.17 lists cetacean species known to inhabit the Study Area. Special designations by SARA and/or COSEWIC are included as applicable. Only those species listed on Schedule 1 of SARA are protected under the Act. The International Union for Conservation of Nature (IUCN) red list designation is also provided. Note that the IUCN designations may vary from SARA and COSEWIC status as it considers and refers to global populations.

The sightings data that were used to generate Figures 3.16 to 3.21 were obtained from the DFO Maritimes Region Whale Sightings Database and OBIS. The Whale Sightings Database provided sightings records between 1966 and November 2019 for both baleen and toothed whales. OBIS provided sightings records between 1963 and September 2019 for baleen whales, and toothed whale sightings back to 1913. A data request was not submitted to the North Atlantic Right Whale Consortium as part of this assessment in part due to timing considerations for this report.

It is possible that there are multiple observations of the same whale and that there may be overlap between the data sets; all sightings records from these two data sets are presented in Figures 3.16 to 3.21. These data only indicate the presence of a species in the Study Area at the time of the sighting and are not effort-based surveys. These data are not used to show abundance or to determine times of the year with most common occurrence, as lower numbers of sightings in winter and spring are likely largely due to little search effort during these times of year.

Six species of mysticetes (baleen whales) have been reported to occur in the Study Area, predominantly in the summer and fall, although all six have been sighted in Scotian Shelf waters throughout the year, including in winter months (refer to Table 3.17). Their year-round presence offshore Nova Scotia is also supported by acoustic evidence (Delarue et al. 2018). For example, Davis et al. 2020 assessed the acoustic presence of humpback, sei, fin and blue whales in the Northwest Atlantic Ocean between 2004 and 2014. Acoustic presence was based on daily detections of their vocalizations using bottom-mounted recorders. All of these species occurred in all regions of the Northwest Atlantic in the winter, suggesting that baleen whales are widely distributed during these months (Davis et al. 2020). A general northward shift was observed, and these species were detected less on the Scotian Shelf after 2010, which aligns with documented shifts in prey availability in the region (Davis et al. 2020). Passive acoustic monitoring efforts have recently been expanded to include other areas along the Scotian Shelf (DFO 2020).

Figure 3.16 presents the distribution of baleen whale sightings over the Western Scotian Shelf and Slope, including recorded sightings for the blue whale, fin whale, and North Atlantic right whale. The distribution of fin whale sightings from shipboard and aerial surveys is shown in Figure 3.17. The Canadian range of the North Atlantic right whale is shown (on two maps) in Figure 3.18. Blue whale sightings in the Study Area (by season) are presented on Figure 3.19.

Odontocetes include toothed whales, dolphins and porpoises; 17 species of odontocetes have been reported to occur in the Study Area, particularly along the Shelf Break (refer to Figure 3.20). Critical habitat for the endangered northern bottlenose whale has been designated in the Gully and Shortland and Haldimand Canyons east of the Study Area, although there have been sightings along the Shelf Break in the Study Area and within Dawson and Verrill Canyons. Acoustic recordings collected during vessel-based surveys from 2015-2017 detected bottlenose whale clicks outside their critical habitat in the Gully and Shortland and Haldimand Canyons and as far as the Fundian Channel in the Study Area (DFO 2020). Recorded sightings of northern bottlenose whale off Canada and adjacent waters are shown in Figure 3.21. Critical habitat for the North Atlantic right whale has been designated within the Roseway Basin, to the west of the Study Area (see Figure 3.24). Important blue whale habitat is also presented on Figure 3.24, based on Lesage et al. (2018).

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) *Scientific Name*	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Mysticetes (Toothless or Baleen Whales)				
Blue whale (Atlantic pop.) Balaenoptera musculus	Endangered	Endangered	Endangered	• Has a large range, including the Scotian Shelf, but a low population density. Forages for krill in both coastal and offshore waters, especially in areas of upwelling such as the continental shelf during spring, summer and fall. Found in small migrant herds and surfaces every 5 to 15 minutes for breathing. Figure 3.19 shows seasonal blue whale observations in and around the Study Area. Blue whales most commonly occur on the Scotian Shelf in areas of high primary productivity, including the Emerald Bank. They occur in lower numbers on the Scotian Slope. • There has been a relatively large amount of opportunistic search effort for whales on the Scotian Shelf; however, post-whaling sightings data does not highlight Emerald Bank of the western Scotian Shelf as being particularly important for blue whales (Moors-Murphy et al. 2019). This is different than the pattern observed during the whaling period when most sightings occurred around the Emerald Bank area (Moors-Murphy et al. 2019). • Gomez et al. (2017) developed Species Distribution Models (SDM) to predict priority areas in which to target and enhance blue whale monitoring efforts in eastern Canada. Priority areas were primarily located along the outer margins of the eastern and western Scotian Shelf (Gomez et al. 2017).In 2018, DFO identified the Scotian Shelf and Slope break (including the Gully, located in the Eastern Scotian Shelf) as “habitat important to the blue whale” (Figure 3.24). • Moors-Murphy et al. (2019) collated data from systematic surveys, opportunistic sighting platforms, acoustic monitoring and SDM efforts to predict potentially suitable habitat for blue whales off Nova Scotia, Newfoundland and Labrador. Potentially important areas were identified along the continental slope of the Scotian Shelf, especially in deep water near several submarine canyons on the eastern Scotian Shelf and in shallower areas on the western Scotian Shelf (Moors-Murphy et al. 2019). • Important features and attributes of important habitats to blue whales include: sufficient quantity and quality of prey; free access to transit corridors; enough physical space to freely maneuver; water of sufficient quality to not result in a loss of function; and an acoustic environment that does not interfere with communication, passive detection of prey or navigation, or impede use of important habitats by blue whales and their prey.

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Blue whale (Atlantic pop.) *Balaenoptera musculus*	Endangered	Endangered	Endangered	• In addition to historic hunting and natural sources of mortality such as ice entrapments and predation, a total of nine threats to the recovery of the Northwest Atlantic blue whale population are listed in the recovery strategy for blue whale (Beauchamp et al. 2009). Among the threats described, two could represent a high risk for the blue whale population due to their probability of occurrence or the severity of their effect: anthropogenic noise which causes a degraded underwater acoustic environment and alters behaviour, and food availability. Medium risk threats include persistent marine contaminants, collisions with ships, and disturbance caused by whale-watching activities of tourists or scientists. Lower risk threats include physical damage caused by noise, accidental entanglements in fishing gear, epizootics and toxic algal blooms as well as toxic product spills. There are three recovery objectives listed in the recovery strategy for blue whale: (1) define and undertake a long-term assessment of the number of Northwest Atlantic blue whales, the structure and trends of the population, and determine their range as well as their critical habitat within Canadian waters; (2) implement control and follow-up measures for activities which could disrupt the recovery of the blue whale in its Canadian range by prioritizing reducing anthropogenic noise (e.g., seismic exploration), protecting food resources, reducing disturbance from anthropogenic activities (e.g., whalewatching), reducing the risk of accidents associated to collisions as well as other human activities (e.g., fisheries and by-catch) and by reducing toxic contamination in the marine environment (Beauchamp et al. 2009). • There is a possibility that blue whales may be encountered by future operators in the Study Area, and that the important features and attributes could be affected by exploration activity. Any EA for future proposed programs in the Study Area parcels must consider these important features and attributes of the area for this species.
Fin whale (Atlantic pop.) *Balaenoptera phyalus*	Special Concern	Special Concern	Vulnerable	• This species is the most commonly sighted whale species along the Scotian Shelf. Areas of high concentration for sightings occur on Emerald Bank, Baccaro Bank and Roseway basin, as well as on and around Georges Bank. Fin whales may occur in the Study Area year-round. Calving occurs in winter, in lower latitudes. The estimated population size for the western North Atlantic fin whale stock is 3,985 individuals based on surveys conducted in 2006 and 2007.

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
				• Threats to fin whale, as identified in the management plan, include those of low, medium and high levels of concern (DFO 2016a). Threats identified with a high level of concern include anthropogenic noise from navigation, seismic exploration, and military sonar. Threats identified with a medium level of concern include anthropogenic noise from onshore and offshore development, whaling, changes in availability, quantity and quality of prey, toxic spills, and ship strikes. Other treats identified with a low level of concern include epizootic diseases, entanglement in fishing gear, marine life observation activities, contaminants, and harmful algal blooms. The objective of the management plan is to ensure that anthropogenic threats in Canadian waters do not provoke a decline in the population or a reduction in the currently observed Canadian range through conservation and management measures, stewardship and protection of individuals, education and outreach, and research and monitoring.
Humpback whale (Western North Atlantic pop.) *Megaptera novaeangliae*	Not Listed	Not at Risk	Least Concern	• Humpback whales are common in the summer and can be sighted from the Gulf of Mexico to southeastern Labrador. Most sightings occur in coastal waters. Humpback whales undergo extensive seasonal migrations and have a number of distinct feeding aggregations. Newfoundland and Gulf of Maine subpopulations migrate to the Scotian Shelf and Slope during the summer months to forage. One feeding aggregation occurs in the Georges Bank and Gulf of Maine region. Passive acoustic data from the Northwest Atlantic Ocean have indicated that humpbacks are present year-round in the Gulf of Maine (Murray et al. 2014; Vu et al. 2012), and in winter months off the Scotian Shelf (Kowarski et al. 2018). • Species distribution models have identified the Scotian Shelf as a priority area for monitoring humpback whales (Gomez et al. 2020). Few have been sighted within the area during the winter; however, as noted above, most acoustic detections on the shelf edge have occurred during winter months, indicating that at least some individuals occur in Canadian waters year-round (Kowarski et al. 2018). The estimated North Atlantic population (including Gulf of Maine and Scotian Shelf stocks) is 7,698 based on genetic tagging data.
Minke whale *Balaenoptera acutorostrata*	Not Listed	Not at Risk	Least Concern	• The minke whale can be found from the Davis Strait in the north to the Gulf of Mexico. Minke whales have been sighted in the Study Area during the spring, summer and fall, with occasional winter sightings in adjacent Scotian Shelf areas.

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) *Scientific Name*	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
North Atlantic right whale *Eubalaena glacialis*	Endangered	Endangered	Endangered	• North Atlantic right whales have been detected acoustically in Canadian waters year-round, although the number of detections is lower in the winter (DFO 2019c). Range is along the Atlantic coast from the southeastern U.S. to the Scotian Shelf and extending into the Gulf of St. Lawrence, with the Roseway Basin Area to be Avoided (also SARA-designated Critical Habitat) located on the southwestern Scotian Shelf (Figure 3.24). They can be found feeding and socializing from the western end of Sable Island Bank to Browns Bank and have been sighted in Dawson and Verrill Canyons on the Scotian Slope. North Atlantic right whales have been observed and regularly acoustically detected in Emerald Basin, and this area has the highest number of acoustic detections of North Atlantic right whales on the Scotian Shelf outside of Roseway Basin (Davis et al. 2017). While surveillance and detection efforts increased considerably in 2018 relative to 2017, only low numbers of whales were observed in the Critical Habitat areas of Roseway and Grand Manan Basins (DFO 2019c). • Migration patterns typically bring them to the waters of the Scotian Shelf from July to October. Recent information suggests that the species is present in the Gulf of St. Lawrence and, by extension, the Scotian Shelf (assuming the typical north-south migration routes), from late April to mid-January (DFO 2018b). There has been an increase in the presence of North Atlantic right whales in the Gulf of St. Lawrence beginning in 2015 following an earlier decline in abundance and change in distribution in the Bay of Fundy starting in 2010 (DFO 2019c). • Davis et al. (2017) used passive acoustic monitoring data from 2004 to 2014 to capture year-round presence of North Atlantic right whales in the western North Atlantic Ocean. The study demonstrated nearly continuous year-round presence across their entire habitat range suggesting that not all of the population undergoes a consistent annual migration (Davis et al. 2017). Data that were collected post-2010 showed an increased presence in the mid-Atlantic region and a simultaneous decrease in the northern Gulf of Maine (Davis et al. 2017). • The Grand Manan Basin and Roseway Basin, as well as areas in between, have been identified as suitable habitat for North Atlantic right whales using species distribution models specific to the Scotian Shelf and the Bay of Fundy (DFO 2019c).

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) *Scientific Name*	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
				• The North Atlantic right whale primarily feeds on copepods and other zooplankton. The primary driver of the presence of North Atlantic right whales is the density and availability of its main prey, the copepod Calanus spp. There have been significant changes in the abundance of Calanus in eastern Canadian waters since 2010 (DFO 2019c). While there is interannual variability, biomass of Calanus in most areas has declined, with the greatest declines observed in the Gulf of Maine and on the Scotian Shelf (DFO 2019c).
North Atlantic right whale *Eubalaena glacialis*	Endangered	Endangered	Endangered	• The western North Atlantic population size was estimated to be 450 individuals as of 2016. In 2018, the population was estimated to be about 411 animals. In 2017, the North Atlantic right whale suffered an unprecedented population loss of 12 individuals in the Gulf of St. Lawrence and another five individuals in US waters.Protecting the species is a top priority for DFO. Following this unusual mortality event, there were no right whale deaths in Canadian waters in 2018; however, there were three in US waters. According to the 2019 North Atlantic Right Whale Consortium Report Card, 10 mortalities were confirmed in 2019 (nine of which were in Canadian waters, with the remaining one in US waters) (Pettis 2020). As of June 2020, there has been one death reported in US waters and none in Canadian waters. When possible, necropsies were conducted on whale carcasses to determine cause of death. Where preliminary cause of death could be determined, the most common cause was vessel strike, followed by entanglement (NOAA 2020a). The total number of confirmed whale mortalities in the last three years was 30, whereas the the number of calf births was only 12 (Pettis 2020). • Since whaling ended, the most obvious threats that are potentially depressing the growth rate of the North Atlantic right whale population are strikes by vessels and entanglements in fixed fishing gear (Brown et al. 2009; DFO 2014a). Habitat degradation, which may result from contaminants, acoustic disturbances, vessel presence disturbance or changes in food supply, may also be contributing to the North Atlantic right whale population's failure to recover more rapidly. (Brown et al. 2009; DFO 2014a).The recovery strategy for the North Atlantic right whale (Brown et al. 2009; DFO 2014a) lists the following recovery objectives: (1) reduce mortality and injury as a result of vessel strikes; (2) reduce mortality and injury as a result of fishing gear interactions (entanglement and entrapment); (3) reduce injury and disturbance

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
				as a result of vessel presence or exposure to contaminants and other forms of habitat degradation; (4) monitor population and threats; (5) increase understanding of life history characteristics, low reproductive rate, habitat and threats to recovery through research; (6) support and promote collaboration for recovery between government agencies, academia, environmental non-government groups, Indigenous groups, coastal communities and international agencies and bodies; and (7) develop and implement education and stewardship activities that promote recovery. • While none of the deaths were attributable to petroleum activities, the species regularly transits the Scotian Shelf and Slope area, including the Study Area, possibly residing in the Study Area for weeks or longer. Any future project-specific EAs for programs proposed within the Study Area parcels should consider these population losses into account when assessing potential project-related effects on the North Atlantic right whale.
Sei whale *Balaenoptera borealis*	Not Listed	Endangered	Endangered	• In Atlantic Canadian waters sei whales can be found from Georges Bank and the Bay of Fundy in the south to Baffin Island in the north. During the summer and early autumn months, a large portion of the population can be found on the Scotian Shelf. The species can be found in both nearshore waters (typically deeper than ~ 40 m) throughout the continental shelf and offshore to the edge of the EEZ and beyond (COSEWIC 2019). Sightings are rare in the Gulf of St. Lawrence and this area does not appear to be key habitat for sei whales (COSEWIC 2019). Recent aerial surveys and studies to detect sei whale vocalizations support this general distribution pattern (COSEWIC 2019). They are frequently detected acoustically along the Scotian Shelf, the Grand Banks and off Labrador to ~55.6°N (COSEWIC 2019). • Species distribution models have identified the Scotian Shelf and Bay of Fundy as priority areas for monitoring sei whales (Gomez et al. 2020).
Odontocetes (Toothed Whales)				
Atlantic bottlenose dolphin *Tursiops truncatus*	Not Listed	Not at Risk	Least Concern	• Found in coastal and continental shelf water of tropic and temperate regions and are considered generalists in terms of habitat. This species is occasionally sighted on the Scotian Shelf and Slope in spring, summer and fall, with a few sightings also reported in winter months.

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Atlantic spotted dolphin *Stenella frontalis*	Not Listed	Not at Risk	Least Concern	• Found in tropical and warm temperate waters in the Northwest Atlantic. Species distribution ranges from southern New England to as far south as Venezuela. Typically found on the continental shelf edge and slope. This species does not regularly occur on the Scotian Shelf and Slope.
Atlantic white-sided dolphin *Lagenorhynchus acutus*	Not Listed	Not at Risk	Least Concern	• Atlantic white-sided dolphins are distributed throughout the continental shelf and slope areas of the North Atlantic. Atlantic white-sided dolphins prefer depths of less than 100 m, although many sightings have occurred at depths in excess of 100 m. They have been sighted on the Scotian Shelf and Slope in spring, summer and fall, with a few sightings also reported in winter months. Species distribution models have identified the Scotian Shelf and Bay of Fundy as priority areas for monitoring Atlantic white-sided dolphins (Gomez et al. 2020).
Beluga whale (St. Lawrence Estuary pop.) *Delphinapterus leucas*	Endangered	Endangered	Least Concern	• Generally found in seasonally ice-covered Arctic and sub-Arctic waters. In eastern Canada, their occurrence outside the Gulf of St. Lawrence is rare. Spring is an important feeding period for this population and the timing and extent of seasonal movements are likely influenced by sea ice, food availability and predation risk. In general, this population occurs in the St. Lawrence Estuary during summer months and then migrates eastward into the northwestern Gulf of St. Lawrence during the fall and winter; as a result, their occurrence on the Scotian Shelf and Slope is rare. • The recovery strategy for beluga whale (DFO 2012a) identifies ten threats to the recovery of the St. Lawrence beluga population in this strategy. Four of these threaten the population as a whole: contaminants, anthropogenic disturbances, reduction in prey availability and quality, and other degradation of habitat. Three threats can disturb or cause the death of a number of individual whales annually: ship strikes, entanglement in fishing gear, and scientific research activities. Finally, three occasional threats can hinder the recovery of the St. Lawrence belugas: the discharge of toxic substances, harmful algal blooms, and epizootic diseases. The recovery strategy identifies six recovery objectives for the beluga whale: (1) reduce contaminants in belugas, their prey, and their habitat; (2) reduce anthropogenic disturbances; (3) ensure adequate and accessible food supplies; (4) mitigate the effects of other threats to population recovery; (5) protect the beluga habitat in its entire distribution range; and (6) ensure regular monitoring of the St. Lawrence Estuary beluga population.

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
False killer whale *Pseudorca crassidens*	Not Listed	Not at Risk	Near Threatened	• Distributed worldwide throughout warm temperate and tropical oceans. Generally found in offshore waters but has been observed in coastal waters. While records of false killer whales in the NW Atlantic are not common, the combination of sighting, stranding, and bycatch records indicate that this species occurs.
Harbour porpoise (Northwest Atlantic pop.) *Phocoena phocoena*	Not Listed	Special Concern	Least Concern	• Harbour porpoises are widely distributed over the continental shelves of the northern hemisphere and occur on the Scotian Shelf and Slope year-round. The estimated population size of harbour porpoises in the Gulf of Maine/Bay of Fundy region is 89,054 based on 2006 surveys conducted in the region.Species distribution models have identified the Bay of Fundy and the northern area of the Scotian Shelf as priority areas for monitoring harbour porpoise (Gomez et al. 2020).
Killer whale (Northwest Atlantic / Eastern Arctic pop.) *Orcinus orca*	Not Listed	Special Concern	Data Deficient	• Killer whales occur in the Northwest Atlantic and eastern Canadian Arctic and can be found from Baffin and Hudson Bay to US coastal waters. The size of the Northwest Atlantic-Eastern Arctic population is not known. Killer whales are occasional visitors to the area, although rarely seen.
Long-finned pilot whale *Globicephala melas*	Not Listed	Not at Risk	Least Concern	• Long-finned pilot whales can be found on the Scotian Shelf and Slope year-round. The species can be found frequenting coastal waters of Cape Breton during the summer months and moving further offshore during the winter.Species distribution models have identified the Scotian Shelf as a priority area for monitoring long-finned pilot whales (Gomez et al. 2020).
Northern bottlenose whale (Scotian Shelf pop.) *Hyperoodon ampullatus*	Endangered	Endangered	Data Deficient	• Northern bottlenose whales are found only in the North Atlantic Ocean. The Scotian Shelf population inhabits deep waters (>500 m) along the continental slope off Nova Scotia and southeastern Newfoundland. The majority of sightings to date have been in three adjacent submarine canyons on the eastern Scotian Shelf: the Gully, Shortland Canyon, and Haldimand Canyon. These canyons are located to the east of the Study Area and have been identified as critical habitat for the population under SARA. A Critical Habitat Order was recently published, ensuring legal protection from destruction under SARA. The importance of inter-canyon areas located between designated critical habitat was recently assessed by DFO (2020). Stationary passive acoustic recorders deployed over two years (2012–2014) showed northern bottlenose whale presence and foraging activity in inter-canyon areas throughout the year (DFO 2020). Important habitat for the northern bottlenose population may exist

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) *Scientific Name*	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
				outside these areas and passive acoustic monitoring efforts have recently been expanded to include other areas along the Scotian Shelf, and when available, these data will provide new information on the seasonal presence and foraging activities of northern bottlenose whales (DFO 2020). • Gomez et al. (2017) developed species distribution models to predict priority areas in which to target and enhance northern bottlenose whale monitoring efforts in eastern Canada. High and moderate priority areas for northern bottlenose whales were situated along the outer margins of the Scotian Shelf. The eastern Scotian Shelf was also identified as a relatively high priority area (Gomez et al. 2017). • Stanistreet et al. (2017) used passive acoustic monitoring at six sites in the western North Atlantic Ocean and found that northern bottlenose whale detections occurred only at the Mid-Gully site; however, it is possible that northern bottlenose whales were present but not detected at other recording sites as the detection criteria were not adjusted to optimally detect the lower frequency clicks of this species in all data sets (Stanistreet et al. 2017). • Within the Study Area, there have been sightings primarily along the Shelf Break, including along the Baccaro and LaHave Banks (Figure 3.21), and into deeper waters off the slope. This species is non-migratory with mating and calving occurring in August. They are known to be extremely curious and will investigate vessels or equipment. • The Scotian Shelf population is small, with an estimated 143 individuals as of 2013 (O'Brien and Whitehead 2013). Underwater sound is of particular concern to this species as it relies on sound to carry out life functions, including foraging, socializing and navigation. The deep-diving behaviour of this species may make them especially vulnerable to physiological impacts from acoustic disturbance.
Northern bottlenose whale	Endangered	Endangered	Data Deficient	• Threats to northern bottlenose whales, as identified in the recovery strategy (DFO 2010a), include entanglement in fishing gear, oil and gas activities, acoustic disturbance, contaminants, changes to food supply, and vessel strikes. The recovery

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
(Scotian Shelf pop.) *Hyperoodon ampullatus*				strategy identifies four recovery objectives for northern bottlenose whales on the Scotian Shelf. These include: (1) improve understanding of northern bottlenose whale ecology, including critical habitat requirements, carrying capacity, breeding, trophic interactions, links with other populations (e.g., Davis Strait), and sources of mortality; (2) improve understanding of the population size, trend and distribution; (3) improve understanding of and monitor anthropogenic threats, including fishing gear interactions, petroleum development, noise, and contaminants, and develop management measures to reduce threats where necessary; and (4) engage stakeholders and the public in recovery action through education and stewardship.
Risso's dolphin *Grampus griseus*	Not Listed	Not at Risk	Least Concern	• This species is found globally in tropical and temperate waters and occurs in the Northwest Atlantic from Florida to eastern Newfoundland. This species occupies a narrow niche, which is the steep upper continental slope where water depths usually exceed 300 m. This species is sighted occasionally on the Scotian Shelf and Slope.
Sowerby's beaked whale *Mesoplodon bidens*	Special Concern	Special Concern	Data Deficient	• Only found in the North Atlantic with some known occurrence along the Scotian Shelf but not often sighted; have been seen in the Gully Marine Protected Area (MPA). In recent years, sightings have significantly increased in the Gully, Shortland and Haldimand Canyons, east of the Study Area. There have been sightings within the Study Area along the shelf edge. Habitat tends to concentrate around shelf edges and slopes. Sowerby's beaked whales were detected on 15% of 304 recording days at a site on Georges Bank using passive acoustic monitoring (Stanistreet et al. 2017). • Underwater sound is of particular concern to this species as it relies on sound to carry out its life functions, including foraging, socializing and navigation. Threats to Sowerby's beaked whale, as identified in the recovery strategy (DFO 2016b), include exposure to acute noise, exposure to chronic noise, entanglements, vessel strikes, and contaminants. Three conservation measures are organized under three broad strategies: (1) research and monitoring; (2) management; and (3) engagement and public outreach. In terms of research and monitoring, the strategy seeks to improve understanding of Sowerby's beaked whale biology, behaviour, population size and trends, and distribution, as well as the threats posed to the species by human activities. In terms of management, the strategy seeks to appropriately monitor and mitigate known threats to the Sowerby's beaked whale and its habitat through the application of regulatory and non-regulatory measures. In terms of engagement and

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
				public outreach, the strategy seeks to increase stakeholder and public involvement in, and awareness of, the Sowerby's beaked whale and its threats by establishing regular communication, developing educational materials, and realizing collaborative stewardship opportunities.
Cuvier's beaked whale *Ziphius cavirostris*	Not Listed	Not at Risk	Least Concern	• This species is the most widely distributed beaked whale, with a distribution throughout almost all temperate, sub-tropical and tropical waters of the world as well as sub-polar and even polar waters in some areas (MacLeod et al. 2006). • Passive acoustic monitoring has detected Cuvier's beaked whale at sites in the Mid-Gully and Georges Bank (Stanistreet et al. 2017). Cuvier's beaked whales were detected on 26% of the 605 recording days at the Mid-Gully site, although their daily presence may be underestimated (Stanistreet et al. 2017). Cuvier's beaked whales were detected on 13% of the 304 recording days at the Georges Bank site (Stanistreet et al. 2017). • This species has rarely been encountered along the Scotian Shelf despite several decades of survey efforts (Whitehead 2013).
Short-beaked common dolphin *Delphinus delphis*	Not Listed	Not at Risk	Least Concern	• The common dolphin may be one of the most widely distributed cetacean species, inhabiting tropical, sub-tropical, and temperate areas. The species can be found on the Scotian Shelf year-round, commonly during summer and autumn once water temperatures increase above 11°C. • Species distribution models have identified the Scotian Shelf and the deep-water areas in the offshore margins of the Scotian Shelf as priority areas for monitoring short-beaked common dolphins (Gomez et al. 2020).
Sperm whale *Physeter macrocephalus*	Not Listed	Not at Risk	Vulnerable	• The sperm whale can be found along the Scotian Shelf edge and may be more common in the submarine canyons of the shelf, as it is regularly seen in the Gully. Sperm whales can also be found along the edge of the Laurentian Channel and can be commonly found in areas where water mixes to produce areas of high primary productivity. The sperm whale has been sighted more regularly on the eastern end of

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name (Population) ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
				the Scotian Shelf at depths of 200 m to 1,500 m, but can also occur at depths of less than 200 m. • Species distribution models have identified the deep water of the Scotian Shelf edge as a priority area for monitoring sperm whales (Gomez et al. 2020).
Striped dolphin *Stenella coeruleoalba*	Not Listed	Not at Risk	Least Concern	• The striped dolphin can be found from Cape Hatteras to the southern margin of Georges Bank and also offshore over the continental slope and rise in the mid-Atlantic regions. They prefer the warm waters found on the Shelf edge and are often seen in the Gully. Few striped dolphins have been sighted on the Scotian Shelf over the winter months.
White-beaked dolphin *Lagenorhynchis albirostris*	Not Listed	Not at Risk	Least Concern	• This species is found from Cape Cod to Greenland, often preferring waters less than 200 m in depth. The species is a year-round resident of the area inhabiting waters from Cape Cod to Greenland. • Species distribution models have identified the Bay of Fundy as a priority area for monitoring white-beaked dolphins (Gomez et al. 2020).
[1] Note that the IUCN designations refer to global populations rather than specific populations found in Canadian waters.				

Sources: Baird 2018; Braulik and Jefferson 2018; Braulik 2019a, 2019b; Breeze et al. 2002Cooke 2018a-2018f; COSEWIC 2008b, 2014a; COSEWIC 2019; Davis et al. 2017; DFO 1998, 2011a, 2011b, 2013l, 2014a, 2014b, 2017a, 2018c; Hammond et al. 2008a, 2008b; Kiszka and Braulik 2018 a, 2018b; Lowry et al. 2017; Minton et al. 2018; NOAA 2007b, 2014, 2015, 2016a, 2016b, 2017a, 2017b; OBIS 2019; Reeves et al. 2017; SARA 2012; Taylor et al. 2008a, 2008b, 2019; Waring et al. 2011; Wells et al. 2019

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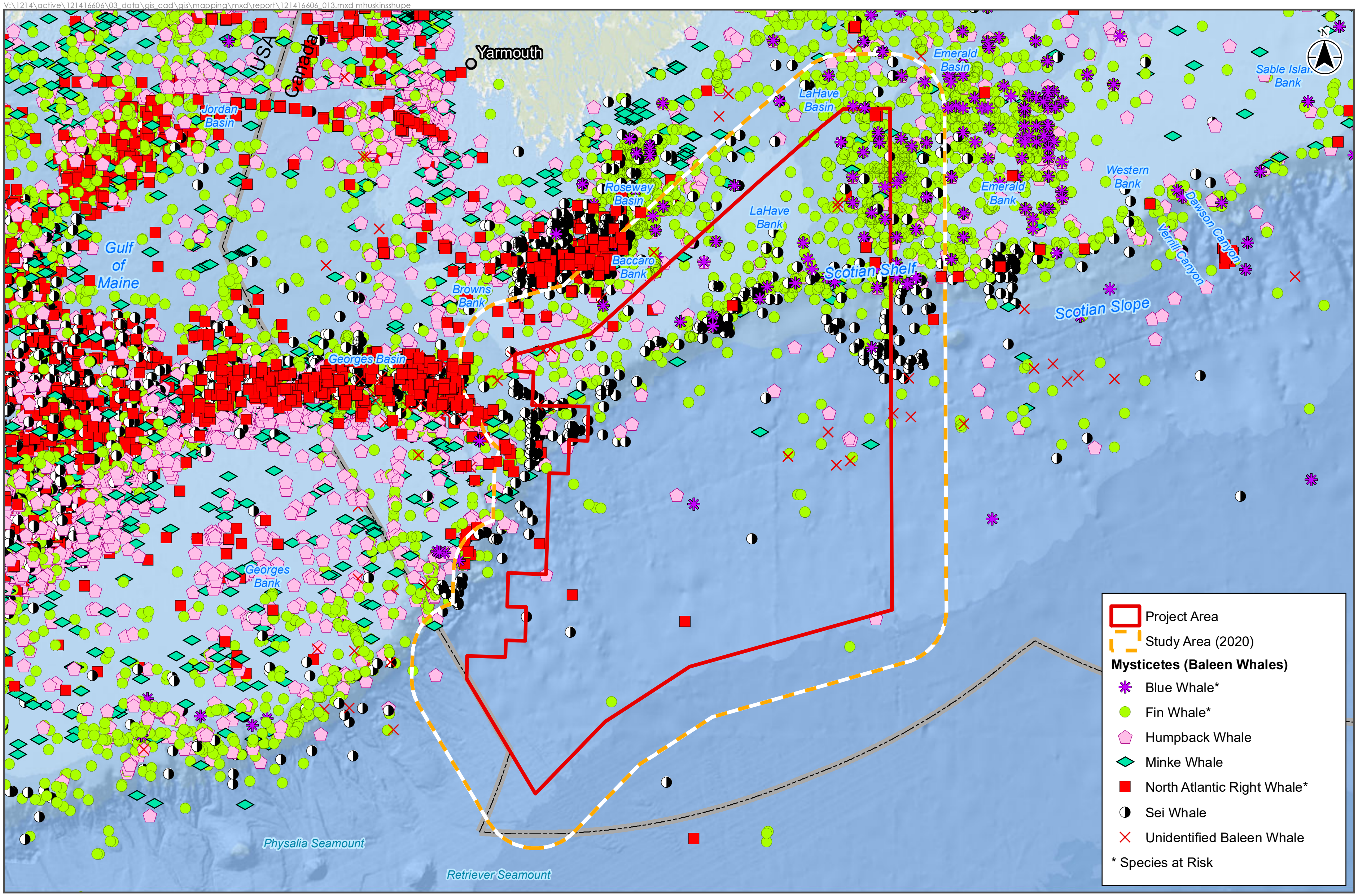

Basemap Sources: Canada Nova Scotia Offshore Petroleum Board and Government of Canada
Marine Mammal Data Source: Ocean Biodiversity Information System (OBIS) and
DFO Maritimes Region Whale Sightings Database (Whalesitng Database, Oceans and Ecosystem Sciences Division, Dartmouth, NS, 20200219)
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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Kilometres

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.
Maritimes Region Whale sightings database contains sightings data that is mainly opportunistic in nature

NAD 1983 UTM Zone 20N

Baleen Whale Sightings in the Study Area (1913 -2018)

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STRATEGIC ENVIRONMENTAL ASSESSMENT

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Figure 3.16

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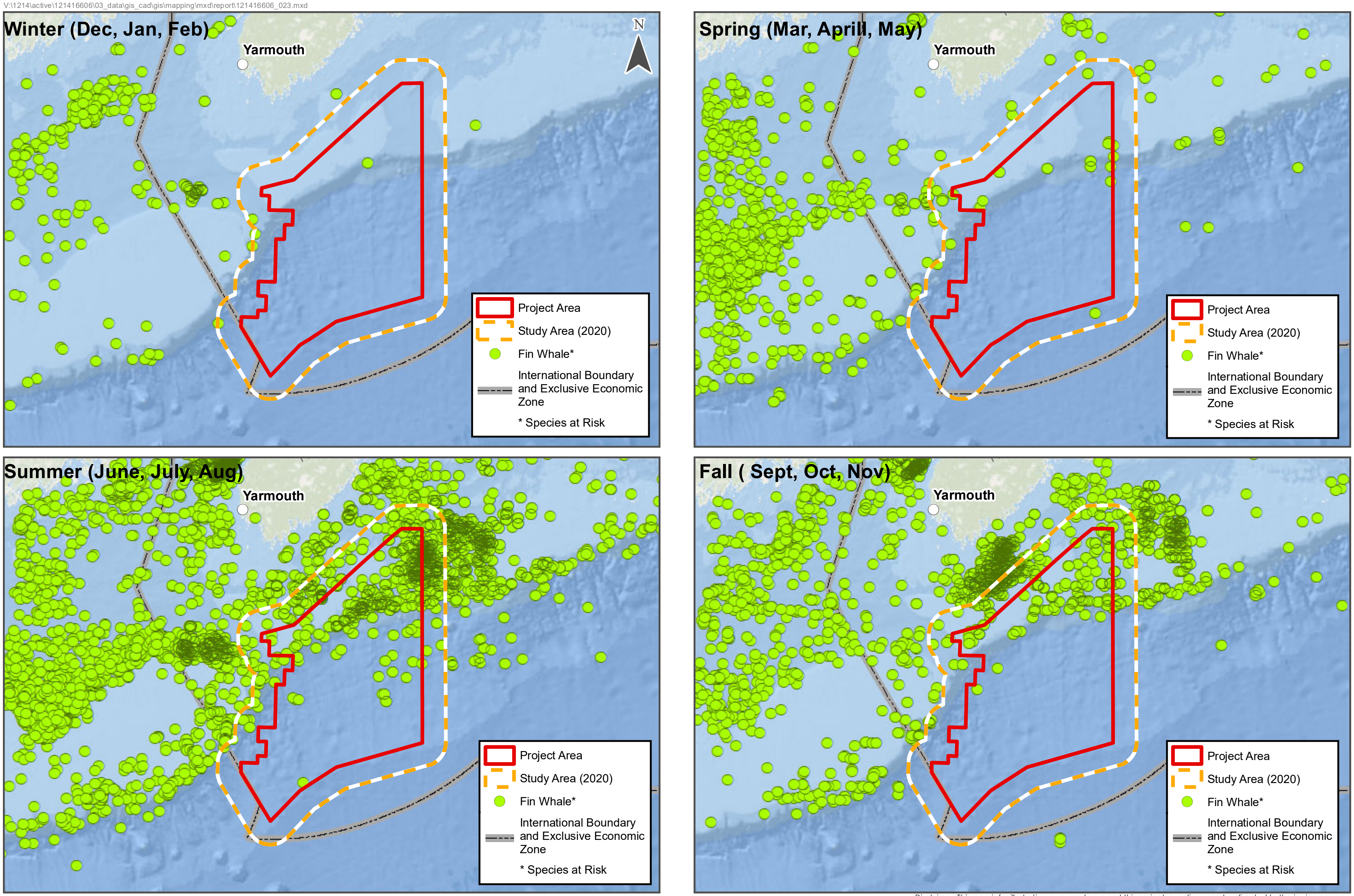

Basemap Sources: Canada Nova Scotia Offshore Petroleum Board, Government of Canada and DFO
Marine Mammal Data Source: Ocean Biodiversity Information System (OBIS) and
DFO Maritimes Region Whale Sightings Database (Whalesiting Database, Oceans and Ecosystem Sciences Division, Dartmouth, NS, 20200219)
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Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.
Maritimes Region Whale sightings database contains sightings data that is mainly opportunistic in nature.

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Fin Whale Sightings in the Study Area by Season (1964-2018)

Figure 3.17

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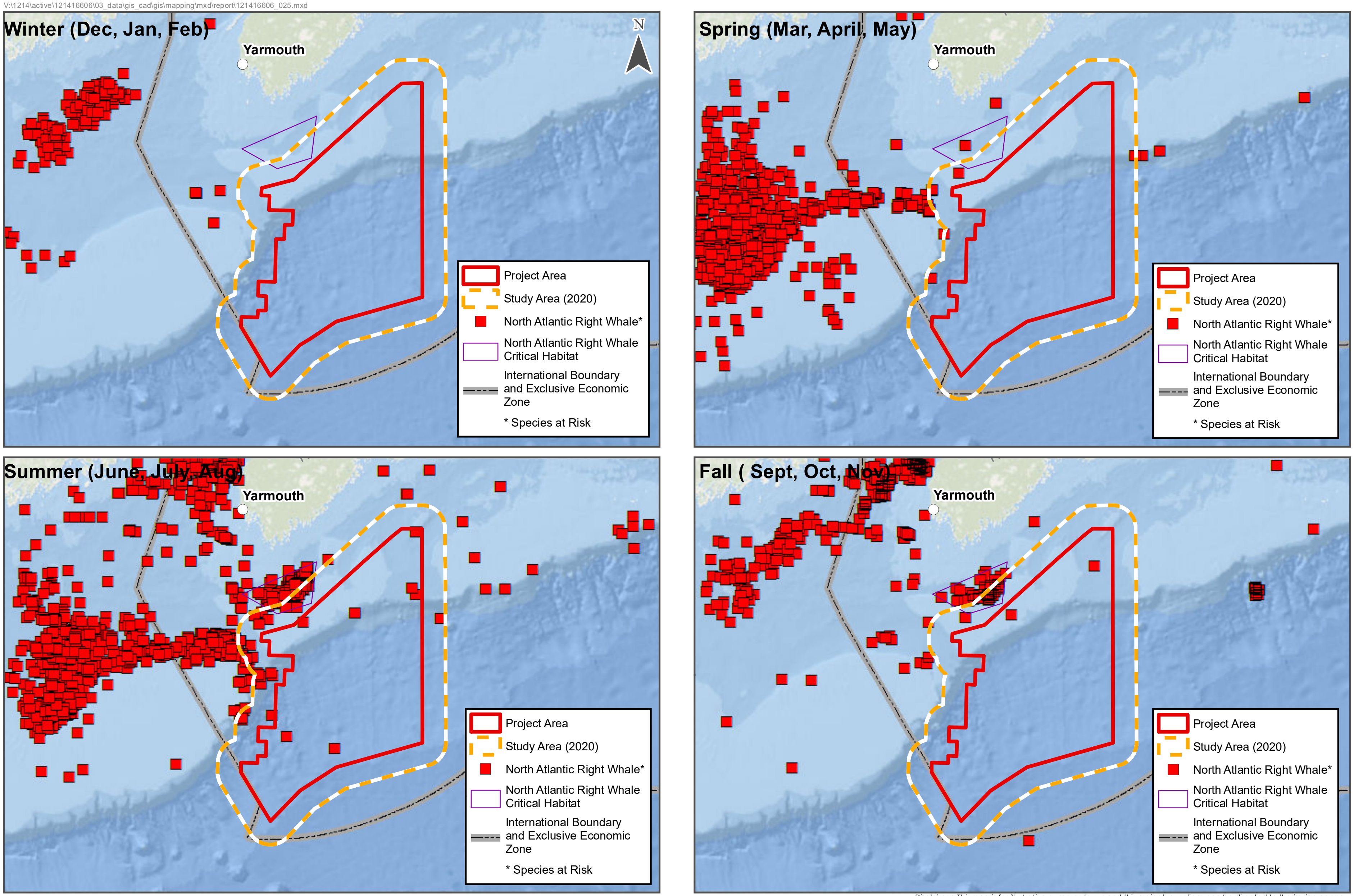

Basemap Sources: Canada Nova Scotia Offshore Petroleum Board and Government of Canada
Marine Mammal Data Source: Ocean Biodiversity Information System (OBIS) and
DFO Maritimes Region Whale Sightings Database (Whalesiting Database, Oceans and Ecosystem Sciences Division, Dartmouth, NS, 20200219)
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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Kilometres

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.
Maritimes Region Whale sightings database contains sightings data that is mainly opportunistic in nature.

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North Atlantic Right Whale Sightings in the Study Area by Season (1968-2017)

Figure 3.18

STRATEGIC ENVIRONMENTAL ASSESSMENT

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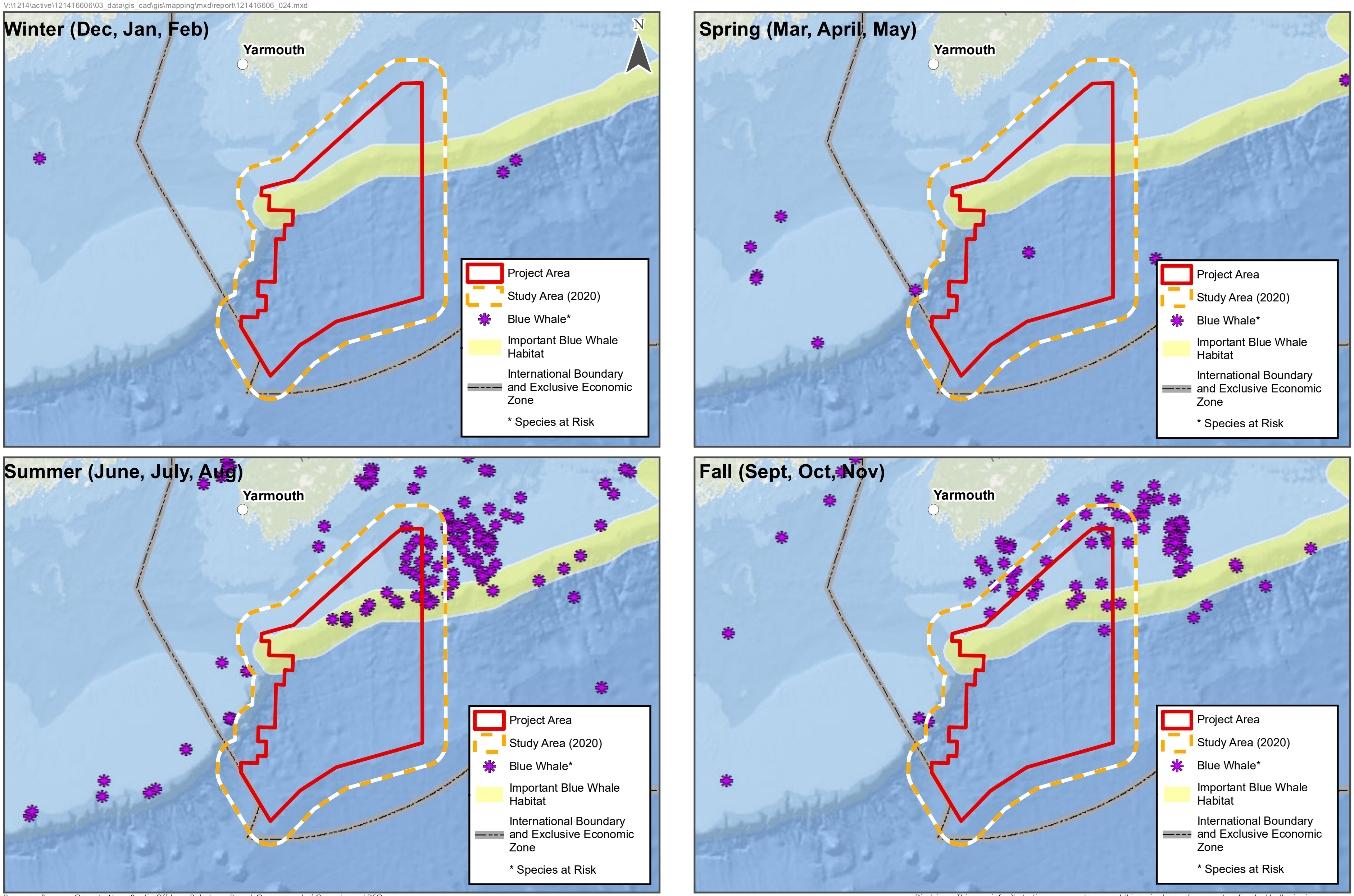

Basemap Sources: Canada Nova Scotia Offshore Petroleum Board ,Government of Canada and DFO
Marine Mammal Data Source: Ocean Biodiversity Information System (OBIS) and
DFO Maritimes Region Whale Sightings Database (Whalesiting Database, Oceans and Ecosystem Sciences Division, Dartmouth, NS, 20200219)
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Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.
Maritimes Region Whale sightings database contains sightings data that is mainly opportunistic in nature.

NAD 1983 CSRS UTM Zone 20N

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Blue Whale Sightings in the Study Area by Season (1966-2017)

Figure 3.19

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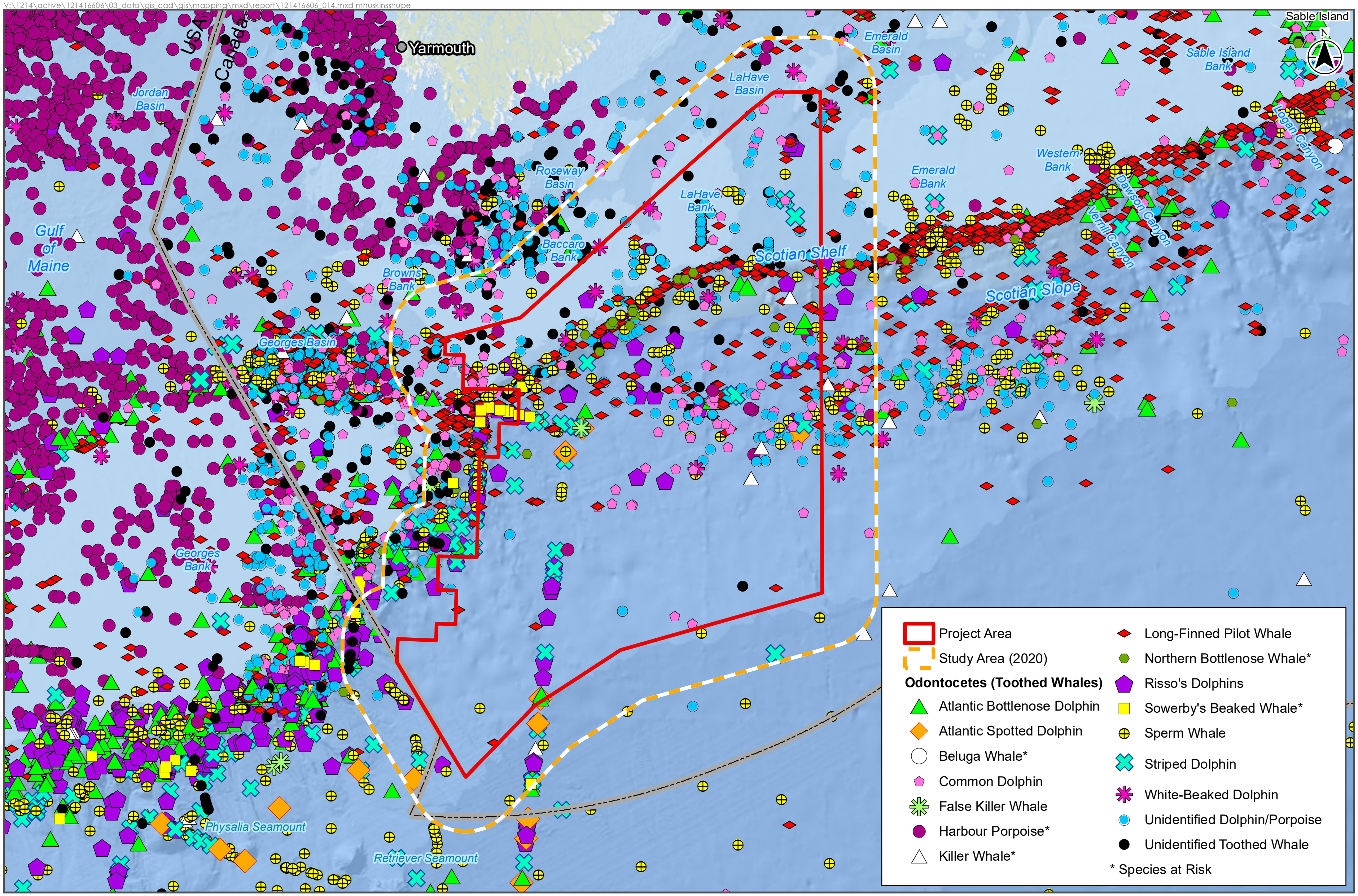

Basemap Sources: Canada Nova Scotia Offshore Petroleum Board and Government of Canada
Marine Mammal Data Source: Ocean Biodiversity Information System (OBIS) and
DFO Maritimes Region Whale Sightings Database (Whalesiting Database, Oceans and Ecosystem Sciences Division, Dartmouth, NS, 20200219)
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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Kilometres

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.
Maritimes Region Whale sightings database contains sightings data that is mainly opportunistic in nature

Toothed Whale Sightings in the Study Area (1963 - 2016)

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STRATEGIC ENVIRONMENTAL ASSESSMENT

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Figure 3.20

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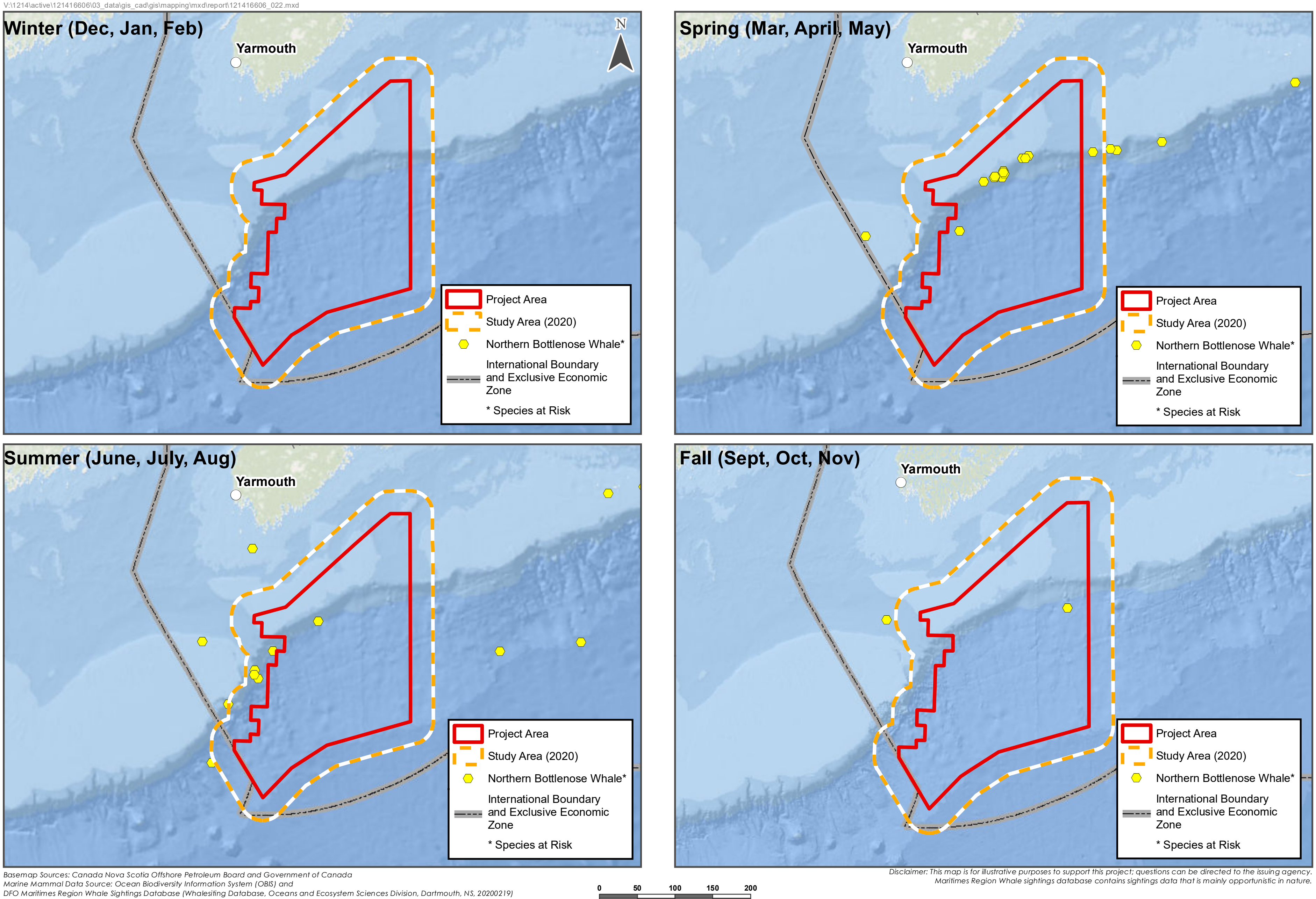

Basemap Sources: Canada Nova Scotia Offshore Petroleum Board and Government of Canada
Marine Mammal Data Source: Ocean Biodiversity Information System (OBIS) and
DFO Maritimes Region Whale Sightings Database (Whalesiting Database, Oceans and Ecosystem Sciences Division, Dartmouth, NS, 20200219)
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.
Maritimes Region Whale sightings database contains sightings data that is mainly opportunistic in nature.

NAD 1983 CSRS UTM Zone 20N

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Northern Bottlenose Whale in the Study Area by Season (1967-2017)

Figure 3.21

3.2.6.2 Pinnipeds (Seals)

Seal species that could occur in the Study Area include grey seal, harbour seal, harp seal, hooded seal and ringed seal. Harbour seals occur in highest concentrations at near-shore habitats that provide haul-out locations for breeding and resting. For this reason, harbour seals are less common in the Study Area than in coastal areas of Nova Scotia. Outside the breeding and moulting periods, which are roughly one month each, grey seals spend the majority of their time at sea. On the Scotian Shelf, most grey seals use Sable Island as a central place to forage from. They also forage on the offshore banks or along the shelf edge, including within the Study Area, as has been established by several studies using satellite telemetry. No known important breeding or hauling out areas occur for seals in the Study Area.

On the Scotian Shelf, the most significant area for seals is located at Sable Island, which is located east of the Study Area in the Eastern Scotian Shelf. It is important for the breeding of grey seals, containing approximately 80% of the world's largest breeding population of grey seals. Sable Island no longer supports a significant breeding population of harbour seals. Seals feed off Sable Island and, in the Gully, year-round (DFO 2011b). Table 3.18 lists pinniped species found within the Study Area.

No seal populations within the Study Area are designated under SARA or assessed as endangered, threatened, or of special concern by COSEWIC. DFO is not required to record seal sightings in their marine mammal sightings database.

Table 3.18 Pinniped Species found within the Study Area

Common Name	Scientific Name	Potential Occurrence in Study Area
Grey seal	*Halichoerus grypus*	Forages in Study Area year-round on a wide range of demersal and small pelagic fishes. This is the only pinniped species with OBIS records occurring in the Study Area .The largest world-wide breeding population of grey seals occurs to the east of the Study Area, on Sable Island, where pupping occurs from mid-December to late January. The estimated total pup production for Sable Island in 2016 was 83,600 (with 95% confidence), an increase from the 62,054 pups in 2010. Smaller breeding colonies found on coastal islands along southwest Nova Scotia at Flat, Mud, Noddy, and Round Islands had a total pup production estimate for the four islands of 2,100 with 95% confidence. This is a five-fold increase from the 2010 count of approximately 417 pups.
Harbour seal	*Phoca vitulina*	Habour seals are typically found in nearshore water, where haul out locations are present. For this reason, they are not common in the Study Area. They may forage in the Study Area year-round. To the east of the Study Area, breeding population uses Sable Island for pupping mid-May to mid-June. However, it is expected that Sable Island may become a non-breeding site for harbour seals due in part to competition with an increasing grey seal population.
Harp seal	*Pagophilus groendlandica*	Occasionally found foraging in Study Area, although generally not found in waters of the Scotian Shelf
Hooded seal	*Cystophora cristata*	Occasionally found foraging in Study Area, although generally not found in waters of the Scotian Shelf.
Ringed seal	*Phoca hipsida*	Occasionally found foraging in Study Area, although generally not found in waters of the Scotian Shelf.

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

3.2.6.3 Sea Turtles

There are four species of sea turtles that can be found migrating and foraging within the Study Area (Table 3.19), including leatherback, loggerhead, green and Kemp's ridley sea turtles. Of these, only the leatherback turtle and the loggerhead turtle (both endangered) are known to regularly forage in Atlantic Canada waters. DFO used satellite tracking data to define important habitat for leatherback turtles in Atlantic Canada (DFO 2012c). The information generated by this exercise, along with other information, will be used to inform the identification of critical habitat in an amendment to the leatherback turtle recovery strategy. A draft version of this recovery strategy, including the draft critical habitat, was made available for consultation in 2014-2015. The draft critical habitat includes an area that occurs in the southern half of the Study Area extending from the southwest of the Study Area to include the edge of Georges Bank. Sea turtle sightings in the Study Area based on DFO's marine mammals sighting database are shown in Figure 3.22.

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

Common Name ***Scientific Name***	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Leatherback sea turtle *Dermochelys coriacea*	Endangered	Endangered	Vulnerable	• The leatherback turtle is the most commonly occurring sea turtle in the Western Scotian Shelf and Slope and has been observed throughout the Study Area (Figure 3.22). This species is the most widely distributed and largest of all marine turtles. Data comprised of satellite tracking studies as well as sighting information indicate that the species can be found in Atlantic Canadian waters from April to December. The Western Scotian Slope (which includes the Study Area) was noted as a high area of use for foraging by the species with the highest densities found from July to September. The distribution of the species generally shifts from the southwest shelf and slope to the northeast, as the foraging period progresses in the area. Draft critical habitat has been identified for this species in the southern half of the Study Area. Additional areas where the species is found in Atlantic Canadian waters include south of Georges Bank, the southeastern Gulf of St. Lawrence including Sydney Bight, the Cabot Strait, Magdalen Shallows, waters adjacent to the Laurentian Channel, and waters south of the Burin Peninsula off Newfoundland. Some of these areas have been identified as draft critical habitat as leatherbacks are known to actively forage in these areas. The geographic locations of the draft critical habitat will be identified in an amended recovery strategy (in development) (ECCC 2018). • The species distribution in Canadian waters is believed to be primarily based on foraging habitat. The leatherback turtle forages on gelatinous zooplankton and jellyfish, consuming an average of 330 kg/day, between April and December. While foraging, they spend approximately two-thirds of their time in the top 6 m of the water column. Approximately 50% of day and evening hours are spent at the surface. Leatherback turtles begin a migration south in September and October, although they have been observed to be in the vicinity of Georges Bank as late as November/December. Leatherbacks found in Atlantic Canada originate from nesting beaches in the Caribbean, South and Central America, and Florida. The leatherback sea turtle may swim more than 10,000 km between nesting locations in the tropics and foraging areas in the north. • The size of the seasonal foraging population in Atlantic Canadian waters is not known; however, sightings data suggest that the population in Canadian Atlantic waters numbers in the thousands.

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

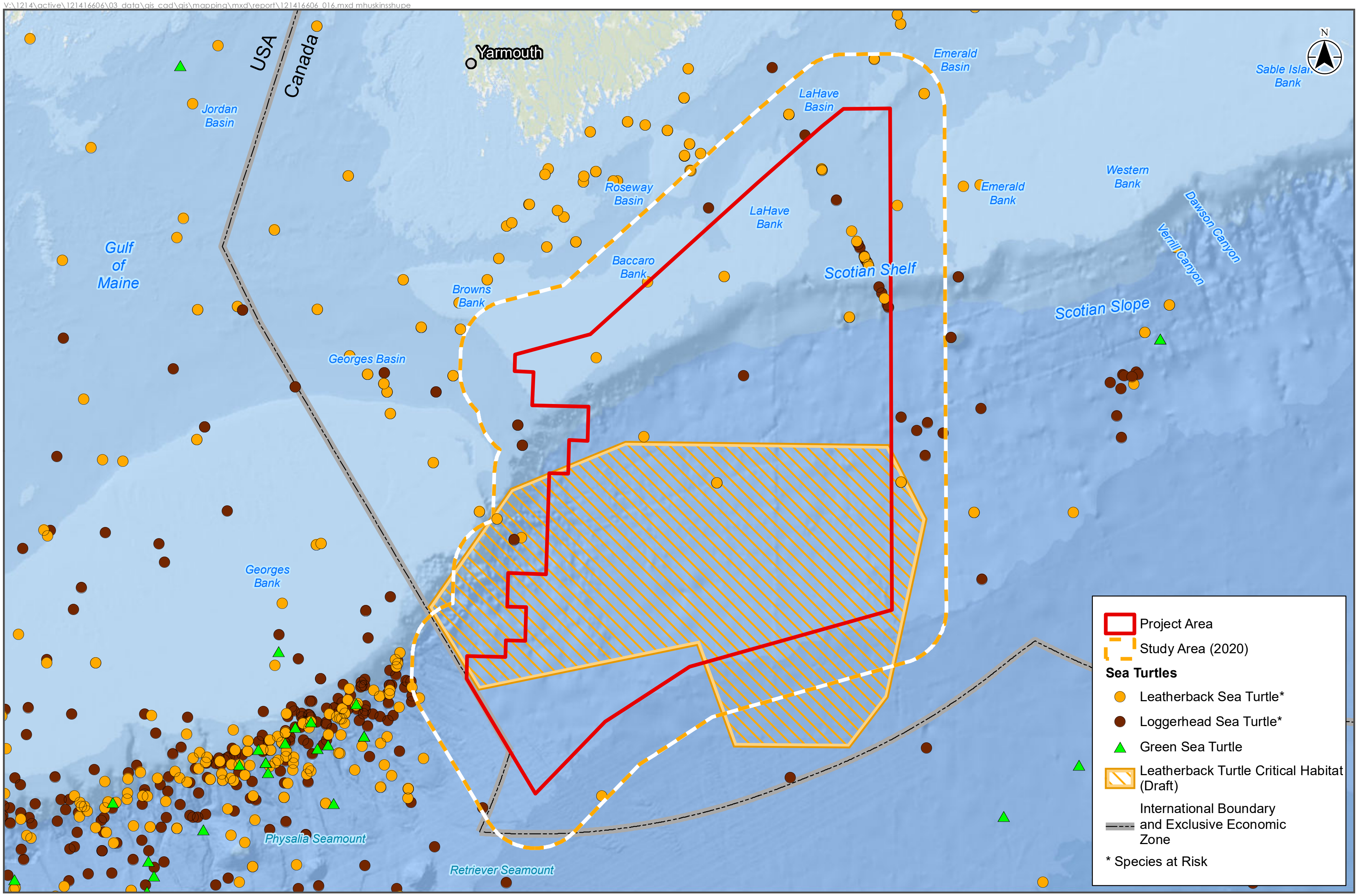
Common Name *Scientific Name*	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Leatherback sea turtle *Dermochelys coriacea*	Endangered	Endangered	Vulnerable	• The leatherback turtle is listed as *Endangered* under Schedule 1 of SARA. Interactions with fisheries pose a large threat to leatherbacks. A new Threat Assessment is underway and should be considered by any future project-specific EAs. They are caught incidentally by fisheries (as bycatch), which can lead to injury and mortality. Vertical and surface fishing lines also present a threat of entanglement to sea turtles throughout much of their range. Ship strikes can also injure or kill turtles. Outside of Canada, disturbance to nesting beaches, including coastal development and construction, threatens females and their eggs.
Loggerhead turtle *Caretta caretta*	Endangered	Endangered	Vulnerable	• Immature / juvenile loggerhead turtles, the size class most frequently found in Canadian waters, occur regularly at the edge of the Scotian Shelf and on the slope and are routinely found foraging on the Scotian Shelf and Slope and Georges Bank in the Study Area. The origins prior to entering Canadian water, their migration, or their temporal cycle have not yet been established, nor has it been established that juveniles return to Canadian waters on some temporal cycle (e.g. annual remigration to Canadian waters). In general, mature loggerhead sea turtles migrate from southern breeding grounds in the Southern US (breeding as far north as Virginia), Caribbean, Gulf of Mexico, and South America to temperate foraging grounds in the Northern Atlantic. The largest breeding colony in North America is in Florida. Recent findings have determined that not all loggerhead turtles leave the area during the winter months. Telemetry data has shown that some turtles move east and northeast during winter. • Loggerheads are vulnerable to threats through all of their life stages from egg to adult, in a variety of habitat types. Within Atlantic Canada, small and large juveniles are present. Threats to loggerheads within the broader Northwest Atlantic can affect the number of juveniles that come into Atlantic Canadian waters. Potential threats associated with offshore petroleum exploration include underwater noise, marine pollution (contaminants and debris), and vessel strikes.

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

Common Name *Scientific Name*	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Life History Characteristics**
Loggerhead turtle *Caretta caretta*	Endangered	Endangered	Vulnerable	• Loggerhead turtles are listed as *Endangered* under Schedule 1 of SARA and must be considered appropriately in future EAs/IAs in the Study Area. Threats assessed for both the Northwest Atlantic population as a whole and Canada include: bycatch in fisheries; entanglement (from debris such as ghost fishing gear); underwater noise; marine pollution (contaminants and debris ingestion); and vessel strikes. (DFO 2017b). Threats assessed that occur outside of Canada are harvesting (legal and illegal), coastal development and beach use, and artificial light (DFO 2017b). Of these, entanglement has the highest threat risk in Atlantic Canadian waters (DFO 2017b).
Kemp's ridley turtle *Lepidochelys kempii*	Not Listed	Not Listed	Critically Endangered	• Kemp's ridley turtle is the smallest of sea turtles. Occasionally seen in the waters of Nova Scotia, it is generally found further south. The Scotian Shelf is not a confirmed foraging area. Kemp's ridley are found stranded along the coast of Nova Scotia with some regularity, suggesting their presence offshore may be also regular. It is also possible that some Kemp's Ridleys observed by marine mammal and fisheries observers are misidentified as loggerheads.
Green turtle *Chelonia mydas*	Not Listed	Not Listed	Endangered	• The green sea turtle is unique among sea turtles in that it is herbivorous, feeding on plants. However, there is evidence that juvenile turtles in particular (the size class encountered in Canadian waters) are known to be omnivorous, eating jellyfish, crabs, and a suite of other marine animals (Bjorndal 1997; Nagaoka et al. 2012). Green sea turtles are widely distributed in tropical and sub-tropical waters between 30° North and 30° South. In the Western Atlantic they are found from the Gulf of Mexico to Massachusetts. The nesting season of the green sea turtle varies from location to location, but females usually nest in the summer months from June to July on beaches throughout their southern range. • A green sea turtle and green sea turtle—loggerhead hybrid recently documented in nearshore waters off Nova Scotia represent the most northerly confirmed records of green turtle in the Northwest Atlantic. There have also been opportunistic sightings of green sea turtles on the Grand Banks in the DFO sightings database, though these are not confirmed sightings. There is some evidence that the green sea turtle occurs regularly on the Scotian Shelf seasonally.

[1] Note that the IUCN designations refer to global populations rather than specific populations found in Canadian waters.

Sources: Casale and Tucker 2017; COSEWIC 2010e, 2012e; DFO 2011a, 2012b, 2017a; James et al. 2004, 2005, 2006; NOAA 2013m, 2013n; Price et al. 2017; Seminoff 2004; Shell Canada Limited 2013; Wallace et al. 2013; Wibbels and Bevan 2019



Basemap Sources: Canada Nova Scotia Offshore Petroleum Board and Government of Canada
Marine Mammal Data Source: Ocean Biodiversity Information System (OBIS) and
DFO Maritimes Region Whale Sightings Database (Whalesighting Database, Oceans and Ecosystem Sciences Division, Dartmouth, NS, 20200219)
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.
Maritimes Region Whale sightings database contains sightings data that is mainly opportunistic in nature

Sea Turtle Sightings in the Study Area (1979-2018)

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

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Figure 3.22

3.2.7 Marine and Migratory Birds

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

Data on pelagic seabird distribution on the east coast of Canada has been collected through various research programs for nearly 50 years. From 1965-1992, data on pelagic seabirds were collected under the Programme intégré de recherches sur les oiseaux pélagiques (PIROP). The PIROP program was designed to be implemented by professional biologists and interested volunteers and employed a simple survey protocol. A series of atlases were produced from these data to summarize pelagic seabird distribution in the northwest Atlantic (Brown et al. 1975, Brown et al. 1977, and Brown et al. 1986). Although this program was discontinued in 1992, the PIROP data are still used in offshore EAs (Gjerdrum et al. 2012a).

Following the 2004 crude oil spill at the Terra Nova Floating Production, Storage and Offloading vessel on the northeastern Grand Banks and the subsequent identification of a lack of area-specific seabird abundance information, the Environmental Studies Research Fund (ESRF) funded a 3.5-year project (2006 to 2009) to assess seabird abundance and distribution in multiple areas of oil industry activity in eastern Canada, including the Scotian Shelf. This resulted in the ESRF Offshore Seabird Monitoring Program (Fifield et al. 2009).

In 2005, the Canadian Wildlife Service (CWS) of Environment Canada reinstated the pelagic seabird monitoring program (Eastern Canadian Seabirds at Sea; ECSAS) with the intent to update information on the abundance, distribution and threats of seabirds occurring offshore, to minimize these threats, and increase awareness and support for seabird conservation (Gjerdrum et al. 2012a). Although this program relies on ships of opportunity (in addition to DFO's Atlantic Zone Monitoring Program [AZMP] surveys), it has adopted a more scientifically rigorous data collection protocol than the original PIROP program (Gjerdrum et al. 2012a). In 2018, the Atlas of Seabirds at Sea in Eastern Canada 2006-2016 was published, and all data were made available through ECCC.

The Atlas of Seabirds at Sea in Eastern Canada (2006-2016) seasonal distribution mapping for select species groups are presented in Appendix B. Mapping is presented for alcids, shearwaters, storm petrels, phalaropes, fulmar, gannets and gulls, which represent the majority of pelagic seabirds occurring in the Study Area. For each group, three seasonal maps are included, representing April to July, August to November, and December to March. The data indicated the density in which species in each of these groups were observed.

Table 3.20 lists marine bird species found within the Study Area. Shorebirds known to be present on the Scotian Shelf that could be found in the Study Area are also included. Special designations by SARA and/or COSEWIC are included, as applicable. The IUCN red list designation is also provided. Note that the IUCN designations may vary from SARA and COSEWIC status as it considers global populations. Project-specific EAs may need to consider non-breeding species that can be found in the Study Area. (e.g., Bermuda petrel, black-capped petrel).

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

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

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

Common Name *Scientific Name*	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Potential Occurrence in Study Area**
Wilson's storm-petrel *Oceanites oceanicus*	Not listed	Not at Risk	Least Concern	High potential for occurrence – Breeds in southern hemisphere and spends non-breeding season in North Atlantic. Observed in large flocks primarily between May and October.
Leach's storm-petrel *Oceanodroma leucorhoa*	Not listed	Not at Risk	Vulnerable	High potential for occurrence – Breeds in northern hemisphere (southern Labrador to Massachusetts). Species concentrates at fronts and eddies when feeding. Most abundant in Study Area between March and September.
Bermuda Petrel *Pterodroma cahow*	Not listed	Uncertain	Endangered	High potential for occurrence - Although the Bermuda petrel may pass through the Study Area for foraging purposes, it does not breed in the area and predominantly forages in other areas of the Atlantic, particularly areas south and around the Azores (Madeiros *et al.* 2014).
Thick-billed murre *Uria lomvia*	Not listed	Not at Risk	Least Concern	High potential for occurrence – Breeds in southern Labrador, north shore of Gulf of St. Lawrence and in Newfoundland, with largest colonies in the High Arctic. Found mainly in continental shelf waters. Small numbers winter on Georges Bank (December through May).
Common murre *Uria aalge*	Not listed	Not at Risk	Least Concern	High potential for occurrence – Most of common murres in Atlantic Canada breed in eastern Newfoundland. Observed in Study Area during winter.
Dovekie *Alle alle*	Not listed	Not at Risk	Least Concern	High potential for occurrence – Breeds in Greenland and present in Study Area between October and March.
Atlantic puffin *Fratercula arctica*	Not listed	Not at Risk	Vulnerable	High for occurrence – Breeds in North Atlantic. Widely dispersed offshore during the winter and observed in the Study Area.
Razorbill *Alca torda*	Not listed	Not at Risk	Near Threatened	High for occurrence – Breeds in boreal and low arctic regions of the north Atlantic and are observed in the Study Area between January and May.

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

Common Name *Scientific Name*	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Potential Occurrence in Study Area**
Northern gannet *Morus bassanus*	Not listed	Not at Risk	Least Concern	High potential for occurrence – In North America, breeds in six colonies in Quebec and Newfoundland. Birds dispersed over shelf waters in the winter. Are present in the Study Area during migration between northern breeding colonies and wintering grounds in the south (March through May and October through December).
Black-legged kittiwake *Rissa tridactyla*	Not listed	Not at Risk	Vulnerable	High potential for occurrence – Widely distributed, with largest breeding colonies in Atlantic Canada found in eastern Newfoundland and Gulf of St. Lawrence. Distributed offshore during migration, often along edge of sea ice, feeding over varying water depths. Most likely to occur in Study Area between October and April.
Neritic Seabirds				
Herring gull *Larus argentatus*	Not listed	Not at Risk	Least Concern	High potential for occurrence – In eastern North America, breeds along Atlantic coast from Baffin Island to Cape Hatteras. Most commonly observed close to land but also seen regularly offshore outside breeding season. Present in Study Area year-round.
Great black-backed gull *Larus marinus*	Not listed	Not at Risk	Least Concern	High potential for occurrence – Occur only in North Atlantic and breed from North Carolina to Hudson Strait. Most commonly observed close to land but also seen regularly offshore outside breeding season. Common in shelf waters in spring with significant proportion wintering on Georges Bank.
Common tern *Sterna hirundo*	Not Listed	Not at Risk	Least Concern	Moderate potential for occurrence – Breed at colonies in coastal Nova Scotia and along Gulf of Maine coast. May be present in Study Area during migration in May and September. Tend to occur closer to coastline.
Arctic tern *Sterna paradisaea*	Not Listed	Not at Risk	Least Concern	Low potential for occurrence – Breed at colonies in coastal Nova Scotia and along Gulf of Maine coast. May be present in Study Area during migration in May and September. Tend to occur closer to coastline.

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

Common Name *Scientific Name*	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Potential Occurrence in Study Area**
Roseate tern *Sterna dougallii*	Endangered	Endangered	Least Concern	Low potential for occurrence – Primarily a coastal species. Small population breeds almost exclusively on a small number of islands off Nova Scotia, Sable Island being one of them. Noted to be sensitive to increases in large shipping traffic and any possible beach activity on Sable Island.
Double-crested cormorant *Phalacrocorax auritus*	Not listed	Not at Risk	Least Concern	Low potential for occurrence – Common along coast in summer, breeding in the western Gulf of St. Lawrence and on the Atlantic coast of mainland Nova Scotia.
Great cormorant *Phalacrocorax carbo*	Not listed	Not at Risk	Least Concern	Low potential for occurrence – Common resident in Nova Scotia, breeding in colonies on cliff ledges in Nova Scotia. Fall migration begins in September with a substantial portion of the population wintering off New England.
Black guillemot *Cepphus grylle*	Not listed	Not at Risk	Least Concern	Low potential for occurrence – Common resident in Nova Scotia, breeding in coastal waters.
Waterfowl and Divers[a]				
Barrows goldeneye *Bucephala islandica*	Special Concern	Special Concern	Least Concern	Low potential for occurrence – A migratory duck that is largely concentrated in the Rocky Mountains with only a small portion of its population extending east to Atlantic Canada, wintering in coastal areas.
Harlequin duck *Histrionicus histrionicus*	Special Concern	Special Concern	Least Concern	Low potential for occurrence – Eastern population known to winter in Nova Scotia, along the coast with a preference for coastal islands.
Common loon *Gavia immer*	Not listed	Not at Risk	Least Concern	Low potential for occurrence – Immature loons are known to frequent coastal waters year round and adults frequent coastal waters in the winter months.
Red-throated loon *Gavia stellata*	Not listed	Not at Risk	Least Concern	Low potential for occurrence – Common transient, breeding in arctic and winters along Atlantic coast

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

Common Name *Scientific Name*	**SARA Schedule 1 Status**	**COSEWIC Designation**	**IUCN Red List[1]**	**Potential Occurrence in Study Area**
Shorebirds[b]				
Red phalarope *Phalaropus fulicaria*	Not listed	Not at Risk	Least Concern	High potential for occurrence – Breeds in circumpolar Arctic and migrates to winter in south temperate and subtropical / tropical waters. Generally found in Study Area feeding on the banks during fall and spring migration (particularly during northward migration in spring).
Red-necked phalarope *Phalaropus lobatus*	Special Concern	Special Concern	Least Concern	High potential for occurrence – Occur on Georges Bank during spring and fall migration. Western Bay of Fundy was historically an important fall staging area although numbers have been declining.
Piping plover (*melodus* subspecies) *Charadrius melodus melodus*	Endangered	Endangered	Near Threatened (*Charadrius melodus)*	Low potential for occurrence – Population inhabits sandy beach ecosystems throughout Atlantic Canada but is not known to inhabit Sable Island. Winters on the southern Atlantic coast of the U.S.
Savannah sparrow (Ipswich sparrow) *Passerculus sandwichensis princeps*	Special Concern	Special Concern	Least Concern (Passerculus sandwichensis)	Low potential for occurrence – Population nests almost exclusively on Sable Island. Winters in the mid-Atlantic U.S. Could occur during migration.

Notes:

[1] Note that IUCN designations refer to global populations rather than specific populations found in Canadian waters.

[a] This is not intended to be an exhaustive list of waterfowl. A number of other waterfowl species could occur (e.g., common eider, black scoter, white-winged scoter, surf scoter, long-tailed duck), although interactions with the Study Area are expected to be low. Those listed in the Table above are concentrated on species of special status that have a low potential for occurrence.

[b] This is not intended to be an exhaustive list of shorebirds. A number of other shorebird species could occur, although the Table above concentrates on shorebirds most likely to leave coastal waters and/or those which are species of special status that could occur in the Study Area.

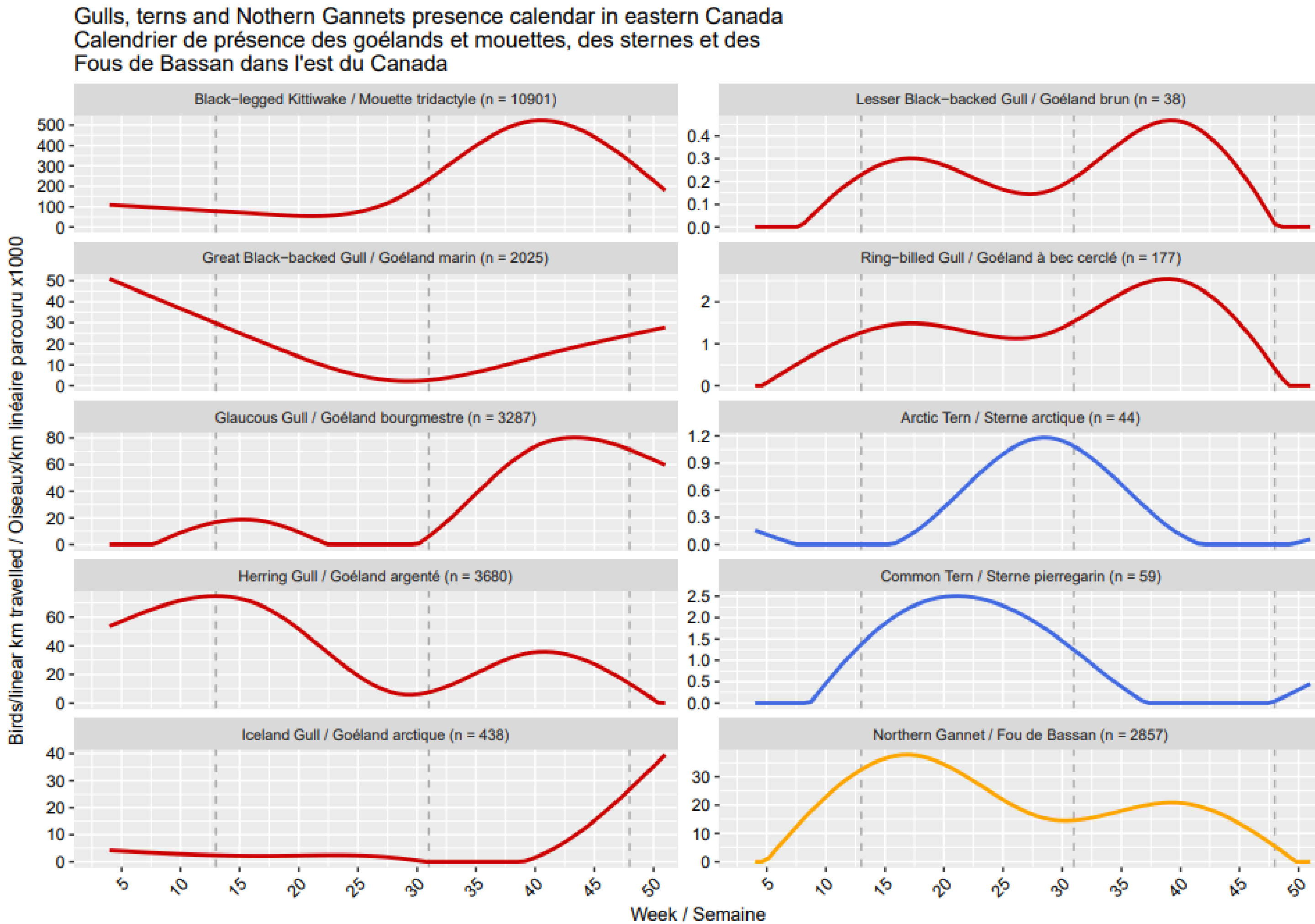
Sources: BirdLife International 2015, 2018a-w, 2019a-e; Brown 1986; DFO 2011a; Fifield et al. 1999; Gjerdrum et al. 2012a; LGL 2013; SARA 2012

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

Through their surveying and analysis, Fifield et al. (2009) identified several geographical areas that they deemed to be important to one or more species/groups of seabirds in one or more seasons. The Scotian Shelf and Laurentian Channel were grouped and designated as one of the geographical areas recognized as important, using the absolute densities of seabirds reported by Fifield et al. (2009). Specifically, they determined this to be one of the more productive regions for seabirds in their study area. The highest density in the entire study area at any time of year was recorded during the summer (May-August) in the Gulf of Maine. This was attributable to large aggregations of great shearwaters found there and in the western Scotian Shelf region. Although the study is relevant and important, it is acknowledged that the results of the Fifield study are somewhat limited as they are based on only three years of study and were collected from ships of opportunity.

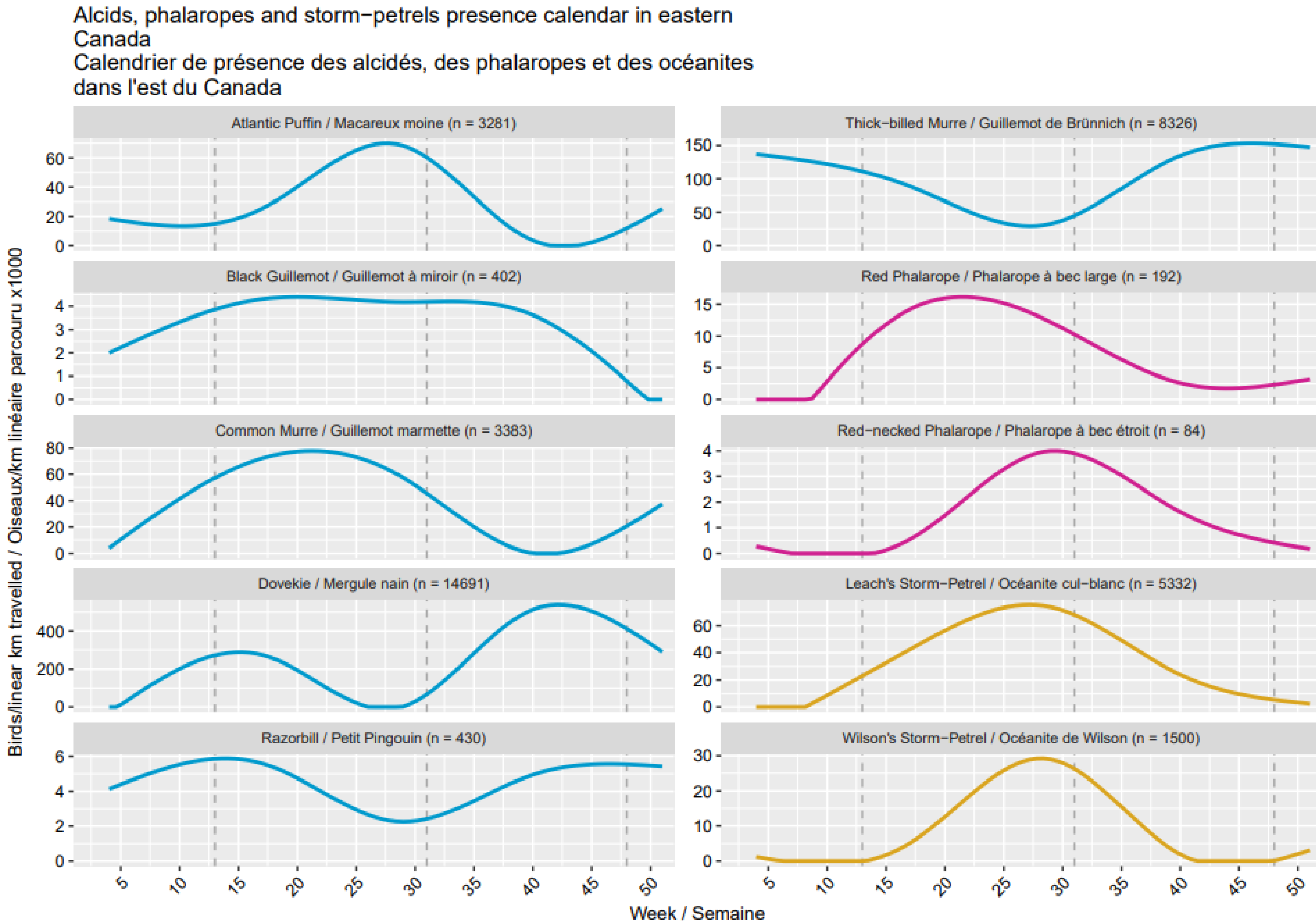
The Atlas of Seabirds at Sea in Eastern Canada 2006-2016 included seasonal occurrence graphs for a variety of species. These graphs are presented in Source: Bolduc et all. 2018 (Atlas of Seabirds at Sea in Eastern Canada 2006-2016), Figures 3.23 A, B and C and represent the seasonal distributions for all of Eastern Canada. Most species occur in the greatest numbers in the spring, summer and/or fall. The winter months (December, January and February) typically have low densities of marine birds, with notable exceptions. Several gulls, including great black- backed gull, Iceland gull and glaucous gull, occur in higher numbers in the winter, relative to other seasons. Manx shearwater and great skua both peak in abundance in December. In addition, some alcid species, including thick-billed murre and razorbill, occur in relatively higher numbers in the winter. Several species have presence that show two distinct peaks, typically occurring in the spring and fall (Source: Bolduc et all. 2018 (Atlas of Seabirds at Sea in Eastern Canada 2006-2016) Figures 3.23 A, B and C)).

This trend is associated with species that migrate through eastern Canada. For example, parasitic jaeger, pomarine jaeger, and several gulls (including glaucous, herring, lesser black-backed and ring-billed) show this trend, where at least a portion of the population of these species migrates to and from more northern breeding areas. Although abundance varies seasonally, certain species, including thick-billed murre and razorbills, occur in Eastern Canada year-round.



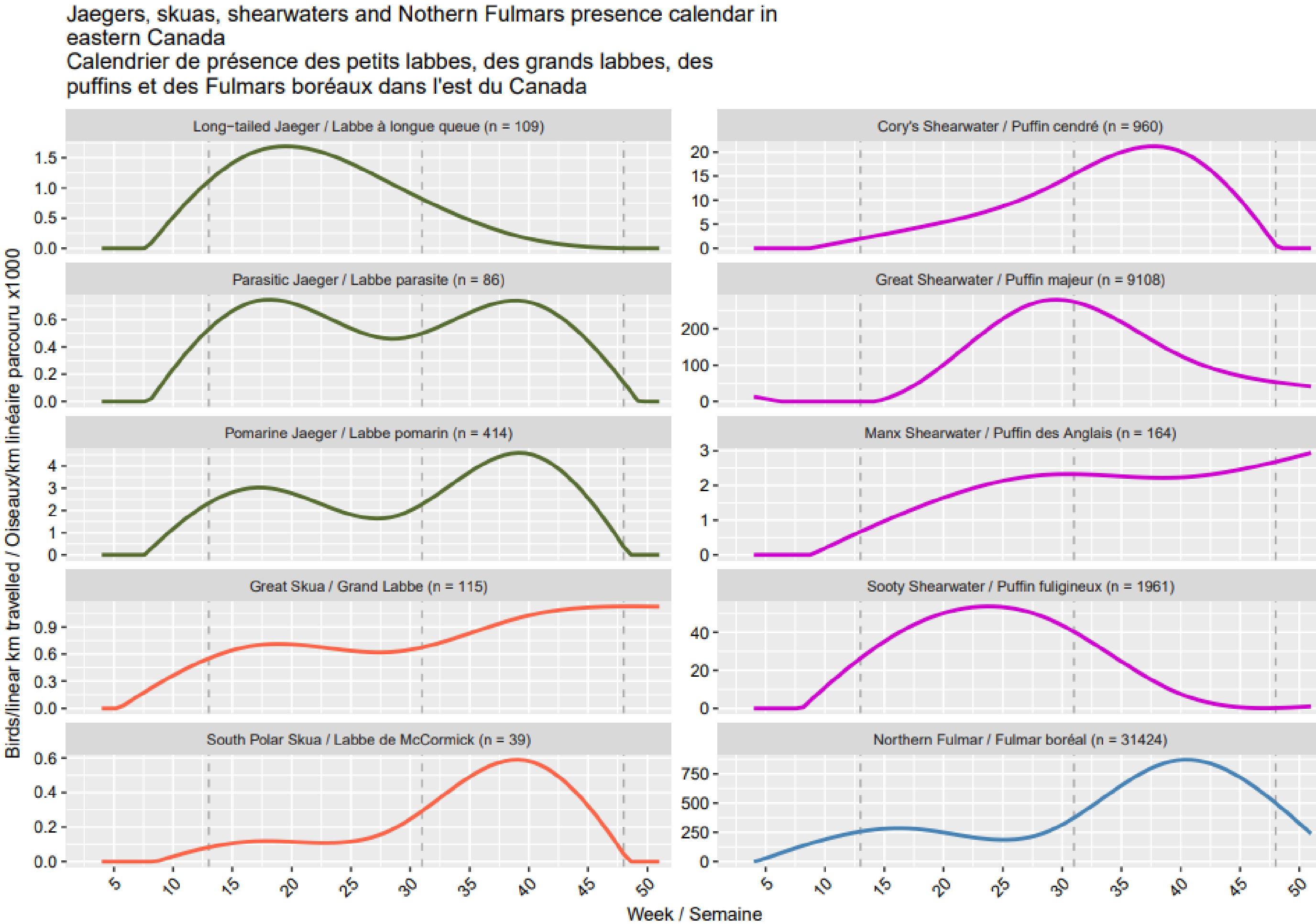
Source: Bolduc et al. 2018 (Atlas of Seabirds at Sea in Eastern Canada 2006-2016)

Figure 3.23A Marine Bird Seasonal Presence in Eastern Canada



Source: Bolduc et al. 2018 (Atlas of Seabirds at Sea in Eastern Canada 2006-2016)

Figure 3.23B Marine Bird Seasonal Presence in Eastern Canada



Source: Bolduc et al. 2018 (Atlas of Seabirds at Sea in Eastern Canada 2006-2016)

Figure 3.23C Marine Bird Seasonal Presence in Eastern Canada

Of the bird species of special status that can occur offshore Nova Scotia, all have a low potential for occurrence, with one exception. The red-necked phalarope is listed as *Special Concern* under SARA and has a moderate potential for occurrence in the Study Area. This species breeds in the Canadian Arctic and sub-Arctic and spends winters in tropical areas along South America. Red necked phalaropes have a high potential to occur in the Study Area during the spring or fall migrations, or while staging in the fall prior to migration (COSEWIC 2014b). Details on this species, as well as other marine bird species of special status are included in Table 3.20.

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

The Bermuda petrel is known to nest on several small islands in the Bermuda archipelago but it spends most its adult life on the open seas ranging from the North Atlantic coastal United States and Canada to waters off western Europe, particularly the Azores (Madeiros *et al.* 2014). This species was historically abundant in Bermuda but its population declined drastically because of habitat modifications, predation by introduced species, and human hunting pressure. It was considered extinct for almost three centuries until reported during the first half of the 20th century (IUCN 2018). Habitat restoration and reintroduction efforts have helped to increase the population to approximately 100 breeding pairs (Madeiros *et al.* 2014). Canada is considered to be within the range of the Bermuda petrel. The Bermuda petrel's presence in Canada is designated as "present - origin uncertain" by the IUCN (2018). Although infrequent and / or in low numbers, data indicates that the Bermuda petrel may forage in waters of the Scotian Shelf and Slope (Madeiros *et al.* 2014).

3.2.8 Special Areas

For the purpose of this SEA, special Areas within the Study Area include the Northeast Channel Coral Conservation Area, Corsair and Georges Canyon Conservation Area, the Sambro Bank Sponge Conservation Area, and the Western/Emerald Banks Conservation Area (including the Haddock Box), which are all recognized by DFO as marine refuges, as well as the Fundian Channel/Browns Bank Area of Interest (AOI) and several areas of importance for fish conservation, critical habitat for the North Atlantic right whale and leatherback sea turtle (draft), important Blue Whale Habitat, and six EBSAs. While fisheries closures may not have direct significance to oil and gas activities, they do generally indicate areas of importance for fish spawning and/or protection of juveniles, and therefore have been included for consideration.

Special Areas (including protected areas and fisheries conservation areas) are presented on Figure 3.24, and Figure 3.25 depicts EBSAs found near the Study Area. Tables 3.21 and 3.22 describe the Special Areas and EBSAs in the Study Area. EBSAs have been identified based on a compilation of ecological and biological data, scientific expert opinion, and traditional knowledge that was solicited through efforts to support integrated ecosystem-based management efforts on the Scotian Shelf (Doherty and Horsman 2007, King et al. 2016). Using the criteria of uniqueness, aggregation, fitness consequences, naturalness, and resilience, DFO experts identified EBSAs to address conservation objectives in accordance with the Oceans Act (Horsman et al. 2011). Although many EBSAs in the Study Area may not yet have official protection under the Oceans Act, they warrant consideration for conservation given the ecological and biological significance of the sites. Therefore, EBSAs are considered as Special Areas in the SEA process. The EBSAs presented on Figure 3.25 are based on King et al. (2016). DFO (2012d) outlines DFO's ocean planning process and objectives and how updated criteria are being used to help build a bioregional network of Marine Protected Areas (MPAs) on the Scotian Shelf.

In April 2019, the Government of Canada adopted a new approach to marine conservation, including protection standards to better conserve sensitive and important parts of our oceans. As part of this approach, Canada is continuing to grow and evolve its marine conservation networks across Canada. These networks will be made up of two distinct forms of protection: marine protected areas (MPAs) and other effective area-based conservation measures (OECM), including marine refuges. Figure 3.24 provides the areas where OECM are present in the Study Area. Currently there are no officially designated MPAs; however, the Fundian Channel-Browns Bank Area of Interest (AOI) (Figure 3.24) partly overlapping with the Study Area has the potential to become an MPA under the Oceans Act.

MPAs designated under the Oceans Act are marine areas that legally protect a range of species, habitats and features from the impacts of a variety of activities, including fishing. They provide many benefits for Canadians, from environmental to social and cultural contributions. Under the new management and protection strategy, Canada's MPAs will now function similar to national parks, by including new standards that prohibit four key industrial activities and will apply to new MPAs: oil and gas activities, mining, dumping, and bottom trawling. The Government of Canada will work with its partners and stakeholders to consider adopting the new protection standards within the existing MPAs as part of regular management review cycles. If an agreement is reached, the regulations for the MPA will be amended to prohibit the activity. If an agreement cannot be achieved, the MPA boundaries will remain unchanged but the area overlapping with the activity would no longer be counted towards Canada's marine conservation targets.

Marine refuges are another tool used to protect oceans. They offer more targeted protection to species and their habitat from the impacts of fishing. With respect to marine refuges, activities within these areas will be assessed on a case-by-case basis and will be allowed if they are consistent with the conservation objectives of the specific area. Before any proposed activity can take place, the Minister of Fisheries, Oceans and the Canadian Coast Guard will need to be satisfied that any risks to the area have been avoided or mitigated effectively. Mitigation is developed on a case-by-case basis in consultation with DFO. The following areas that overlap to some extent with Study Area are referenced specifically as Marine Refuges, which are considered as OECM under the Fisheries Act: Corsair and Georges Canyons Conservation Area; Emerald Basin and Sambro Banks Sponge Conservation Areas; Jordan Basin Conservation Area; Northeast Channel Coral Conservation Area; and Western/Emerald Banks Conservation Area (Figure 3.24).

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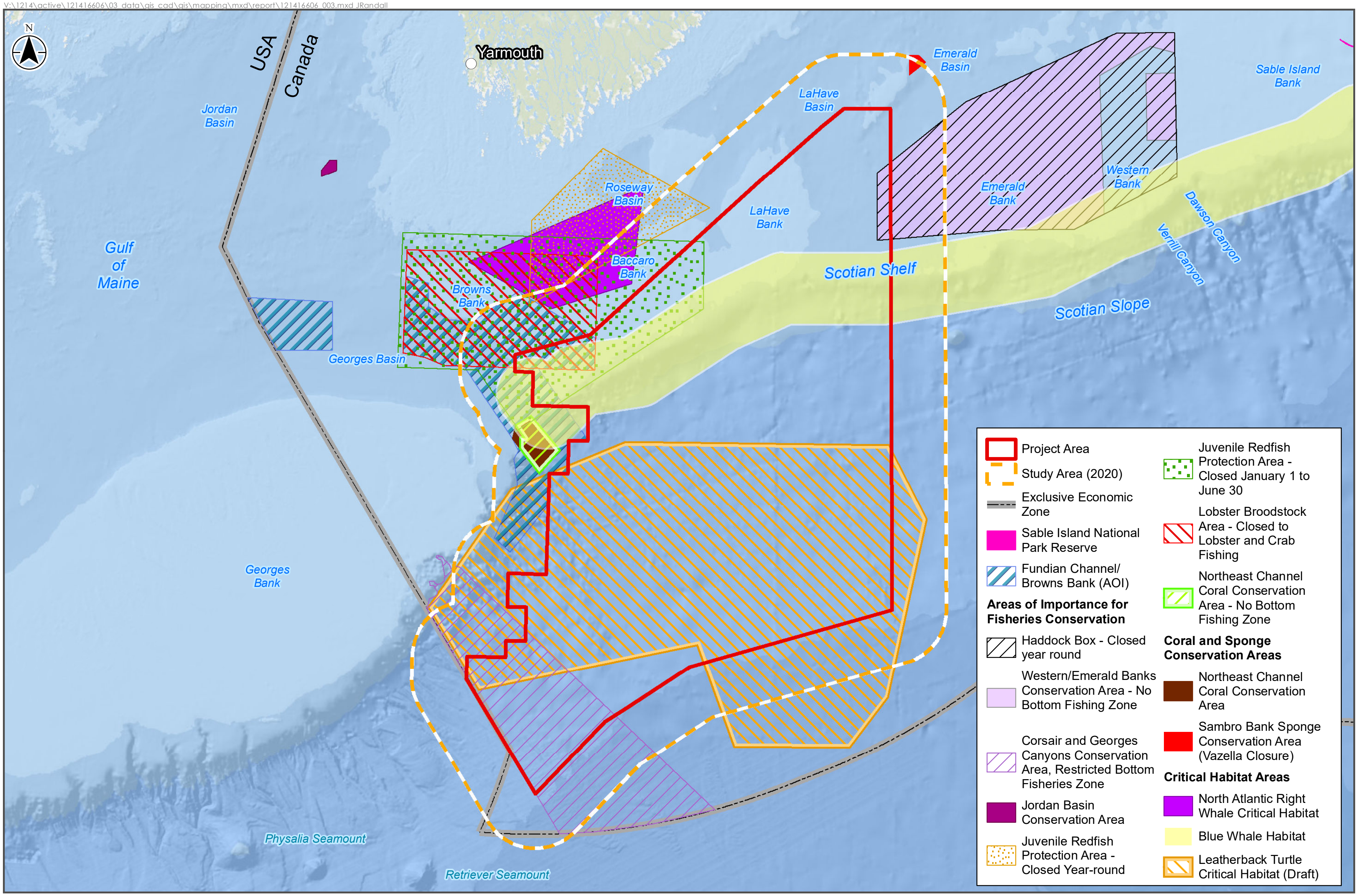

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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Special Areas

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Figure 3.24

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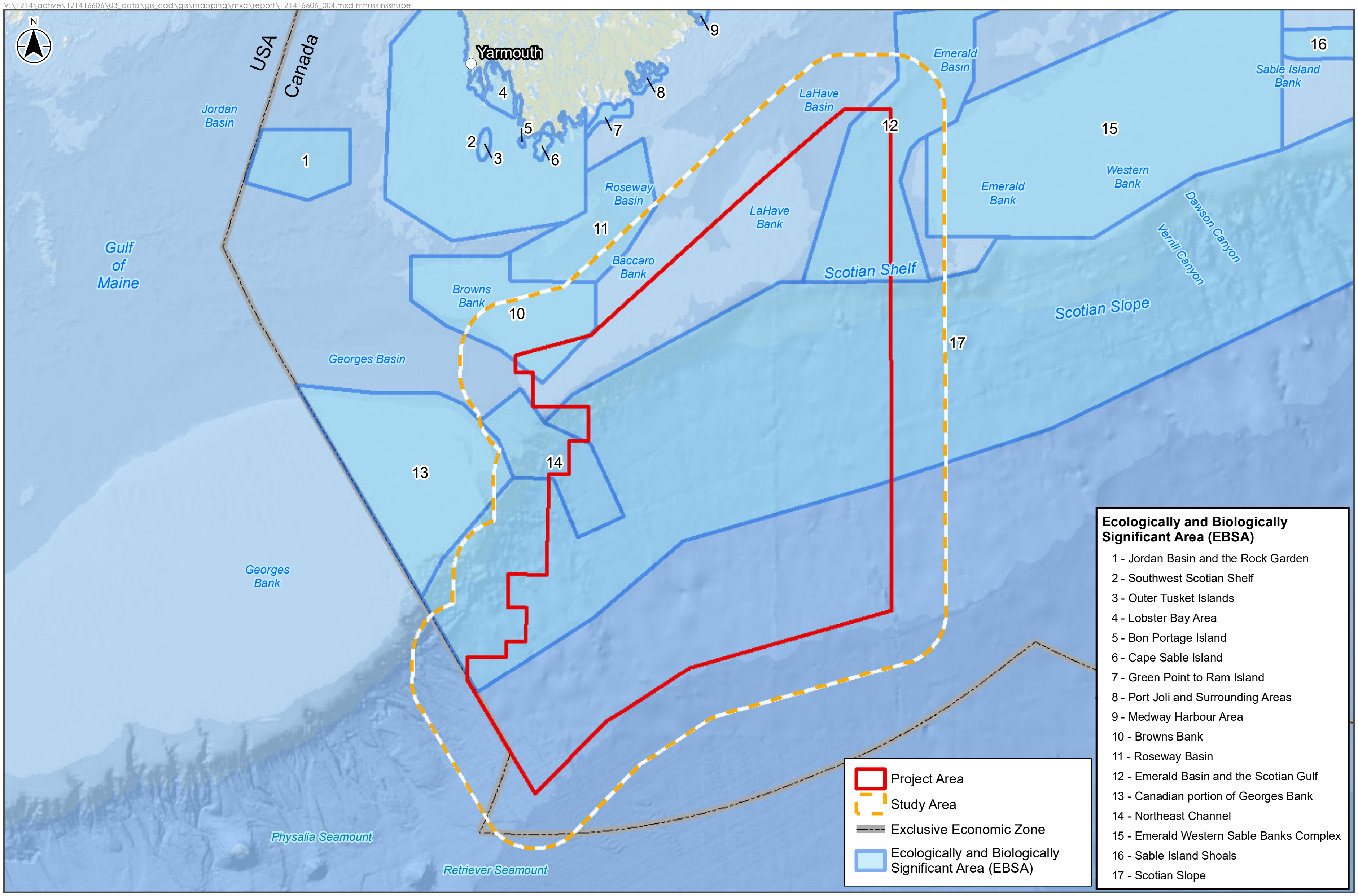

Basemap Sources: Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
EBSA Data Sources: Fisheries and Oceans Canada Open Government Portal
(https://open.canada.ca/data/en/dataset/d2d6057f-d7c4-45d9-9fd9-0a58370577e0)
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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Ecologically and Biologically Significant Areas (EBSA)

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Figure 3.25

Table 3.21 Designated Protected Areas Overlapping the Study Area

Roseway Basin: North Atlantic Right Whale Critical Habitat (SARA) and IMO Area to be Avoided	
Location	• Approximately 3318 km2 located in Roseway Basin between Baccaro and Browns Banks.
Designation and Administration	• The North Atlantic right whale is listed as an endangered species on Schedule 1 of SARA. The Recovery Strategy for the North Atlantic right whale (Eubalaena glacialis) in Atlantic Canadian Waters (Brown et al. 2009; DFO 2014a) identified Roseway Basin as Critical Habitat for the North Atlantic right whale. The Recovery Strategy was amended in 2014 (DFO 2014a) to augment and improve the description of the already identified Critical Habitat. Under SARA, critical habitat must be legally protected from destruction within 180 days of being identified in a final recovery strategy or action plan and included in the Species at Risk Public Registry. Right Whale critical habitat is protected by a SARA Critical Habitat Order made under subsections 58(4) and (5). The Order, which came into effect in December 2017, invokes the prohibition in subsection 58(1) against the destruction of the identified critical habitat. Examples of activities with the potential to result in destruction of right whale critical habitat are described in section 1.9.5 of the Recovery Strategy and includes (but is not limited to) acoustic disturbance and contaminants (Brown et al. 2009, DFO 2014a). • In 2007 Transport Canada submitted a proposal to the International Maritime Organization (IMO) for the designation of a recommend seasonal Area to be Avoided (ATBA) by ships 300 gross tonnage and upwards in transit during the period of 1 June through 31 December in order to significantly reduce the risk of ship strikes of the highly endangered North Atlantic right whale. This was adopted by IMO in 2007 and implemented in May 2008 (IMO 2007; Brown et al. 2009; DFO 2014a). • In 1993, Roseway Basin was designated as a conservation area for right whales (Brown et al. 2009; DFO 2014a).
Ecological Significance	• Right whales have shown an affinity for edges of banks and basins, upwellings and thermal fronts, and appear to be highly dependent on a narrow range of prey (e.g., Calanoid copepods) (Brown et al. 2009; DFO 2014a). • Roseway Basin is an important area of right whale aggregation where right whales have been observed feeding and socializing in the summer and autumn months. Right whale abundance and stage C5 Calanus finmarchicus concentrations peak during this time (Brown et al. 2009; DFO 2014a). • Research is ongoing to evaluate prey distribution in Roseway Basin to refine critical habitat boundaries (Brown et al. 2009; DFO 2014a).
Blue Whale Important Habitat	
Location	• Runs along the Scotian shelf edge (the Scotian rise). • Located in the northern half of the Study Area.
Designation and Administration	• Important blue whale habitat identified by DFO in 2018 in a Science Advisory Report (DFO 2018c; Lesage et al. 2018). This report was requested by the Species at Risk program to provide information on blue whale habitat in relation to efforts to identify critical habitat in a future amendment to the blue whale recovery strategy. The report described the functions, features and attributes of important habitat for blue whales off Eastern Canada as well as the activities likely to destroy the important habitat which include (but is not limited to) acoustic disturbance, environmental contaminants, and physical disturbance.

Table 3.21 Designated Protected Areas Overlapping the Study Area

	• There is no legislation associated with the areas that DFO Science has advised are important habitat for the blue whale. However, if any of these areas are identified as critical habitat in an amendment to the blue whale recovery strategy in the future, it is anticipated that the identified critical habitat would be protected using a SARA Critical Habitat Order made under subsections 58(4) and (5), which would invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat.
Ecological Significance	• The western Scotian Shelf is an important area of concentration for blue whales. This area is important for feeding during the summer months. • There is evidence of year-round blue what presence along the continental shelf edge south of Nova Scotia.
Leatherback Turtle Critical Habitat (Draft)	
Location	Located through the majority of the southern half of the Study Area.
Designation and Administration	• Identified by DFO as Draft Critical Habitat in a draft version of the amended Leatherback Turtle Recovery Strategy (DFO 2012c). The functions, features and attributes of the draft critical habitat were described, as well as the activities likely to destroy critical habitat which include, but are not limited to, acoustic disturbance and marine pollution. A new Threat Assessment is being prepared and should be considered by any future Proejct assessments. • Because this is currently only at the draft stage, it has no legal implications under SARA. If this area proceeds to be identified as critical habitat in a final version of the amended Recovery Strategy it is anticipated that the identified critical habitat would be protected using a SARA Critical Habitat Order made under subsections 58(4) and (5). This Order would invoke the prohibition in subsection 58(1) against the destruction of the identified critical habitat.
Ecological Significance	• This area has been identified as important habitat for the leatherback turtle. • This area is used for foraging and migration during the summer and fall months.
Northeast Channel Coral Conservation Area	
Location	Approximately 424 km^2 in the Northeast Channel, east of Georges Bank.
Designation and Administration	• In June 2002 DFO established a Coral Conservation Area in accordance with the Fisheries Act and the Oceans Act with the objective of protecting high densities of intact octocorals (Paragoria arborea, bubblegum coral and Primnoa resedaeformis, seacorn coral). This is one of three areas of significance for cold-water corals offshore Nova Scotia (the Gully and Lophelia Coral Conservation Area in Laurentian Channel being the other two) (DFO 2006). • The Northeast Channel Coral Conservation Area is divided into two zones: 1. Restricted bottom fisheries zone - ~ 90 % of the area is closed to all bottom fishing gear used for groundfish or invertebrate fisheries (e.g., longline, otter trawl, gillnet, trap). The highest density of corals, as observed in scientific surveys, is found in this zone. 2. Limited bottom fisheries zone – about 10 % of the area is open to authorized fishing activities. At the present time, the area is open only to longline gear for groundfish (with an At-sea Observer) and is closed to all other bottom fishing gear.

Table 3.21 Designated Protected Areas Overlapping the Study Area

	• In 2006 DFO developed a coral conservation plan (DFO 2006) for the Maritimes Region which provides an objective and strategy to protecting and understanding important benthic habitats. • This area is recognized by DFO as a marine refuge and contributes 0.01% towards Canada's marine conservation objectives.
Ecological Significance	• The conservation area was primarily selected on basis of having the highest density of large branching octocorals (gorgonian), Paragorgia arborea and Primnoa resdaeformis in the Maritimes and visual evidence indicated vulnerability to bottom fishing damage (Cogswell et al. 2009). The Canadian portion of Georges Bank is considered an EBSA by DFO (DFO 2014b; King et al. 2016). • The conservation area contains 12 taxa of coral (amalgamating the genus Primnoa and Paragorgia), including gorgonian corals, sea pens, and stony corals and is optimally positioned to protect the highest density and least impacted branching gorgonians in the area (Cogswell et al. 2009). • Corals provide various ecosystem functions and coral biomass has been shown to be closely correlated to fish biodiversity (Campbell and Simms 2009). • Sponge grounds are important for benthic-pelagic coupling and nutrient recycling. Sponges are a leading source of marine natural products including anti-foulants and cancer-fighting drugs.
Georges Bank Oil and Gas Moratorium Area	
Location	• Georges Bank is an offshore bank located on the outer continental shelf straddling the Canada-United States maritime boundary, with the northeast portion of the Bank in Canadian waters. • The moratorium area covers approximately 15,000 km2 and includes the Canadian portion of Georges Bank and much of the Northeast channel to the southwest edge of Browns Bank (DFO 2011a).
Designation and Administration	• In 1988, the Governments of Canada and Nova Scotia placed a moratorium on all petroleum activities on the Canadian portion of Georges Bank and adjacent areas. The moratorium was extended until 2012 following an independent panel review in 1999. • Schedule IV of the Accord Acts delineates the Canadian portion of the moratorium area. • In early 2010, the moratorium was extended by both governments to 2015 and in December 2010, the Province of Nova Scotia passed the Offshore Licensing Policy Act which prohibits the exploration or drilling for or the production, conservation, processing or transportation of petroleum on Georges Bank indefinitely. A public review, no earlier than December 31, 2022, may be ordered at the discretion of the Minister of Energy to re-examine the moratorium. There is currently no mirror legislation for the federal government. • Exploration rights issued to leaseholders on the Canadian portion prior to the moratorium are suspended while the moratorium remains in effect. • The Government of the United States established a moratorium on the United States portion of Georges Bank in 1984.

Table 3.21 Designated Protected Areas Overlapping the Study Area

Ecological Significance	• Georges Bank is recognized internationally as a unique ecosystem that exhibits high levels of biological productivity and biodiversity. • Georges Bank is at the northern edge of southern assemblages of plankton and fish and at the southern edge of northern assemblages, therefore biodiversity is very high in this area (of both subpolar and subtropical assemblages); with the Northeast Peak being the most productive part of Georges Bank (NRCan and Nova Scotia Petroleum Directorate [NSPD] 1999). • Georges Bank supports a highly productive, diverse, and economically valuable fishing industry with landings of scallops, lobster, groundfish and large and small pelagics. Fish productivity has been reported to be two to two and half times that in other comparable areas such as the Gulf of Maine or the Scotian Shelf (NRCan and NSPD 1999). • The high and persistent productivity of phytoplankton and fish and the co-occurrence of spawning and nursery areas on the Northeast Peak are biological features that contribute to Georges Bank uniqueness and ecological significance (NRC and NSPD 1999). • Strong and persistent tidal currents (dominant physical factor on the Bank) result in high mixing rates, nutrient supply and overall dispersion (Boudreau et al. 1999). • Georges Bank serves as a feeding ground, nursery, and migration corridor for more than two dozen whale (including SARA-listed species) and four seal species (NRCan and NSPD 1999). • Georges Bank serves as an important feeding area for birds owing to high mixing rates and nutrient supply.
Fundian Channel/Browns Bank AOI	
Location	• This area is approximately 7,200 km2 and includes two geographically separate components. The western section is centered on Georges Basin while the larger eastern section encompasses the Fundian Channel (also known as the Northeast Channel) and part of Browns Bank.
Designation and Administration	• In February 2018, DFO identified this region as an AOI (DFO 2019d). • Selection of this AOI is the beginning of the establishment of an MPA. The final boundary, conservation objectives, management measures and regulations for the future MPA will be informed through information collected through consultation and data analysis. Consultation with Indigenous groups, local communities, industry, and government partners is underway. The collection and analysis of ecological and socio-economic data will be included in the process.
Ecological Significance	• Includes diverse benthic habitats and important oceanographic processes (such as upwelling that creates unique ecological conditions). • The Fundian Channel (also known as the Northeast Channel) portion of the Area contains the densest-known concentrations of large gorgonian corals (e.g., bubblegum coral) in the Maritimes, and the Browns Bank portion contains significant concentrations of sponges. • Areas of high diversity and productivity for fish and invertebrate species, including larvae • Habitat for a variety of species of concern (Atlantic doc, Atlantic wolffish, cusk, spiny dogfish, smooth skate, thorny skate and white hake. The channel is the largest entrance to the Gulf of Maine from the open Atlantic Ocean and many species, including basking sharks, use it as a migration corridor. • It is important foraging habitat for various seabirds (DFO 2019d).

Table 3.21 Designated Protected Areas Overlapping the Study Area

Corsair & Georges Canyon Conservation Area	
Location	• Located south of Georges Bank, near the Canadian-United States International border. • Covers 9,106 km2 • Located in the south-western corner of the Study Area.
Designation and Administration	• This area was closed to bottom-contact fishing in 2016 by DFO. • This area qualifies for protection under DFOs Policy for Managing the Impact of Fishing on Sensitive Benthic Areas (SBA Policy) • All commercial bottom-contact fishing gear prohibited, except for two small “limited fishing” zones located next to Georges Canyon which will allow red crab fishing. • No human activities incompatible with the conservation of the ecological components of interest may occur or be foreseeable within the area. • This area is recognized by DFO as a marine refuge and contributes 0.15% towards Canada’s marine conservation objectives.
Ecological Significance	• There are large, deep, steep-sided canyons that contain a variety of cold-water corals, including high densities of gorgonian corals (such as Paragorgia arborea, known as bubblegum coral). • Cold-water corals are long-lived and fragile. They are sensitive to disturbance from human activities, including fishing, or other activities that touch the ocean floor (DFO 2018a).
Sambro Bank Sponge Conservation Areas	
Location	Sambro Bank Vazella Closure area covers 62 km^2 on Sambro Bank, between LaHave Basin and Emerald Basin on the Scotian Shelf.
Designation and Administration	• In 2013, in accordance with DFO’s Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas (DFO 2009c), DFO closed two areas on the eastern Scotian Shelf known to contain the highest density of Vazella pourtalesi to bottom-contact fishing. • DFO’s Sensitive Benthic Areas Policy is guided by the legal and policy framework designed to manage Canada’s fisheries and ocean resources including the Fisheries Act, the Oceans Act and SARA as well as commitments under several international agreements including Canada’s commitment under the United Nations Resolution 61/105 to protect vulnerable marine ecosystems in domestic waters (DFO 2009c). • This area is recognized by DFO as a marine refuge and contributes 0.01% towards Canada’s marine conservation objectives.
Ecological Significance	• The glass sponge Vazella pourtalesi is known to exist in only three locations worldwide – the Gulf of Mexico, the the eastern seaboard of the US, and in Canada. • The locations on the eastern Scotian Shelf are the only instances where large aggregations have been found and thus are regarded as being globally-unique aggregations; the Gulf of Mexico and the eastern seaboard of the US populations exist as individuals or in small aggregations (DFO 2013l). • Slow growth rates, longevity, variable recruitment, and habitat-limiting factors make the sponges particularly vulnerable to physical impacts and limit recovery (DFO 2013l).

Table 3.21 Designated Protected Areas Overlapping the Study Area

	• Coral and sponges provide habitat for other species – they act as nurseries, refugia, spawning and breeding grounds for other aquatic species (DFO 2010b; Baillon et al. 2012; Baker et al. 2012a; Baker et al. 2012b, as cited in DFO 2015).
Select Fisheries Closure Areas for Fisheries Conservation	
Western / Emerald Banks Conservation Area and the Haddock Box	• The Western/Emerald Banks Conservation Area is a complex benthic-shelf habitat of 10,234 km2 and is listed pursuant to the Fisheries Act as a Marine Refuge, which is an 'Other Effective Area-Based Conservation Measure' that contributes 0.18% to Canada's Marine Conservation Targets. • It was established to support productivity objectives for groundfish species of Aboriginal, commercial, and/or recreational importance, particularly Northwest Atlantic Fisheries Organization (NAFO) Division 4VW haddock (O'Boyle 2011), and to manage the disturbance of benthic habitat that supports juvenile and adult haddock and other groundfish species. • The complex array of sediments and bedforms, including bank and trough habitats, is associated with high adult fish and invertebrate diversity compared to other Eastern Scotian Shelf banks. The Western/Emerald Banks Conservation Area is a key nursery area for juvenile haddock. It also provides important habitat for Atlantic cod, American plaice and winter skate, which are considered depleted species that have been assessed as at-risk by COSEWIC. • A partial gyre near the Western and Emerald Banks leads to increased retention of larval fish and locally increased zooplankton diversity, a primary larval food source. Correspondingly, larval fish diversity is exceptionally high compared to other areas on the Eastern Scotian Shelf. • Closed year-round to the commercial groundfish fishery by DFO (pursuant to the Fisheries Act), scallop fishing continues to occur on the easternmost part of the closed area (O'Boyle 2011). • Encompassed within the Western/Emerald Banks Conservation Area, adult haddock aggregate to spawn within the Haddock Box, including Emerald Bank, from March to June, with peak spawning in March/April (BEPCo. 2004). • The area closure may be playing a role in increasing haddock stocks and abundance of other species, such as winter flounder, plaice, and silver hake (O'Boyle 2011).

Table 3.22 Ecologically and Biologically Significant Areas

Emerald Basin and the Scotian Gulf	• The outer edges of this EBSA are approximately at the 200 m depth contour (King et al. 2016). It is delineated to include concentrations of the Hexactinellid sponge (*Vazella pourtalesi)* (King et al. 2016). • The area has unique salinity and temperature, where bottom temperatures are warmer than the rest of the Scotian Shelf (Breeze et al. 2002; Loder et al. 2003). • The area has high concentrations of copepods and euphausiids; an important source of food for juvenile fish (Doherty and Horsman 2007; King et al. 2016). • The area provides important nursery area and habitat for silver hake (Sameoto et al. 1994), and important habitat for white hake, sand lance, northern shortfin squid, redfish, pollock, red hake, monkfish, and seabirds (King et al. 2016). • The area has high fish and invertebrate biomass and species richness (King et al. 2016). • Emerald Basin is an area where North Atlantic right whales have been observed and regularly acoustically detected, with the highest number of acoustic detections of North Atlantic right whales on the Scotian Shelf outside of Roseway Basin (Davis et al. 2017).
Emerald-Western-Sable Bank Complex	• This EBSA overlaps largely with the Western/Emerald Banks Conservation Area, shifted to the east to include ecological features (King et al. 2016). • The area includes important haddock habitat, such as spawning and nursery areas with large areas of gravel and sand-gravel (Frank et al. 2001; Horsman and Shackell 2009; King et al. 2016). It has important habitat for Atlantic cod, including spawning areas (Horsman and Shackell 2009; King et al. 2016), and contains silver hake habitat (Horsman and Shackell 2009). • The area is important habitat for winter skate and yellow flounder (Horsman and Shackell 2009; King et al. 2016), and is a herring spawning area in the fall (Harris and Stephenson 1999). It contains eggs and larvae of haddock, mackerel, pollock, silver hake and yellowtail (King et al. 2016). • The area has a high biomass of fish and invertebrates (King et al. 2016), and high diversity of fish and zooplankton species (Doherty and Horsman 2007; King et al. 2016). • It is important seabird habitat (King et al. 2016).
Scotian Slope	• Defined approximately as the area between 200 and 3000 m depth along the edge of the Scotian Shelf (King et al. 2016). • High primary productivity caused by enhanced vertical mixing due to steep topography (Breeze et al. 2002). • High concentrations of chlorophyll a (King et al. 2016). • Migratory route for leatherback turtle, cetaceans and large pelagic fish (Doherty and Horsman 2007; King et al. 2016). • Sowerby's beaked whale habitat (COSEWIC 2006b). • Important blue whale habitat (Lesage et al. 2018). • Important seabird habitat (King et al. 2016). • High finfish and squid diversity (Doherty and Horsman 2007). • Overwintering area for halibut, mackerel and lobster (Breeze et al. 2002; Doherty and Horsman 2007).

Table 3.22 Ecologically and Biologically Significant Areas

Scotian Slope (cont'd)	• Important habitat for demersal fish including cusk (DFO 2014c), redfish, white hake, thorny skate, Atlantic halibut, longfin hake and Atlantic argentine (Horsman and Shackell 2009; King et al. 2016). • Important habitat for invertebrates including red crab, northern shortfin squid, northern stone crab, American lobster, and sea stars (King et al. 2016). • Submarine canyons occur on the edge of the shelf, providing a wide variety of physical habitats (King et al. 2016). • Northern bottlenose whale habitat, including "critical habitat" (as defined in the SARA) in the Gully, Shortland and Haldimand canyons (DFO 2011c). • Coral species are known to occur along the slope and submarine canyons (Cogswell et al. 2009).
Brown's Bank	• This EBSA includes the Fundian Moraine, which is a rocky shallow ridge-like feature that runs from east to west along the northern flank of Browns Bank. This feature may serve as a natural refuge (Doherty and Horsman 2007; King et al. 2016). • This is a highly productive area with a known concentration of large lobsters, which includes brood stock and adult lobsters (Doherty and Horseman 2007; King et al. 2016). • Important cod and haddock spawning and nursery area. Also, important habitat for herring, Atlantic wolffish, and winter skate (King et al. 2016). • Important seabird habitat (King et al. 2016).
Northeast Channel	• A highly productive area where Paragorgia and Primnoa corals are found in densest known aggregations in Atlantic Canada. Three species of deep-water gorgonian corals are found: Paragorgia arborea and Primnoa resedaeformis (the two dominant species) and Acanthogorgia species. • Juvenile redfish are associated with the corals. The area should include all areas of high coral densities at the mouth of the northeast channel. This area includes the "Hell Hole" which is an area of aggregation of pelagic species (Doherty and Horsman 2007). • High diversity of whales in entrances of channels. • There are likely a variety of species of dolphins to deep diving whales (e.g., sperm whales). • This is a well-known swordfish aggregating area.
Roseway Basin	• Key feeding, socializing and aggregation area for migrating and highly endangered North Atlantic right whales. • Highly productive area, persistent upwelling feature, high level of surface chlorophyll year-round, krill and Calanus concentrations (Doherty and Horsman 2007). • High concentrations of juvenile redfish. • Important habitat for smooth skate, American plaice, Atlantic cod, Atlantic wolffish and cusk (Horsman and Shackell 2009; King et al. 2016). • Important seabird habitat (King et al. 2016).
Note: other ecologically and biologically significant areas located outside the study area, such as important bird areas, may be relevant to a project-specific assessment and warrant consideration if, for example, trajectory modelling indicates that they may be impacted by a spill event.	

3.3 SOCIO-ECONOMIC CHARACTERISTICS

3.3.1 Fisheries

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

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

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

The Study Area falls within NAFO Divisions 4W, 4X, and 5ZE. Within these divisions, the Study Area falls within 10 NAFO units including 4Xo, 4Xm, 4Xp, 4Xn, 4Xl, 4Xx, 4Wl, 4Wm, 5ZEj and 5ZEm (Figure 3.26).Shellfish fisheries (e.g., sea scallop, lobster, crab), pelagic (e.g., shark, swordfish, tuna, mackerel), and groundfish (cod, halibut, flatfish, haddock, hake) fisheries occur throughout the Study Area, with shellfish fisheries dominating the commercial catch value. Fisheries management areas for lobster, scallop, shrimp and crab are shown in Figure 3.27.

Table 3.23 outlines the number of fishery licences (commercial and communal commercial) that may fish in the Western Scotian Slope and Shelf Region within which the Study Area is located. This data, provided courtesy of DFO, demonstrates the relative context of fisheries operating in the vicinity of the Study Area, based primarily on licensing data from NAFO 4W, 4X and 5Zs. The number of licences and tonnage of landings are determined from fisher-submitted documents and landings totals may not add up due to rounding. Data in Table 3.23 are representative of 2019 licence counts and contains preliminary landings data. These data represent a snapshot in time of fishing activity and this activity may vary among years. For an overall depiction of fishing activity over longer time periods, refer to landings maps in Appendix C (Rozalska and Coffen-Smout 2020) as well as landing values in Table 3.24 (DFO 2017c).

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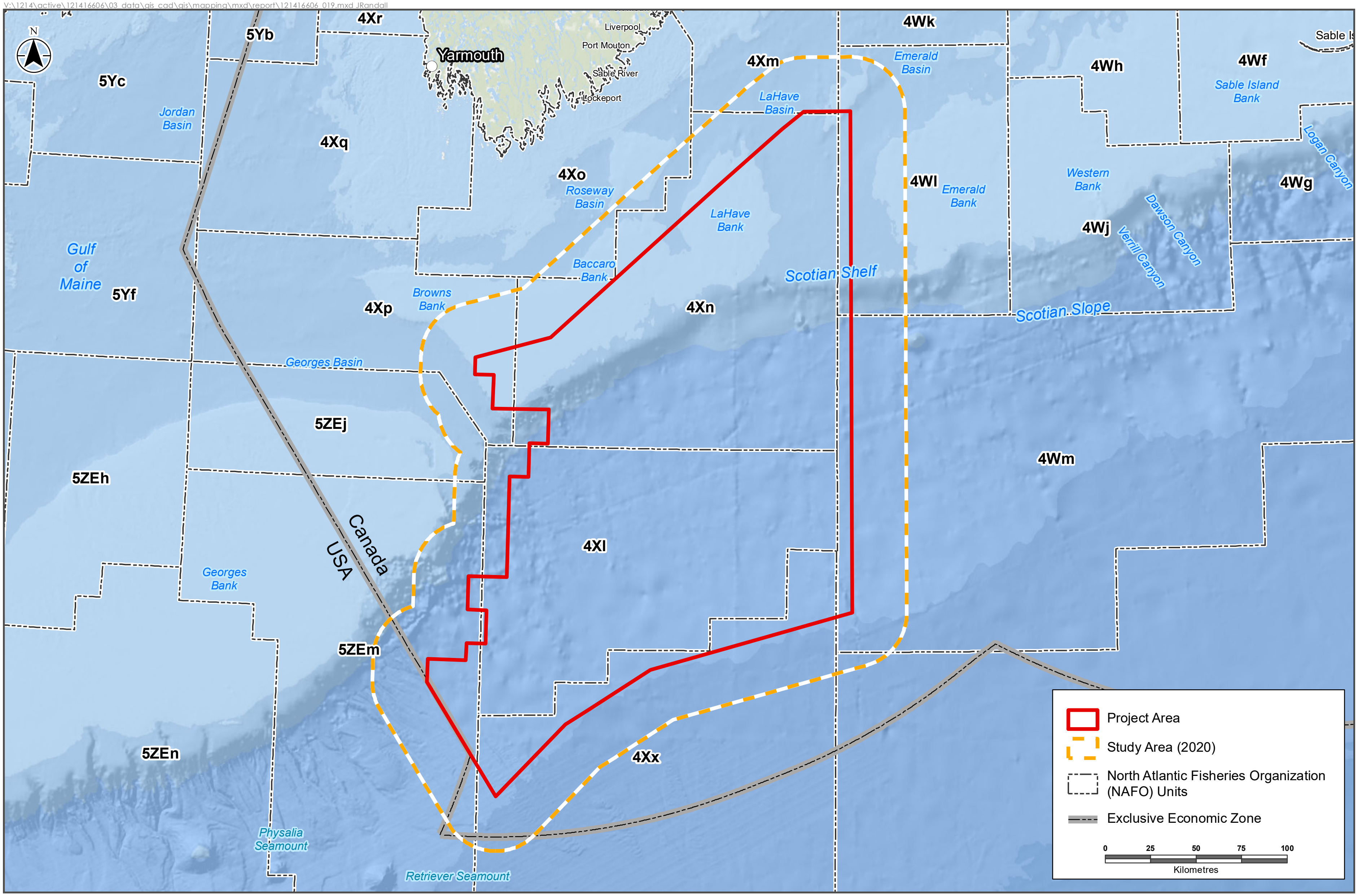

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

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

NAFO Units

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Figure 3.26

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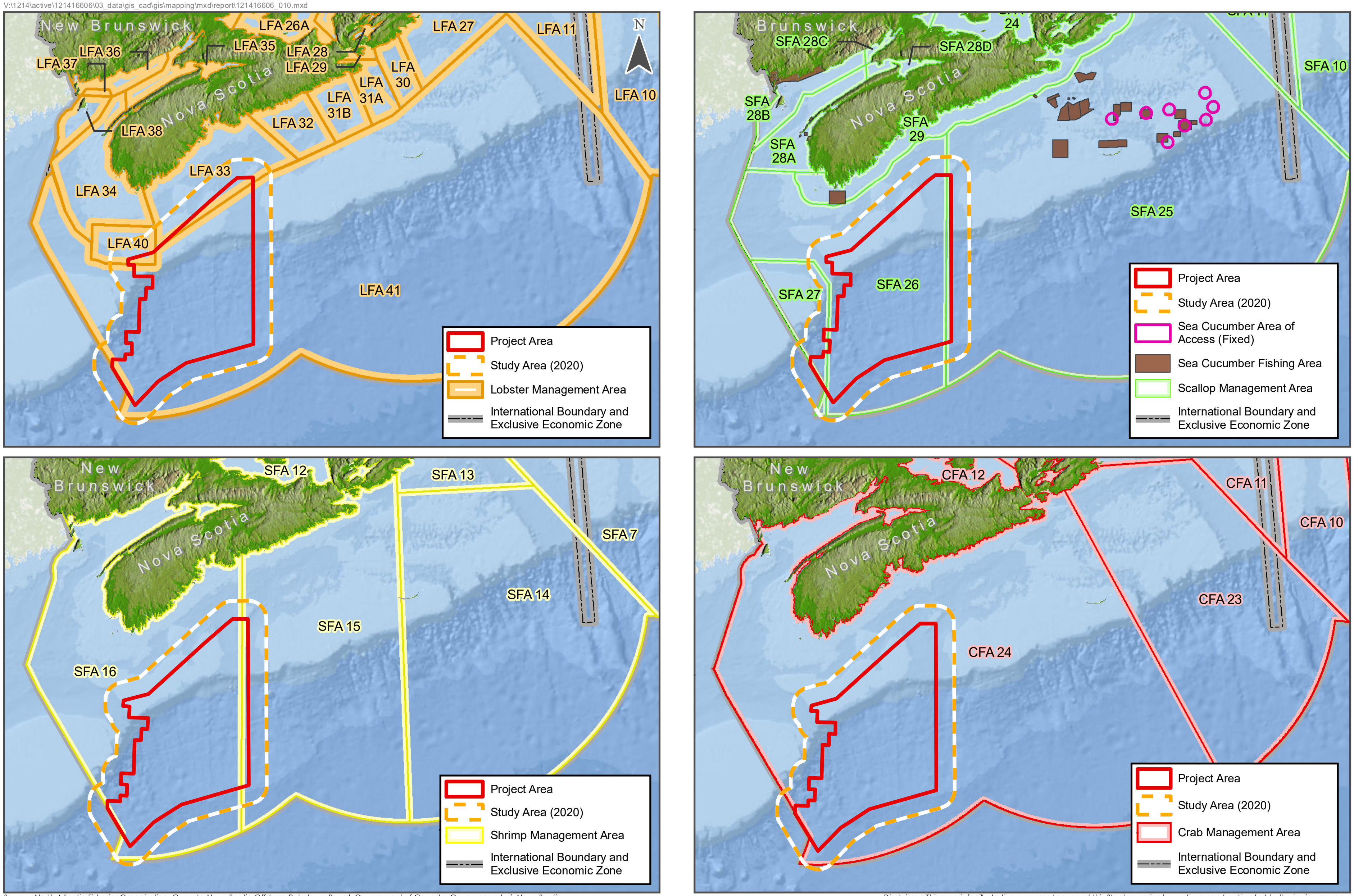

Sources:North Atlantic Fisheries Organization, Canada-Nova Scotia Offshore Petroleum Board, Government of Canada, Governement of Nova Scotia.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 CSRS UTM Zone 20N

0 50 100 150 200
Kilometres

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

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

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Commercial Fisheries Management Areas

Figure 3.27

Table 3.23 Fishery Licence and Landing Information of the Southwest Scotian Slope and Shelf Region

Fishery	Total Number of Licences (*i.e.* Commercial and Communal Commercial) (2019P)	Number of Communal Commercial Licences (2019P)	Total Number of Licences with Landings (2019P[1])	Number of Communal Commercial Licences with Landings (2019P)	Landings for all Licences in tonnes (t, 2019P)	Landings for Communal Commercial Licences in tonnes (t, 2019P)
Crab CFA 23 CFA 24E CFA 24W	CFA 23 - 124 CFA 24E - 136 CFA 24W - 12	CFA 23 - 21 CFA 24E - 28 CFA 24W - 6	CFA 23 - 25 CFA 24E - 24 CFA 24W - *	CFA 23 - 9 CFA 24E - 9 CFA 24W - *	Total landings for all areas - 6684 t	Total communal commercial landings for all areas - 2226 t
Groundfish (All Gear) (Includes cusk, dogfish, flatfish, red hake, white hake, silver hake, halibut, redfish, wolfish) NAFO 4W NAFO 4X NAFO 5ZE	Total licences for all areas (some licences may fish multiple areas) = 2072 4W - 875 4X - 1822 5ZE - 556	Total Communal Commercial licences for all areas (some licences may fish multiple areas) = 32 4W - 14 4X - 30 5ZE - 12	Total licences with landings for all areas (some licences may have landings from multiple areas) = 487 4W - 184 4X - 374 5ZE - 46	Total Communal Commercial licences with landings for all areas (some licences may have landings from multiple areas) = 6 4W - * 4X - * 5ZE - *	Total landings for all areas = 12,848 t 4W - 4663 t 4X - 7951 t 5ZE - 233 t	Total Communal Commercial landings for all areas = * t 4W - * 4X - * 5ZE - *
Hagfish NAFO 4W NAFO 4X NAFO 5ZE	Total licences for all areas (some licences may fish multiple areas) = 6 4W - 5 4X - 4 5ZE - 2	Total Communal Commercial licences for all areas = 1 4W - 1 4X - 0 5ZE - 0	Total licences with landings for all areas (some licences may have landings from multiple areas) = * 4W - * 4X - * 5ZE - 0	Total Communal Commercial licences with landings for all areas = 0 4W - 0 4X - 0 5ZE - 0	Total Landings for all areas = * t 4W - * 4X - * 5ZE - 0	Total Communal Commercial landings for all areas = 0 t 4W - 0 4X - 0 5ZE - 0

Table 3.23 Fishery Licence and Landing Information of the Southwest Scotian Slope and Shelf Region

Fishery	Total Number of Licences (*i.e.* Commercial and Communal Commercial) (2019P)	Number of Communal Commercial Licences (2019P)	Total Number of Licences with Landings (2019P[1])	Number of Communal Commercial Licences with Landings (2019P)	Landings for all Licences in tonnes (t, 2019P)	Landings for Communal Commercial Licences in tonnes (t, 2019P)
Large Pelagics (Licences that are valid to fish DFO Maritimes Region.)	Total licences for all areas (some licences may fish multiple areas) - All Large Pelagics - 850	Total Communal Commercial licences for all areas - All Large Pelagics - 14				
Shark			Total licences with landings for all areas (some licences may have landings from multiple areas) - Shark = 61	Total Communal Commercial licences with landings for all areas - Shark = *	Total Landings for all areas - Shark = 39 t	Total Communal Commercial landings for all areas - Shark = *
Swordfish			Swordfish Total - 81 4W - 46 4X - 55 5ZE - 46	Swordfish Total - * 4W - * 4X - 0 5ZE - 0	Swordfish Total - 707 t 4W - 488 t 4X - 138 t 5ZE - 82	Swordfish Total - * 4W - * 4X - 0 5ZE - 0

Table 3.23 Fishery Licence and Landing Information of the Southwest Scotian Slope and Shelf Region

Fishery	Total Number of Licences (*i.e.* Commercial and Communal Commercial) (2019P)	Number of Communal Commercial Licences (2019P)	Total Number of Licences with Landings (2019P[1])	Number of Communal Commercial Licences with Landings (2019P)	Landings for all Licences in tonnes (t, 2019P)	Landings for Communal Commercial Licences in tonnes (t, 2019P)
Tuna			Tuna (Bluefin) Total - 123 4W - 100 4X - 47 5ZE - 16	Tuna (Bluefin) Total - 23 4W - 18 4X - 8 5ZE - *	Tuna (Bluefin) Total = 314 t 4W - 201 t 4X - 90 t 5ZE - 25 t	Tuna (Bluefin) Total Communal Commercial landings for all areas = 44 t
Other Large Pelagic			Other Large Pelagic Total -58 (Albacore Tuna, Bigeye Tuna, Yellowfin Tuna, Blue Marlin, White Marlin, Mahi Mahi,) 4W - 33 4X - 43 5ZE - 25	Other Large Pelagic Total- 0 4W - 0 4X - 0 5ZE - 0	Other Large Pelagic Total- 322 t 4W - 121 t 4X - 158 t 5ZE - 43 t	Other Large Pelagic Total- 0 4W - 0 4X - 0 5ZE - 0
Lobster (Inshore and Offshore) LFA 41 LFA 30 LFA 31A LFA 31B LFA 32 LFA 33	LFA 41 - 1 LFA 30 - 20 LFA 31A - 71 LFA 31B - 71 LFA 32 - 156 LFA 33 - 661	LFA 41 - 0 LFA 30 - 0 LFA 31A - 0 LFA 31B - 0 LFA 32 - 6 LFA 33 - 20	LFA 41 - * LFA 30 - 18 LFA 31A - 62 LFA 31B - 69 LFA 32 - 133 LFA 33 - 577	LFA 41 - 0 LFA 30 - 0 LFA 31A - 0 LFA 31B - 0 LFA 32 - * LFA 33 - 14	LFA 41 - * LFA 30 - * LFA 31A - 977 t LFA 31B - 1356 t LFA 32 - 1138 t LFA 33 - 7816 t	LFA 41 - 0 LFA 30 - 0 LFA 31A - 0 LFA 31B - 0 LFA 32 - * LFA 33 - *

Table 3.23 Fishery Licence and Landing Information of the Southwest Scotian Slope and Shelf Region

Fishery	Total Number of Licences (*i.e.* Commercial and Communal Commercial) (2019P)	Number of Communal Commercial Licences (2019P)	Total Number of Licences with Landings (2019P[1])	Number of Communal Commercial Licences with Landings (2019P)	Landings for all Licences in tonnes (t, 2019P)	Landings for Communal Commercial Licences in tonnes (t, 2019P)
Mackerel (Vessel-based licences that are valid to fish DFO Maritimes Region) NAFO 4W NAFO 4X NAFO 5ZE	Total licences for all areas (some licences may fish multiple areas) = 1968	Total Communal Commercial licences for all areas = 32	Total licences with landings for all areas (some licences may have landings from multiple areas) = 82 4W - 30 4X - 61 5ZE - 0	Total Communal Commercial licences with landings for all areas = * 4W - 0 4X - * 5ZE - 0	Total Landings for all areas = 261 t 4W - 52 t 4X - 209 t 5ZE - 0 t	Total Communal Commercial landings for all areas = * t 4W - 0 4X - * 5ZE - 0
Scallop (Licences that are valid to fish - DFO Maritimes Region) SFA 25 SFA 26 SFA 27	Total licences for all areas (some licences may fish multiple areas) = 6 (Offshore) SFA 25 - 6 SFA 26 - 6 SFA 27 - 6	Total Communal Commercial licences for all areas = 0 SFA 25 - 0 SFA 26 - 0 SFA 27 - 0	Total licences with landings for all areas (some licences may have landings from multiple areas) = 6 SFA 25 - * SFA 26 - 6 SFA 27 - 6	Total Communal Commercial licences with landings for all areas = 0 SFA 25 - 0 SFA 26 - 0 SFA 27 - 0	Total Landings for all offshore areas (SFA 25,26,27) = 48,724 t	Total Communal Commercial landings for all areas = 0 t SFA 25 - 0 SFA 26 - 0 SFA 27 - 0

Notes:
[1]Data for reporting 2019 is preliminary (denoted by 2019P) and as such, may be incomplete and/or subject to change without notice.
[2]To protect confidentiality, landings totals are denoted by an asterisk (*) in instances where less than five separate license holders have been active.

Source: DFO, pers. comm. 2020

Table 3.24 summarizes landings weight and values for each NAFO divisions 4W and 4X for pelagic, groundfish, shellfish and other (e.g., marine algae) fisheries for 2012-2017. Although the Study Area also overlaps NAFO division 5ZE, those data were not available. The portion of the Study Area in NAFO division 5ZE is relatively small; the majority of the Study Area is in 4X. DFO does not distribute data from NAFO units with few licences in order to protect privacy. Therefore, actual landing weights and values may be higher. Detailed data per NAFO Unit are provided in Appendix C (DFO 2017c). Table 3.25 summarizes fishing seasons for key commercial fisheries with the potential to occur in the Study Area. Additional details on the pelagic, groundfish, and shellfish (invertebrate) fisheries are provided in the following sections. Spatial data for fisheries landings 2014 to 2018 are provided in Appendix C (Rozalska and Coffen-Smout 2020) to illustrate a regional context of fisheries activities in and around the Study Area.

Table 3.24 Landed Weight and Value of Commercial Fish Species in NAFO Divisions 4W, 4X (2011-2017)

	2013		2014		2015		2016		2017		Grand Total	
	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)
Groundfish												
4W	9,881	13,916	9,459	13,618	8,018	13,865	7,532	13,468	8,147	13,672	55,640	82,182
4X	14,142	28,435	11,482	25,311	11,141	29,171	12,870	33,540	14,703	34,202	84,727	184,054
Total Groundfish	24,023	42,351	20,941	38,929	19,159	43,036	20,402	47,008	22,849	47,874	140,367	266,236
Pelagics												
4W	3,854	9,851	2,288	9,142	3,644	8,175	3,486	13,701	3,177	10,422	18,912	57,457
4X	54,289	25,304	47,109	22,957	48,345	25,652	48,412	22,590	36,164	24,570	280,806	141,995
Total Pelagics	58,143	35,155	49,398	32,099	51,989	33,827	51,898	36,290	39,341	34,992	299,718	199,452
Shellfish												
4W	11,045	58,022	11,746	81,670	12,112	86,653	10,023	101,677	8,484	116,442	64,538	516,527
4X	53,725	412,950	69,470	591,847	69,027	725,031	68,833	743,045	64,655	739,302	381,689	3,568,519
Total Shellfish	64,770	470,972	81,216	673,516	81,139	811,683	78,856	844,722	73,139	855,744	446,227	4,085,046
Other												
4W	0	0	0	1	0	1	0	0	0	0	0	1
4X	200	90	13	6	0	0	0	0	0	0	532	227
Total Other	200	90	13	7	0	1	0	0	0	0	532	228
Grand Total	**147,135**	**548,567**	**151,568**	**744,551**	**152,287**	**888,547**	**151,156**	**928,020**	**135,330**	**938,610**	**1,773,687**	**9,101,925**

Source: DFO 2017c

Table 3.25 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially Within the Study Area

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

Table 3.25 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially Within the Study Area

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

*Note: The Study Area falls within several LFAs (33, 40 and 41) with different fishing seasons. See below for the various Lobster fishing seasons (DFO 2018b):
LFA 33: last Monday in November – May 31
LFA 40: Closed to inshore-offshore lobster fishing
LFA 41: Open year-round

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

Source: Breeze and Horsman (2005)

Indigenous groups in Nova Scotia also conduct commercial fishing, which occurs under communal commercial licences issued to Indigenous organizations. Communal commercial licences for fishing in waters offshore Nova Scotia are issued through DFO Maritimes Region and Gulf Region, giving access to 34 different Indigenous organizations to waters offshore Nova Scotia. Where available, the number of communal commercial licenses, and communal commercial landings are shown in Table 3.23.

3.3.1.1 Pelagic Fisheries

During the period from 1980-2000 pelagic species have shown fluctuations in catch and have ranged from 8% to 15% of the total landed value on the Scotian Shelf (Worcester and Parker 2010). In 2012 pelagic species accounted for approximately 9% ($55 million) of the total landed value of commercial landings in the Maritimes Region (DFO 2013n). The stock status of large pelagic species is evaluated by the International Commission for the Conservation of Atlantic Tuna (ICCAT) rather than DFO. Stock assessments are quantitative estimates of the status (abundance) of the fish stocks and of the intensity of fishing upon them. These assessments underpin the scientific advice for management of current and future harvest practices. According to the ICCAT, albacore tuna yellowfin tuna, swordfish and blue shark stocks are considered to be in a relatively stable state. Bluefin tuna, blue marlin, and white marlin stocks declined for many years but are now in a relatively stable state or slowly improving. Stocks of other pelagic species such as as bigeye tuna, shortfin mako, and porbeagle shark are in a critical state and require many years (decades) to recover even with low to no total allowable catch rates.

Figures C.1 to C.8 in Appendix C (Rozalska and Coffen-Smout 2020) demonstrate pelagic fisheries (using longline and does not include rod and reel) in the Study Area are concentrated primarily along the shelf break (e.g., swordfish) or in deeper waters off the Scotian Slope (e.g., tuna). Table 3.26 summarizes information regarding fishing seasons and gear types.

Table 3.26 Pelagic Fishery Seasons and Gear Type

Species	Fishing Season and Gear Type
Bluefin tuna	• Season is open year-round with the main season taking place during the summer and fall months and may stretch into November and December • Catch limits are governed by the International Commission for the Conservation of Atlantic Tuna (ICCAT) • Gear used is either direct fishing by angling (rod and line), tended line trap, or electric harpoon and indirect fishing by longline or traps
Albacore tuna Bigeye tuna Yellowfin tuna	• Season is open year-round with the main season taking place from June to November • Gear used is pelagic (floating) longline, with some harpoon and trolling using rod and line • Mainly fished for along the shelf edge and slope and in the vicinity of Hell Hole in particular
Swordfish	• Season is open year-round with the main seasons taking place from June to September for harpoon, and July to November for longline • Catch limits are governed by the ICCAT • Gear used includes pelagic longline and harpoon • Mainly fished for along the shelf edge and slope, Emerald basin and the edge of the • Gulf Stream, which varies between years

Table 3.26 Pelagic Fishery Seasons and Gear Type

Species	Fishing Season and Gear Type
Porbeagle shark Mako shark	• A large proportion of sharks are caught as bycatch in the swordfish longline fishery. • The directed fishery Porbeagle Shark closed in 2013. All live bycatch from pelagic longline must be released • The main commercial fishery occurs along the Scotian Slope.

Source: DFO 2005a

3.3.1.2 Groundfish Fisheries

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

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

Figures C.9 to C.23 in Appendix C (Rozalska and Coffen-Smout 2020) depict locations of groundfish species catches within and around the Study Area. Table 3.27 summarizes information regarding fishing seasons and gear types.

Table 3.27 Groundfish Fishery Seasons and Gear Type

Fishing Seasons and Areas	• Groundfish fishery is open during all seasons. • Fishing occurs in NAFO divisions 4W, 4X and 5ZE. • Cod and haddock fisheries have been closed since 1993, and species can only be caught and kept through by-catch. • Some seasons are more important than others based on the seasonal movement of fish species. • Most intensive fishing occurs in the summer from July to September where fishing activity is widespread on the Scotian Shelf. • The central shelf basins and valleys yield high landings year-round. • In the fall months there is less fishing pressure and landings, as many fishermen fishing for groundfish switch to lobster in late November. • Halibut catch is concentrated along the shelf break, Roseway Basin, and Browns and Baccaro Banks. Cod, haddock, and pollock landings are concentrated on the LaHave, Baccaro and Brown Banks and Georges Bank and Basin.
Gear Type	• The main gear types used are trawls and longlines.

Table 3.27 Groundfish Fishery Seasons and Gear Type

	• Longlines are used most frequently on the shelf edge and deep-water channels and basins. • Handlines and gillnets are rarely used.
Other Information	• The collapse and closure of the cod and haddock fisheries has resulted in a switch from groundfish as the main target to invertebrates (shellfish) in 4W. Groundfish remain an important fishery in 4X.

Source: Breeze and Horsman 2005

3.3.1.3 Shellfish Fisheries

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

LFA 34 (Figure 3.27), located to the northwest of the Study Area off southern Nova Scotia, has the highest landings of lobster of any area in Canada, accounting for 40% of Canadian landings and 23% of the world landings (Worcester and Parker 2010). The snow crab fishery is the third-most valuable commercial fishery in Atlantic Canada, and the fourth-most valuable fishery in Nova Scotia (Hubley et al. 2018). Commercial fishing for lobster and crab in the Study Area is concentrated on Georges Bank outer shelf and upper slope, Georges Basin, Southeast Browns Bank outer shelf and upper slope east of the Northeast Channel, and West Browns Bank (DFO 2011b). The scallop fishery, concentrated on Georges Bank and Browns Bank in the Study Area, accounts for approximately 70-80% of the annual scallops landed in Canada (DFO 2011a).

Figures C.1 to C.28 in Appendix C (Rozalska and Coffen-Smout 2020) depict locations of shellfish landings within and around the Study Area. Table 3.28 summarizes information regarding fishing seasons and gear types.

Table 3.28 Shellfish Fishery Seasons and Gear Type

Species	Fishing Season and Gear Type
Clam species (propeller, Stimpson's surf, quahog)	• Clam fishing occurs mainly on Banquereau Bank. • The fishing season is open year-round. • Hydraulic clam dredges are the main type of gear used.
Snow crab	• The Study Area is located within CFA 24. • Snow crab is the primary crab species harvested in the Study Area • In 2019, the fishing season for CFAs 24 ran from April 1 – Aug 31 (DFO 2019e). • Gear used are crab traps, which are conical in shape.

Table 3.28 Shellfish Fishery Seasons and Gear Type

Species	Fishing Season and Gear Type
Lobster	• Within the Study Area, inshore and offshore lobsters are fished within LFAs 33, 40 and 41 (with the majority of the Study Area falling into LFA 41); however, LFA 40 is currently closed to inshore-offshore lobster fishing. • Has been historically fished with traps and trawls although use of trawls has been significantly reduced in recent years. Trawls for lobster are multiple traps attached on one line which is the preferred method used in offshore areas. • Fishery season is open year-round subject to Total Allowable Catch.
Northern shrimp	• The Study Area falls within Shrimp Fishing Areas 15 and 16. • The fishing season is open year-round. DFO creates quotas based on information received from the Eastern Scotian Shelf Shrimp Advisory committee. • The gear used are shrimp trawls.
Sea cucumber	• Main fishery is harvested from May to November using modified scallop drags. • Also caught as by-catch in the scallop fishery.
Sea scallop	• The Study Area is located within Scallop Management Areas SFA 25, 26 and 27. • The fishing season is open year-round, with the exception the portion of SFA 26 located on the German Bank (west of the Study Area) which is open from June 1 – November 15. There is a lull in fishing activity during the winter months. • The gear used for fishing is mainly scallop drags.
Exploratory	• There is the possibility of exploratory fisheries occurring in the Study Area. • Exploratory whelk fishing surveys are ongoing.

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

3.3.2 Other Ocean Uses

In addition to the fisheries described above, there are several other ocean activities and uses occurring within and around the Study Area, including commercial shipping, military exercises, petroleum decommissioning, telecommunication cables, and scientific research (refer to Table 3.29).

Table 3.29 Other Ocean Uses In and Around the Study Area

Use	Description
Commercial Shipping (refer to Figure 3.28)	• There is heavy vessel traffic throughout the Study Area. • The Study Area is heavily used for domestic and international commercial shipping consisting of mostly tankers and bulk and containerized cargo carriers, as well as a range of fishing vessels, cruise ships and various government vessels. • There are four distinct regional traffic patterns including: international shipping over the Scotian Shelf as part of the “great circle route” (i.e., shortest distance over the Earth’s surface) between Europe and the eastern seaboard of the United States and Canada; international and domestic shipping along the coast of Nova Scotia bound to and from the United States, Bay of Fundy, Gulf of St. Lawrence and Newfoundland; shipping through the Cabot Strait, a major sea route linking trans-Atlantic shipping lanes to the St. Lawrence Seaway and the Great Lakes; and traffic associated with the major ports of Halifax, Saint John, Port Hawkesbury (Strait of Canso) and Sydney (DFO 2011a). • Fishing vessels account for over 70% of marine traffic volume southeast of Nova Scotia (essentially between Cape Breton and Yarmouth out to the EEZ) (Pelot and Wootton 2004). • A designated ballast water exchange zone exists in the southern portion of Study Area, extending from the Scotian Slope to the EEZ, providing ships the opportunity to exchange ballast waters mid-ocean to reduce the risk of alien species introduction and transfer.
Offshore Petroleum Activity – Petroleum Exploration (refer to Figure 3.29)	• There are no active applications for seismic exploration or exploration wells in the Nova Scotia offshore. • There are three active ELs offshore Nova Scotia but no applications for work authorizations. • In 2018 BP Canada Energy Group ULC drilled an exploration well on its exploration licence 2434R on the Scotian Slope. This well was plugged and abandoned in December 2018. In January 2019, BP surrendered 50% of its lands and paid a drilling deposit to extend the initial term of its licence to January 2020 (CNSOPB 2019c). In January 2020, BP paid to again extend the licence period until January 2021 (CNSOPB 2020a). There is currently no application for any additional wells on BP’s exploration licence. • Equinor Canada Ltd. was awarded ELs 2435 and 2436 in a Call for Bids process in 2015. No work program authorization applications have been submitted to the CNSOPB for exploration activity on these licences.

Table 3.29 Other Ocean Uses In and Around the Study Area

Use	Description
Offshore Petroleum Activity (based on CNSOPB website, includes decommissioning - refer to Figure 3.29)	Sable Offshore Energy Project (SOEP) • Gas production has ceased at all gas fields at SOEP. The final two fields were permanently shut down on December 31, 2018. Well plugging and abandonment activities have been completed. • All platforms are being de-inventoried of hydrocarbons and left unmanned, with only navigational aids functional, until removal in 2020. All pipelines were cleaned and flushed of hydrocarbons until the point that they were nvironmentally benign. Prior to removal of the platforms, the pipelines will be disconnected and left in place on the seabed, in a manner that is non-hazardous to other users of the sea. Deep Panuke • Gas production ceased from the Deep Panuke field in May 2018 and decommissioning and abandonment is planned to be complete by 2021. As of early 2019, the platform was completely hydrocarbon free, and the gas export pipeline and flowlines to the wells were depressurized. The export pipeline and well flowlines have been cleaned and flushed of hydrocarbons until the point that they are environmentally benign. • All five wells in the Deep Panuke field will be plugged and abandoned in 2020, and the cleaned pipeline and flowlines will be disconnected and left on the seabed in a manner that is non-hazardous to other users of the sea.
Seabed Cables (refer to Figure 3.30)	• There are numerous inactive cables on the Scotian Shelf and Slope, some of which are more than 100 years old (Breeze and Horsman 2005). Many of these inactive cables run thought the Study Area. • Several active submarine telecommunications cables make landfall in Nova Scotia. Three of these cables, Hibernia Atlantic Sections A, D and E, pass through the Study Area. Two of these cables, Hibernia Atlantic Sections A and D, pass through the northeast portion of the Project Area.
Shipwrecks and Legacy Sites (refer to Figure 3.30)	• As illustrated on Figure 3.30 there are several shipwrecks existing within the Study Area. • There are two explosive dumpsites within the Project Area.
Military Activity (refer to Figure 3.31)	• Canada's east coast naval presence is provided through Maritime Forces Atlantic (MARLANT), which has its headquarters in Halifax. • MARLANT engages in a range of operations and activities including sovereignty patrols, maritime surveillance, naval training and combat readiness, search and rescue, humanitarian relief and aid to civil authorities, and operational support to other government departments, including fisheries and environmental protection (DFO 2011a). • MARLANT also conducts naval training activities in designated exercise areas off Nova Scotia. Exercise areas may also be used by foreign vessels or aircraft during periodic multinational exercises or with permission from the Government of Canada. Maps, coordinates and descriptions of military activities permitted in these exercise areas are provided in the Canadian Coast Guard's Annual Notice to Mariners (NOTMAR). • Operators are requested to consult with DND during project-specific EAs to present project locations and timing to confirm no adverse interactions with military activity.

Table 3.29 Other Ocean Uses In and Around the Study Area

Use	Description
Scientific Research	• There are several ongoing scientific research programs on the Scotian Shelf, some of which occur in the Study Area. • The Continuous Plankton Recorder Survey, run by the Sir Alister Hardy Foundation for Ocean Science, has been using vessels of opportunity to collect plankton samples since 1931 (Sir Alister Hardy Foundation for Ocean Science 2020; DFO 2011a). • Scientists at DFO monitor fish populations of the Scotian Shelf, Bay of Fundy, and Gulf of Maine on an ongoing basis. Some of the most important sources of information on the state of marine fish populations are bottom trawl surveys (DFO 2011a) which are generally conducted in the winter and summer within the Study Area. • Scientists from Dalhousie University (Whitehead Lab) conduct cetacean studies within the Study Area. • The Ocean Tracking Network (OTN), based at Dalhousie University, and DFO jointly operate a fixed and semi-permanent series of almost 200 acoustic receivers along the ocean bottom of the Halifax Line. There is the potential that these receivers could be impacted by seismic surveys in the area.

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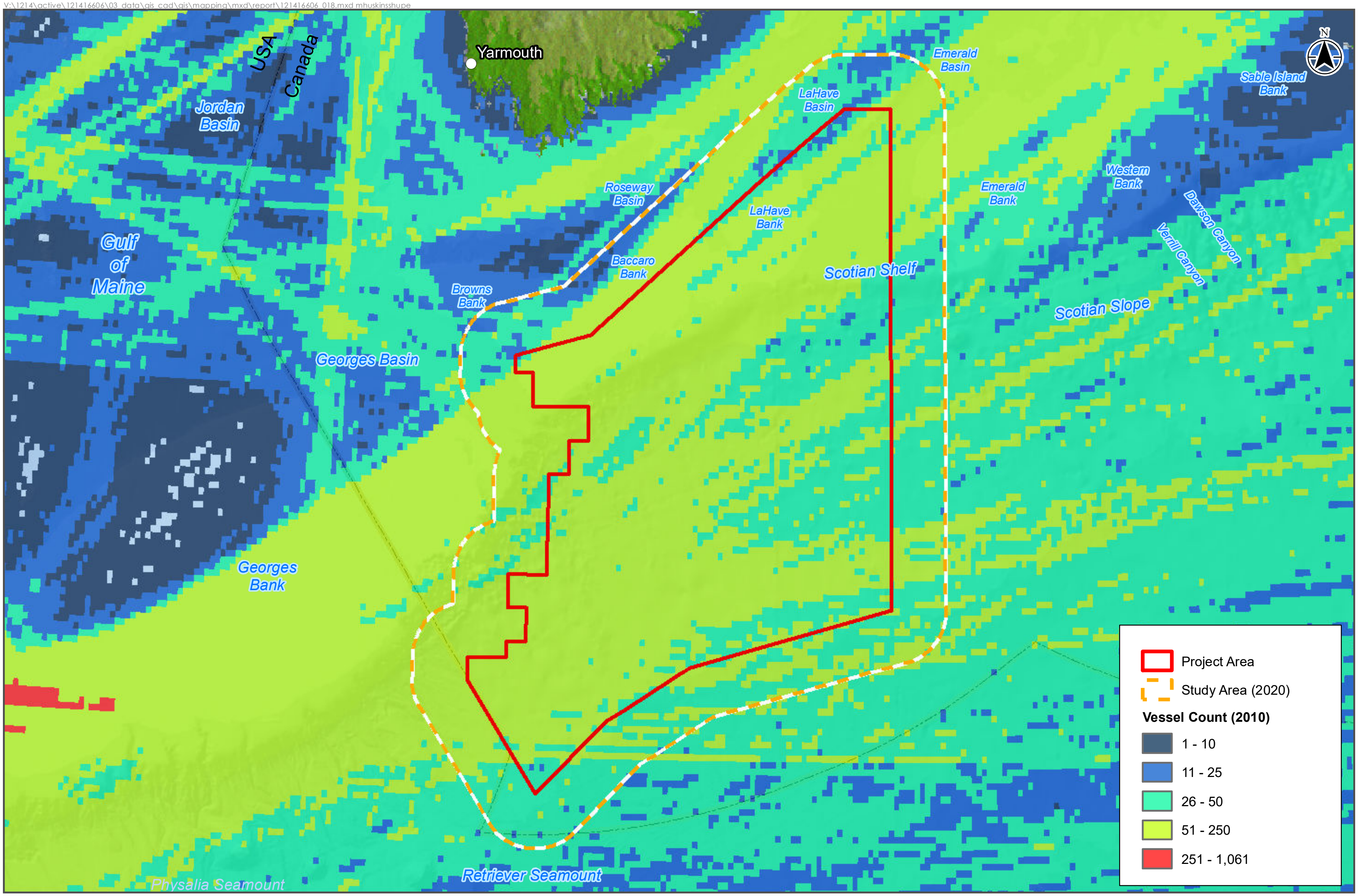

Sources:North Atlantic Fisheries Organization, Canada-Nova Scotia Offshore Petroleum Board, Government of Canada, Governement of Nova Scotia.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Vessel Traffic

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

121416606_018

Figure 3.28

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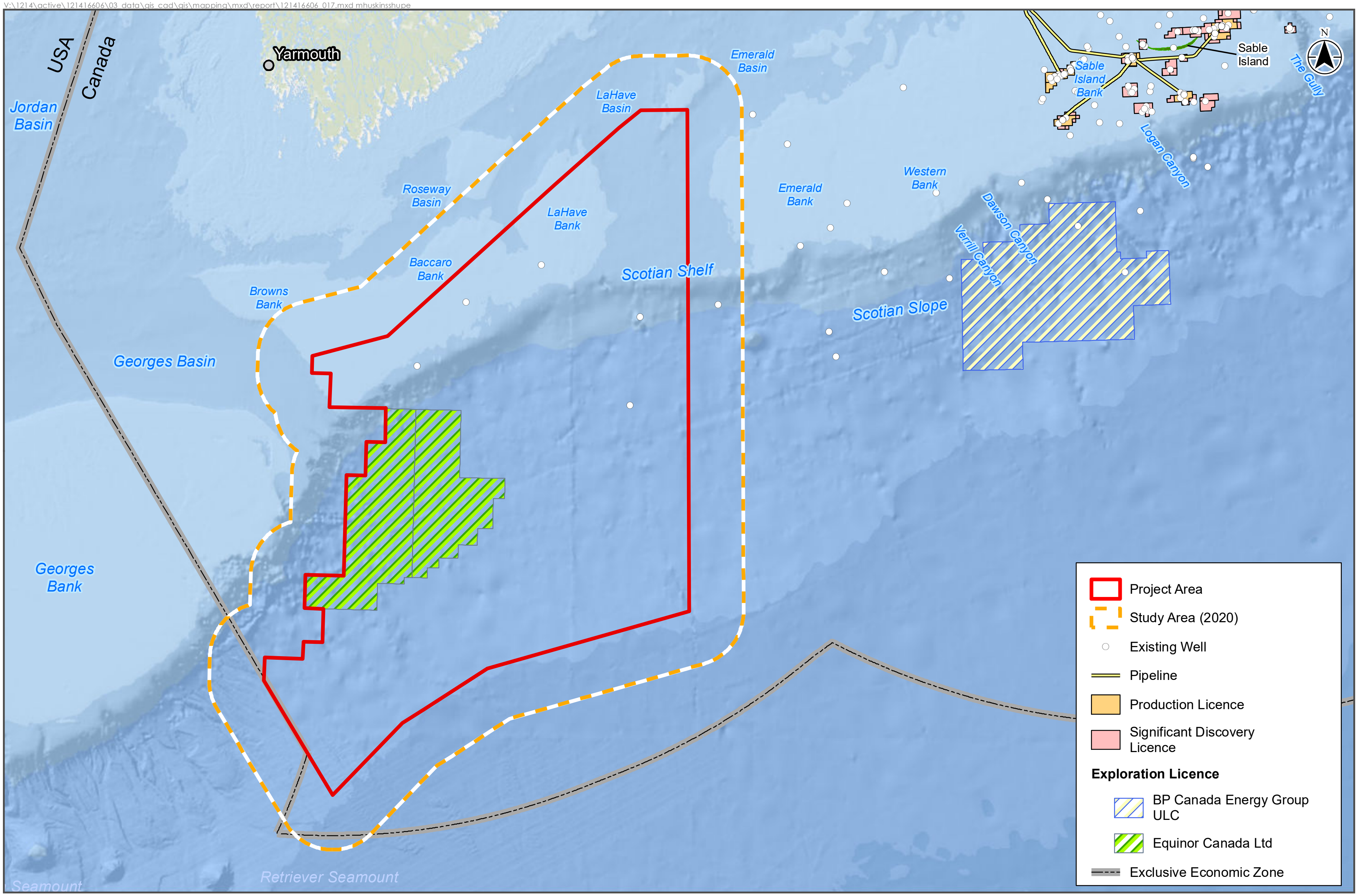

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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

Offshore Petroleum Activities

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

121416606_017

Figure 3.29

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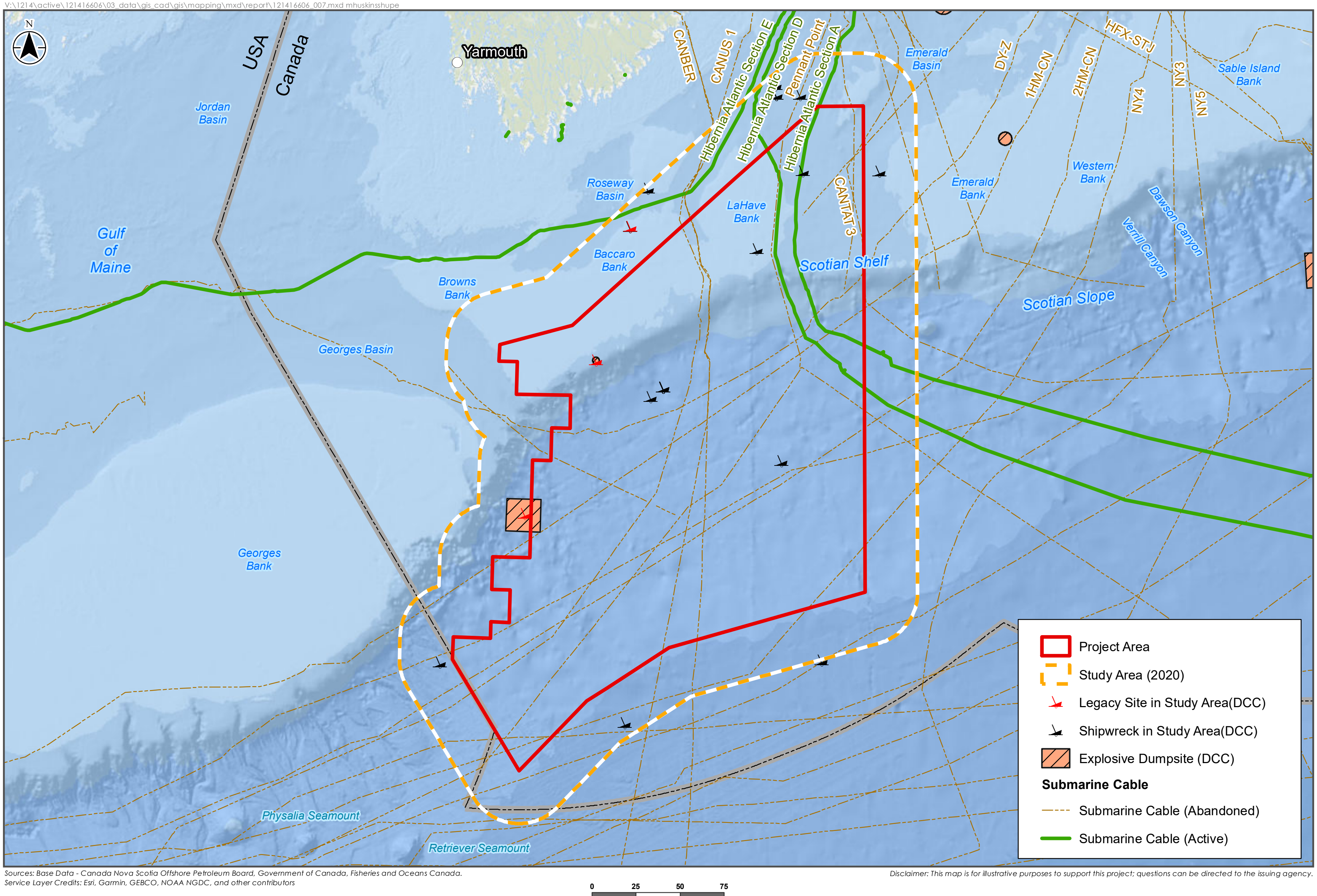

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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

NAD 1983 UTM Zone 20N

Seabed Hazards

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

121416606_007

Figure 3.30

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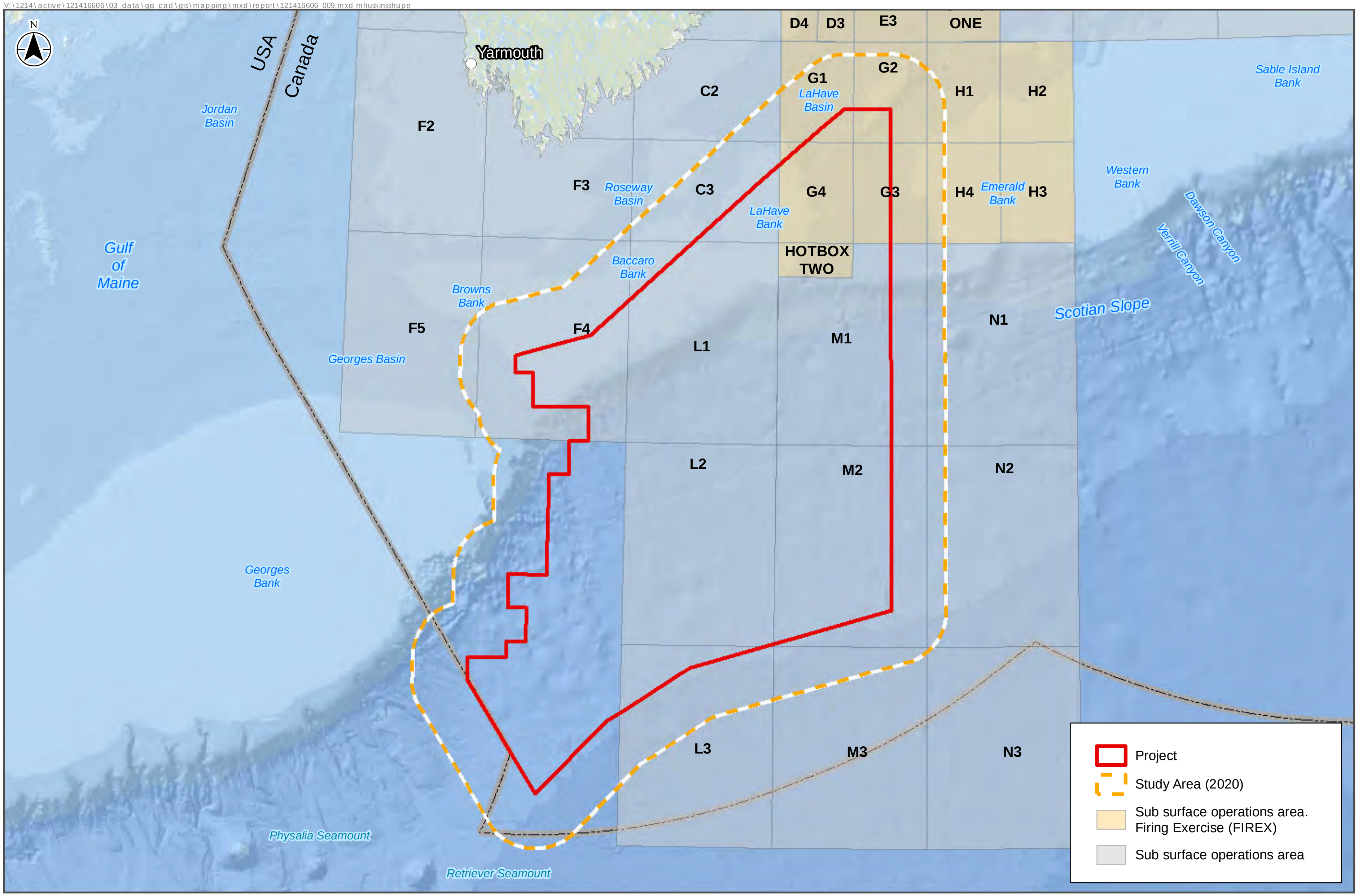

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Military Firing Practice and Exercise Areas

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT
121416606_009

Figure 3.31

4.0 STRATEGIC ENVIRONMENTAL ASSESSMENT APPROACH

4.1 OVERVIEW OF SEA APPROACH

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

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

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

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

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

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

4.2 SCOPING CONSIDERATIONS

The scope of environmental assessment, including definition of components and activities to be assessed as well as spatial and temporal assessment boundaries, must be established at the outset of the analysis so that the analysis remains focused and manageable. A stand-alone scoping document was prepared for this SEA (Section 2.2). The scope was based primarily on scoping conducted for previous SEA reports on the Scotian Shelf and Slope (i.e., Stantec 2012a, 2012b, 2013, 2014, 2017, 2019); knowledge of existing environmental conditions including any changes that have occurred, and new information that has become available, since the previous SEAs were published (refer to Section 3); applicable regulatory guidance including updated legislation and guidelines (refer to Section 2.1); review of relevant publications, including project-specific EAs conducted for recent petroleum exploration projects offshore Nova Scotia (Shell 2014; BP 2016); and experience of the study team and government reviewers. Section 2.1 provides an overview of the regulatory context for exploration activities that contributed to scoping of the SEA.

In addition to relevant regulations and guidelines, the following key documents informed issues scoping for the SEA. Numerous other sources were drawn on for the effects assessment – refer to Section 9 for a complete list of references consulted:

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

4.3 SPATIAL AND TEMPORAL BOUNDARIES

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

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

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

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

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

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

4.4 SELECTION OF VALUED COMPONENTS

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

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

Table 4.1 Selection of Valued Environmental Components

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

Table 4.1 Selection of Valued Environmental Components

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

Table 4.1 Selection of Valued Environmental Components

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

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

- Species of Special Status
- Special Areas
- Fisheries

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

4.5 POTENTIAL EXPLORATION ACTIVITY-ENVIRONMENT INTERACTIONS

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

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

Exploration Activity	VC			Nature of Interactions
	Species of Special Status	Special Areas	Fisheries	
Seismic surveying	✓	✓	✓	• Interference with fisheries and other ocean uses during routine operations. • Underwater sound issues (e.g., hearing loss, behavioural effects) on species of special status, commercial, recreational, Aboriginal (CRA) fish species and spawning areas, and species which may be inhabiting Special Areas. Degradation of habitat quality of Special Areas due to underwater sound. • Attraction of marine and migratory birds to vessel lights, and discharges during seismic operations. • Disturbance, harm, or harassment of individuals of a SARA listed species, or intererence with critical habitat of a SARA listed species.
Seabed surveying (i.e., geophysical, geotechnical data collection)	✓	✓	✓	• Localized disturbance to marine benthos, including areas designated to protect benthic habitat and benthic species, including species of special status and CRA fish species. • Attraction of marine and migratory birds to vessel lights, and discharges during survey operations.

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

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

5.0 POTENTIAL EFFECTS OF EXPLORATION ACTIVITIES

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

5.1 SPECIES OF SPECIAL STATUS

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

5.1.1 Potential Effects on Species of Special Status

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

5.1.1.1 Seismic and Seabed Surveys

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

Surveys may also be conducted prior to spudding a well, to identify seabed features and subsurface conditions that may interfere with well-drilling operations (i.e., geohazards), and to characterize the seabed and benthic habitat. The wellsite surveys are typically conducted using 2DHR digital seismic, similar to a standard 2D seismic program but likely with reduced impacts compared to standard 2D seismic as it uses a small-volume compressed air source or device. Additional data collection techniques may include sidescan sonar, sub-bottom profiling, multibeam echo sounder and/or camera imagery. Seabed surveys may also involve physical collection of seabed samples through geotechnical surveys (e.g., core sampling, vibrocores, cone penetrator technology) and environmental sampling to characterize benthic habitat (e.g., grab samples). This seabed and shallow subsurface information may also be obtained by reprocessing high resolution 3D seismic data, where available, as has been the case in recent years offshore Nova Scotia.

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

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

Physiological and Behavioral Effects on Fish and Invertebrates	• Effects of underwater sound on fish and invertebrates are still being studied (Hawkins et al. 2014) and would be considered as part of any future project-specific EAs; there is a gap in the scientific literature for most fishes and invertebrates, particularly related to sound thresholds and recovery from impact: few data on physical impacts such as barotrauma (damage to internal organs); no data on masking of natural sound cues; and substantial gaps in understanding potential impacts on metabolic rate, reproduction, larval development, foraging and intraspecific communication (Carroll et al. 2017). Additional references include Popper and Hawkins (2019) for an updated overview of the potential effects of acoustic energy on finfish. • There are no well-documented cases of large-scale fish mortality due to exposure to seismic sound under regular operating conditions. Exposure to seismic pulses at very close range (<15 m from air gun) may affect fitness and survival of fish and invertebrates through abnormal development and mortality to eggs and larvae, with more frequent and severe effects occurring at distances <1.5 m (Dalen et al. 2007; Payne 2004). • Field-based seismic exposure studies on scallops found no mortality attributable to seismic exposure (Przeslawski et al. 2018); conversely, Day et al. (2017) reported significantly increased mortality rates, disrupted behavioral patterns (during and following exposure) and physiological changes. • Laboratory-based seismic exposure studies observed significant developmental delays and body abnormalities in 46% of scallop larvae (de Soto et al. 2013). No evidence of mortality or overt gross pathology was observed in lobster from eight hours of recorded seismic survey soundtrack, and no mortality or altered general pathology or protein, glucose or triglyceride serum concentrations over a 6-month period following seismic exposure (Payne et al. 2015). • As eggs and/or larvae may be present throughout the water column, adverse effects on developmental stages are possible (at close range) even for demersal species (e.g., redfish species, cod and cusk) (DFO 2011a). • There is evidence of injury to hearing organs of adult fish from sound levels lower than those expected near seismic sources (McCauley et al. 2003, cited in DFO 2011a). Repetitive firing of air guns on caged fish resulted in severe damage to sensory hair cells of inner ear after 18 hours of exposure, and damaged cells were not regained after 58 days (DFO 2011a). Peak sound levels corresponded to those encountered <500 m from the source (180-190 dB rms [root mean squared]). Note that experimental animals were caged and could not reduce exposure levels by natural avoidance/flight response. As most fish species swim away from the sound source when not caged, permanent and/or severe damage to hearing organs from seismic surveys is considered unlikely. • Seismic exposure has potential to elicit short-term behavioural impacts on fish. Startle responses are commonly reported (e.g., changes in swimming patterns, changes in vertical distribution), with such short-term effects observed up to a 30-km radius (Worcester 2006). Larger fish, such as sharks, may be displaced from preferred foraging areas, or their ability to detect prey may be obscured (Martin 2003). For example, white sharks are thought to be sensitive to even the smallest vibration or sound (Martin 2003). Field and laboratory experiments on other shark species indicate that sharks can hear sounds with frequencies ranging from about 10 Hz (hertz, cycles per second) to about 800 Hz, and are most responsive to sounds lower than 375 Hz).

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

	• Hawkins and Popper (2017) note that key life functions are not likely to be affected by brief startle responses that do not change the overall behaviour of the animals. Effects of seismic sound in displacing fish from their usual habitat is of most concern during spawning season, on nursery and foraging grounds and possibly during seasonal migrations. Should seismic surveys coincide with spawning (or travel to spawning grounds), spawning success could be affected; energy may be expended through avoidance behaviour, delayed spawning could impact year class sizes and recruitment. • Research on potential population, community and ecosystem -level impacts from seismic surveys is inconclusive (Lee et al. 2011). Disrupted behavioural patterns could delay and/or displace migration, spawning and feeding, potentially resulting in population-level impacts, should this coincide with ecologically-important life history events such as spawning (Worcester 2006; Boudreau et al. 2001). • Virtually all research on impacts of anthropogenic underwater sound has focused on (and only reported values for) the pressure component of sound (Carroll et al. 2017); many fish species (especially those lacking a gas-filled bladder, such as all elasmobranchs and marine invertebrates) are sensitive only to the particle motion component of sound (Edmonds et al. 2016; Solan et al. 2016). Seismic surveys result in large vertical and horizontal particle motion components (in addition to pressure components) when the acoustic energy encounters the seabed; particle motion is a priority research area in understanding impacts of seismic sound on demersal and benthic species (Hawkins and Popper 2017). • One study suggests that exposure to seismic sound may cause substantial mortality in zooplankton populations (McCauley et al. 2017), potentially impacting species at higher trophic levels. Experimental airgun signal exposure decreased zooplankton abundance and caused a two- to three-fold increase in dead adult and larval zooplankton, with impacts observed out to 1.2 km (the maximum range sampled). It should be noted that aspects of this research have received criticism in the scientific community. Considering the concern around this issue, and that the Study Area overlaps with an area of high larval fish and zooplankton density, this issue should be revisited, including the results of any new research, during Project-specific EAs.
Physiological and Behavioral Effects on Marine Mammals	• Potential effects of seismic surveys on marine mammals include behavior disruption (e.g., feeding, breeding, resting, migration); change in vocalizations; masking of sounds necessary for communication and navigation (conspecific sounds); localized displacement; physiological stress; and physical injury including temporary or permanent hearing damage (Hildebrand 2005; Weilgart 2007; Dalen et al. 2007; Southall et al. 2008 and Moore et al. 2012, cited in Cordes et al. 2016; DFO 2011a). More recent studies such Wensveen et al. (2019) should be considered as part of any future project-specific EAs to present the latest study results of underwater acoustics on marine mammals. • Temporary threshold shift (TTS) can occur with brief exposure to loud sounds, temporarily increasing hearing thresholds (Davis et al. 1998). TTS and permanent threshold shift (PTS) are important considerations; some marine mammals (e.g., seals) do not avoid seismic arrays, and prolonged exposure to continuous loud sound may cause permanent hearing damage. Exposure experiments and noise propagation modelling suggest potential hearing damage within a few 100 m to kms from the sound source, with avoidance behaviors generally detected over greater distances (Southall et al. 2008 in Cordes et al. 2016). • Alterations in swimming behaviour (diving and foraging) could produce acute physiological effects such as gas exchange problems resulting from repetitive shallow dive patterns (Zimmer and Tyack 2007). The extent of effects varies depending on species of marine mammal, sound level/proximity to seismic source, and pre-exposure activity (Dalen et al. 2007).

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	• In addition to physiological effects, potential behavioural effects of airgun sounds on marine mammals may includ changes in dive and respiratory patterns, displacement and migratory diversion, changes in social behaviour, changes in vocalization patterns, changes in time budget, and changes in cognitive processes, and ecological effects such as hampered passive acoustic detection of prey, predators and conspecifics, hampered avoidance of anthropogenic threats, and hampered use of critical habitat or reduced occupancy (Theriault and Moors-Murphy 2015). • Masking can be described as: "The process by which the threshold of hearing for one sound is raised by the presence of another (masking) sound; and the amount by which the threshold of hearing for one sound is raised by the presence of another (masking) sound, expressed in dB" (American National Standards Institute, 2008). Erbe et al. (2016) note that, as underwater sound may interfere with the abilities of marine mammals to receive and process relevant sounds and could potentially impact individual fitness, offshore oil and gas activities (as well as other noise-generating activities in marine mammal habitats) require careful consideration with respect to possible auditory effects. They identify several priority research areas for increasing understanding of the process of masking, the risk of masking by various anthropogenic activities, the biological significance of masking, and anti-masking strategies, and state that such research is needed before masking can be incorporated into regulation strategies or approaches for mitigation (Erbe et al. 2016). • Little is known about the hearing of mysticetes (baleen) whales (e.g., blue, fin and North Atlantic right whales), but it is assumed they are sensitive to low to medium frequency sounds (Dalen et al. 2007). Mysticetes produce communication sounds in the very low frequency range (<100 Hz) and can hear sounds in the low frequency range (<1000 Hz), within the range of seismic activity (Clark and Gagnon 2006, cited in DFO 2011a). There is documented evidence of blue whales changing vocalization patterns and frequencies during seismic surveys (Di Loro and Clark 2009, cited in DFO 2011a). Seismic surveys using airgun arrays have been identified as an activity that has the potential of affecting important habitat to blue whales (DFO 2018c) and critical habitat of North Atlantic right whales (Brown et al. 2009, DFO 2014a). This activity has the potential to affect adult foraging and feeding, calf nursing and rearing and socializing and resting of North Atlantic right whales (Brown et al. 2009, DFO 2014a), and feeding and foraging and/or reproduction, socializing and resting of blue whales (DFO 2018c). • Anthropogenic sound can greatly reduce the ability and range of cetacean communications, as cetaceans rely on low and mid frequency communication (as evidenced on the West coast of Canada, Williams et al. 2013). Fin whales lose only <1% of their communication space under chronic natural ocean sound; humpback whales can lose 80-94% of their communication space within the 71-708 Hz communication range in the noisiest environments and 35-52% in moderate environments (Williams et al. 2013). Killer whales in British Columbia were shown to lose up to 97% of their communication space in the mid frequency range (1.5 to 3.5 kHz). • In the Northwest Atlantic, Moulton and Holst (2010) reported significantly lower sighting rates and observations of whales swimming away from active air guns, as compared to when the airguns were not active. Blue, minke and fin whales were all observed keeping greater distances from seismic ships while airgun arrays were operational. • Blue, sei and minke whales have often been seen in areas where seismic surveys are ongoing and operational (Stone and Tasker 2006). Studies conducted during seismic surveys in the U.K. from 1997 to 2000 reported similar sighting rates (in good visibility) of mysticetes (primarily fin and sei whales) when air gun arrays were operational versus silent (Stone 2003; Stone and Tasker 2006); however, the whales did show localized avoidance and remained at significantly farther distances when the array was operational. It is noted that during BP's 2014 3D seismic program along the Scotian Shelf edge and slope, there were five shutdowns due to the presence of blue whales in the safety zone, including four whales over a period of 48 hours in August.

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	• Odontocetes (toothed whales) (e.g., long-finned pilot whale, Northern bottlenose whale, Sowerby's beaked whale, sperm whale) appear more sensitive than mysticetes to seismic sound, tending to show the strongest lateral distance/avoidance and moving out of the immediate area, whereas mysticetes and killer whales demonstrated more localized avoidance to seismic sound (i.e., orient themselves away from the sound but do not leave the area) (Stone and Tasker 2006). • Harbour porpoises have been observed displaying avoidance behaviour to seismic operations. The harbour porpoise was the species affected by the lowest received airgun sound (<145 dB re 1 µParms at a distance of > 70 km) during seismic operations in Washington state (Bain and Williams 2006). Statistically significant differences in travel directions were observed between periods of operational versus non-active airguns during U.K. seismic operations from 1997 to 2000 (Stone 2003; Stone and Tasker 2006). • In other cases, dolphins have been observed in close proximity to active seismic surveys, indicating that they were not avoiding the noise. For example, hundreds of dolphins were observed swimming in the wake of active WAZ seismic programs in the Canada-Nova Scotia Offshore Area in 2014, and were seemingly unbothered by the noise (RPS Energy Canada 2014). • There is virtually no data on responses of beaked whales to seismic surveys; however, it is likely they would exhibit avoidance behaviour to seismic vessels: most beaked whales avoid approaching vessels in general (Würsig et al. 1998) and may dive for extended periods of time when approached by a vessel (Kasuya 1986). There is no conclusive evidence of seismic surveys causing strandings (LGL 2013). • An assessment of the effects of seismic sound on cetaceans for the Shelburne Basin 3D Seismic Survey predicted that baleen whales (including the North Atlantic right whale) and odontocetes (including the Northern bottlenose whale) would have to occur within <30 m from the operating airgun array to experience hearing impairment (198 dB SEL criterion for Permanent Threshold Shift). Behavioral or disturbance effects were predicted to occur within approximately 8-26 km from the operating air gun array, based on a 160 dB rms isopleth (LGL 2013). Proposed thresholds for behavioral responses and auditory damage or other physical injury for cetaceans have been identified at sound pressure levels of 160 dB rms and 180 dB rms, respectively (Compton et al. 2007). • Several cetacean species at risk occur in the Study Area (refer to Section 3.2.6), including the endangered North Atlantic right whale. There is limited data on North Atlantic right whale responses to seismic sound; based on predicted sound modeling results and expected avoidance behavior, hearing impairment effects on the North Atlantic right whale are not likely to occur. Depending on proximity of the air gun array and timing of the survey, disturbance effects (e.g., displacement from feeding and socialization area) could occur, with potential adverse effects on species of special status. • The Northern bottlenose whale could occur in the Study Area, primarily along the shelf break, and could be affected by seismic sound. Deep-diving species may be more sensitive to seismic sound, as sound may concentrate in water layers at depth, travelling farther as a result. Seismic arrays produce significant acoustic energy in the 1-20 kHz range, which overlaps with the hearing range of beaked whales (DFO 2010a). The maximum acoustic energy from seismic arrays is in the 20-160 Hz frequency range, substantially lower than the peak hearing range for Northern bottlenose whales (predicted and assumed from their vocalization range). • Potential indirect effects of seismic surveys on odontocetes in the Study Area (particularly Northern bottlenose whale and Sowerby's beaked whale) may result from effects on squid, their main prey. Trials with caged squid found startle and avoidance responses (McCauley et al. 2000a); squid emptied their ink sacs and jetted away from the activated air gun, remaining as far away as possible from the sound source (McCauley et al. 2000a), suggesting that squid could exhibit avoidance behaviour during seismic surveys. As an

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	important prey item for top predators, such avoidance behaviour in squid could indirectly impact whales in the Study Area, depending on the timeframe of avoidance in a given area (McCauley et al. 2000a). • Multiple Canadian and international agencies conducted the Gully Seismic Research Program in 2003, observing marine mammals before, during and after exposure to seismic exploration in the Gully and adjacent shelf edge. Marine mammals, including endangered species (e.g., blue whale and Northern bottlenose whale), were observed during the Marathon and Encana seismic programs (Lee et al. 2005), although marine mammals avoided the seismic arrays at close range (<100 m) and appeared to be less vocal when seismic sources were active (Potter et al. 2005). The results from Lee et al. (2005) provide data on species presence and behaviour during seismic surveys; however, data was not collected before or after the seismic vessels were present. Therefore, direct comparisons of cetacean behaviour before, during and after seismic operations could not be made. Several peer-reviewed papers resulted from this monitoring study (Cochrane 2007; Gosselin and Lawson 2004; Lee et al. 2005; McQuinn and Carrier 2005; Potter et al. 2007; Thomsen et al. 2011); nevertheless, very little information was gleaned about whale behavior in the presence of active seismic programs. • There have been no documented cases of marine mammal mortality or injuries due to seismic surveys (Dalen et al. 2007); however, behavioural effects are possible and detrimental effects suffered by one species at risk may translate into detrimental effects on the population (DFO 2011a).
Physiological and Behavioral Effects on Sea Turtles	• There is relatively little research on effects of seismic activities on sea turtles; available information indicates that turtles hear at low frequency range (similar to seals) (e.g., 100-900 Hz (Office of Naval Research website 2002; Environment Australia 2003; Ketton and Bartol 2005). A size/age difference in hearing range and response to underwater sound was observed for loggerhead and green sea turtles, with smaller younger individuals having a greater hearing range than larger, older individuals (Ketton and Bartol 2005). Martin et al. (2012) demonstrated the loggerhead turtle has low frequency hearing (best sensitivity between 100 and 400 Hz). Dow Piniak et al. (2012) determined that leatherback sea turtle hearing sensitivity overlaps with frequencies and source levels produced by low-frequency anthropogenic sources including seismic source arrays, offshore drilling and vessel traffic. • Studies indicate that seismic surveys have short-term effects including changes in hearing sensitivity (Moein et al. 1994; McCauley et al. 2000b), behavioural effects (e.g., increased and erratic swimming behavior) (McCauley et al. 2000a) and physiological responses. Exposure to low frequency sounds may cause displacement from areas near the sound source and increased surfacing behaviour, potentially leading to displacement from preferred foraging areas (Atlantic Leatherback Turtle Recovery Team 2006). • An additional potential adverse effect on sea turtles is entanglement in seismic gear. Some work has been conducted on developing mitigation measures (e.g., turtle exclusion devices, referred to as turtle guards), however the effectiveness of these measures is not well known. Turtle guards are expected on seismic vessels operating in Nova Scotian waters under an authorization overseen by the CNSOPB. • A DFO Canadian Science Advisory Secretariat (CSAS) publication is pending that assesses threats to the leatherback sea turtle, which once published, should be reviewed and considered in future project-specific EAs. In addition, the following references for sea turtles should be considered in future project-specific EAs, as applicable and where available: • DeRuiter, S., and K. Larbi Doukara. 2012. Loggerhead turtles dive in response to airgun sound exposure. Endangered Species Research. 16: 55–63.

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	• Lohmann, K.J., Luschi, P., and Hays, G.C. 2008. Goal Navigation and Island-finding in Sea Turtles. J. Exp. Mar. Biol. Ecol. 356: 83 95. • DFO. 2017. Threat Assessment for Loggerhead Sea Turtle (Caretta caretta), Northwest Atlantic Population. DFO Can. Sci. Advis. Sec. Sci. Resp. 2017/014.
Physiological and Behavioural Effects on Marine and Migratory Birds	• Baseline data for the evaluation of effects of oil and gas exploration activity on seabirds at sea in the Northwest Atlantic is sparse (Wiese et al. 2001). Available studies focus primarily on established drilling platforms, with a lack of data specific to exploration-based seismic surveys. The greatest potential for effects on marine birds from seismic and seabed surveys is associated with sound disturbance (i.e., underwater sound from air guns). • Sound created by air guns is focused downward below the surface of the water. Above the water, the sound is reduced to a muffled shot that should have little or no effect on birds with heads above water or in flight. The nature of a seismic and seabed survey program will result in only temporary incremental increases in ambient sound and disturbance from the vessel in any one area. While it is possible that diving birds within close range of seismic activity could be startled by the sound, the presence of the ship and associated seismic equipment in the water will have already indicated unnatural stimuli to any birds in the vicinity (LGL 2005a). Air guns will undergo a ramping-up process, which encourages birds to move away from the sound source before it reaches maximum volume. It is unlikely that non-diving birds would be affected by the underwater sound of air guns. • No effects on movement or diving behaviour of moulting long-tailed ducks were observed from seismic surveys in the Beaufort Sea (Lacroix et al. 2003); however, the authors note that the study was not designed to detect more subtle disturbance effects. Overall, a precautionary note must be applied to any environmental interactions and effects discussion with respect to the effects of sound emissions on marine birds. Scientific data gaps associated with the environmental effects of sound emissions limit the degree of certainty associated with environment effects predictions. • There is a potential for attraction of migratory and marine birds to vessel lights and discharges during the relatively short operation period of seismic and support vessels. Guidance for handling birds stranded on seismic vessels as a result of attraction and/or disorientation is provided in ECCC's Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada (ECCC 2016), and per conditions of CNSOPB authorizations (such as a bird handling permit). • Potential interactions between marine/migratory birds and vessel lighting is further discussed in Section 5.1.1.2.

5.1.1.2 Exploratory Drilling

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

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

Burial and Toxicity of Benthic Fauna and Habitat-forming Species	• Discharge of drilling muds and cuttings can result in smothering of benthic species, obstruction of filter-feeding mechanisms and gills, and health effects as result of chronic exposure of bentonite, barite or other drilling fluid components (Järnegren et al. 2017; Lee et al. 2011). • Effects of offshore petroleum activities on deep-sea sponges have been identified at the community level (decrease in diversity and density of benthic communities associated with deep-sea sponges from physical disturbance); individual level (interrupting filtration from increased sedimentation); and cellular level (decreasing cellular membrane stability from exposure to drilling muds) (Vad et al. 2018). • Given the vital role of benthic-pelagic coupling in aquatic ecosystems (i.e., the exchange of energy, mass and nutrients between benthic and pelagic habitats), impacts to benthic species and habitats may result in subsequent adverse effects to non-benthic biota (Griffiths et al. 2017). • Effects of drilling waste discharges on commercial fish species are discussed in Section 5.3.1.2.
Physiological and Behavioural effects on Marine and Migratory Birds	• Food and sanitary discharges from MODUs can attract birds, as they are drawn to an associated increase in attracted prey (Burke et al. 2012). Section 5.1 of the MBCA prohibits the deposition of oil, oil wastes and other substances harmful to migratory birds; Fisheries Act (Section 36), which prohibits the deposition of a deleterious substance into waters frequented by fish, also protects seabirds in the marine environment. • Seabirds are highly visually oriented and can become disoriented at night in the presence of illuminated vessels, drill rigs and flares, with resulting collisions, incineration and mortality. Weather, season, age of the birds and the lunar phase can affect the extent of attraction (Montevecchi 2006). Night-flying birds such as storm-petrels can be particularly attracted to vessel lighting (LGL 2005a). Birds may become disoriented and fly into vessel or platform lights or infrastructure, becoming injured and stranded. • Low-light conditions from inclement weather (e.g. fog) will also require vessel lighting; it is suggested that seabird disorientation occurs most frequently during periods of drizzle and fog, as moisture droplets in the air refract the light and greatly increase the illuminated area, enhancing the attraction (Wiese et al. 2001). • Although it was conducted in a different location with different species composition, a Norwegian study on bird impacts associated with offshore drilling found that the impact of flaring on flocks of birds is negligible and is only considerable at night during migration periods (OSPAR Commission 2007). The study concluded that sound associated with drilling did not affect bird migrations and that 10% of birds were affected by light emitted from the main deck of offshore oil installations. It is noted there are no Leach's Storm-petrel in the area observed in the Norwegian study, but the Western Scotian Shelf hosts a high occurrence/density of Leach's Storm-petrel, which studies have shown are vulnerable to artificial light attraction to offshore activities.

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

Physiological and Behavioural Effects on Marine Mammals, Fish, and Turtles	• Underwater sound from drilling can potentially cause a temporary avoidance of an area by marine species of special status. Continuous sound generated by a drill rig or dynamic positioning (thrusters) of support vessels may cause prolonged avoidance by some demersal fishes (prey species) from the immediate area (e.g., up to 400 m) (ICES 1995, cited in JWEL 2003), and aggregations of fish species of special status could be displaced from critical spawning, feeding and nursery areas (refer to Table 5.1 for potential effects of underwater sound on fish and invertebrates). • Thompson et al. (2000) reports avoidance of marine mammals from a drill rig is expected to be limited beyond 100 m whereas avoidance from a drill ship may range from 1 to 10 km. The North Atlantic right whale is known to exhibit long distance avoidance behavior. Recent acoustic modelling for drilling programs offshore Nova Scotia suggested that underwater sound levels exceeding behavioural thresholds could extend over 150 km from the drill site in winter (BP 2016). • In addition to avoidance, underwater noise from exploration drilling and associated activities can potentially result in impacts to fish, marine mammals and sea turtles such as masking, and displacement from critical spawning, feeding and nursery areas.

5.1.1.3 Vessel Traffic

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

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

Physiological and Behavioural Effects on Marine and Migratory Birds	• An increase in vessel traffic can increase artificial light within the Study Area, potentially attracting migrating birds. Nocturnal disturbance from light may lead to increased opportunities for predators, collisions due to attraction to vessels, exposure to vessel-related risks and the disruption of natural conditions (CWS, pers. comm. 2012). Increased vessel presence during seismic surveys and exploratory drilling may physically displace migratory birds from foraging grounds for short periods of time (CWS, pers. comm. 2012). • Increased vessel presence may lead to increase in and/or attraction of predator species due to waste disposal practices. Sanitary and food wastes disposed of into the marine environment could attract species which prey on marine and/or migratory birds. • Incremental addition of vessels associated with exploration is not anticipated to substantially affect mortality rates from vessel collisions, as the increase in vessels will be temporary and nominal compared to existing traffic in the Study Area. With proper mitigation, vessel-related adverse effects on bird species of special status are anticipated to be minimal. Guidance is provided in ECCC’s Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada (ECCC 2016), • There is a small potential for attraction of migratory and marine birds to vessel lights due to the relatively short operation period of support vessels. With proper mitigation such as limiting lighting to that required for safe operations adverse effects are anticipated to be minimal. Birds stranded on vessels as a result of attraction and/or disorientation should be handled using the instructions outlined in and per conditions of the bird handling permit issued by ECCC, if required.

Physiological and Behavioural Effects on Marine Mammals	• Vessel strikes have been known to be a considerable cause of marine mammal mortality to some species; an increase in vessel traffic due to oil and gas exploration could increase the number of mortalities of marine mammals due to vessel impacts. The species most frequently affected by vessel strikes include the following:
	  • North Atlantic right whales
	  • Fin whales
	  • Blue whales
	  • Northern Bottlenose whales
	  • Sowerby's beaked whales
	• The North Atlantic right whale is the species most affected by vessel strikes, with mortalities twice as frequent as for any other whale species (Vanderlaan and Taggart 2007). In fact, it is anticipated that the species will be extinct within 200 years unless anthropogenic-induced mortalities are curbed (Caswell et al. 1999). Right whales tend to be easily injured because they are slow moving and have a low profile in the water, making them difficult to detect. Results have shown that reducing vessel speed can reduce the number of deaths by vessel impact (e.g., Vanderlaan and Taggart 2007); therefore, vessel speed limits may be warranted in highly-populated and important habitat areas. In recent years, Transport Canada has put speed restrictions in place for shipping lanes in the Gulf of St. Lawrence in order to reduce the impacts of vessel strikes on North Atlantic right whales (Transport Canada 2020). Similarly, NOAA has implemented speed restrictions in seasonal management areas along the U.S. east coast to help protect right whales (NOAA 2020b).
	• Increased vessel presence can increase levels of sound below the 1-kHz range (Wright 2008). Low-frequency noise from large ships (20–200 Hz) overlaps acoustic signals used by baleen whales. Increased ambient sound can mask biologically-significant sounds (e.g., masking may result in the disruption of breeding in animals that use sound during mating and reproduction, and of foraging in animals that use sound to detect prey) and important acoustic environmental cues used to navigate and to detect predators (Wright 2008). The potential for masking is greatest for marine mammals that produce and perceive sounds within the same range as that produced by vessels. Baleen whales are those most susceptible to increased levels of sound below the 1-kHz range. Studies on North Atlantic right whales indicate that these species will adjust their vocalizations in the presence of vessel sound (Wright 2008). Some species can alter their communications to avoid being masked by anthropogenic sounds, although these alterations are not optimal behaviour for these species, as these alterations may be costly for survival and reproductive success.
	• Potential effects of underwater noise on marine mammals, particularly the North Atlantic right whales in the Study Area, would depend on the type of seismic survey, sound sources and drilling platforms, and results from underwater noise modelling for project-specific EAs.
	• Additional references provided by DFO pertaining to the effects of underwater noise on marine mammals (Parks and Clark 2007; Parks et al. 2007, 2008, 2009, 2011, 2016; Rolland et al. 2012) should be consulted for project-specific EAs.It is advised that future proponents review and consider these and other available references for future project-specific EAs, as applicable.
	• While the Study Area falls within feeding and migratory paths of some marine mammal species, the increase in vessel presence due to exploratory operations is not expected to be substantial although any marine mammal strike leading to injury or mortality is considered a serious event. Given temporary and/or transient nature of activity and proper mitigation (e.g., implementation of the latest version of SOCP, timing of surveys, reduced vessel speeds), considerable adverse effects of vessel traffic on marine mammals are not expected.

5.1.1.4 Well Abandonment

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

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

5.1.1.5 Accidental Events

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

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

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

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

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

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

Effects of Chemical Dispersants	• Chemical dispersants are often used in the event of an accidental spill to remove oil from the water's surface (Adams et al. 2014). The dispersion of oil increases the concentration of petroleum hydrocarbons in the water column and at the same time increases the rate of decomposition through dilution and biodegradation. However, in the case of the Deepwater Horizon accident, dispersant use was shown to impede hydrocarbon degradation by microorganisms (Kleindienst et al. 2015, cited in Cordes et al. 2016). • Advancements in dispersant formulas have decreased their toxicity but have shifted the concern from the toxicity of the dispersant itself to the toxicity of the dispersed oil mixtures. Chemically-dispersed oil is known to reduce larval settlement, cause abnormal development, and produce tissue degeneration in sessile invertebrates (Epstein et al. 2000; Goodbody-Gringley et al. 2013; and DeLeo et al. 2016, cited in Cordes et al. 2016). • Adams et al. (2014), exposed embryos of Atlantic herring and rainbow trout to chemically-dispersed crude oil. Atlantic herring embryos experienced delayed development as well as edema; similar responses were found for rainbow trout embryos. Embryos with delayed development may be less viable in a natural environment and as a result subject to high rates of predation. The study concluded that the toxicity of the petroleum hydrocarbons did not change with chemical dispersion; however, chemical dispersion of oil increases the bioavailability of petroleum hydrocarbons, by increasing the surface area to volume ratio of oil droplets and the rate of partitioning of hydrocarbons from droplets into aqueous solution (Adams et al. 2014).
Effects on Fish and Invertebrates	• Alterations in fish larvae mortality have been documented with increasing concentrations of oil contaminants in the surface microlayer (DFO 2011a).

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

	• Sublethal effects on fish can include changes in biochemical responses of enzyme systems, increased frequency of histopathological changes and diseases in bottom fish, and degradation of ichthyoplankton communities in response to oil contaminants. • Spawning events of fish are generally restricted in time and place; therefore, year class strength can be impacted if a spill coincides with a spawning event. Several studies have shown that oil presence can have both lethal and sublethal effects (reduced growth and abnormal development) in eggs, larvae and juveniles. • The effects of oil on mature fish are difficult to study in the field as mature fish can generally avoid a spill, provided the affected area is adequately small. As a result, fish can mainly be affected by spills from the egg stage until maturity and full mobility is reached. • White sharks (and likely porbeagle and shortfin mako sharks) are especially susceptible to the bioaccumulation of pollutants due to their diet and longevity (COSEWIC 2006c). For example, muscle and liver tissue from white sharks caught in the Bay of Fundy-Gulf of Maine area had higher levels of PCBs and chlorinated hydrocarbon pesticides than other fishes (Zitko et al. 1972).

Effects on Marine Mammals and Sea Turtles	• Depending on the scale and nature of the spill, marine mammals can be affected in several ways (Marine Mammal Commission 2011), including:
	  • Direct contact, ingestion or inhalation of oil (or other product), its metabolites or dispersants;
	  • Injury and/or disturbance from spill response activities; and
	  • Short and long-term ecological changes resulting from the spill and response efforts.
	• Exposure to oil and its metabolites is known to be harmful to marine mammals. Inhalation of by-products can cause respiratory irritation, inflammation, or emphysema (Marine Mammal Commission 2011). The ingestion of oil may cause gastrointestinal inflammation, ulcers, bleeding, diarrhea, or maldigestion. Certain inhaled or ingested by-products may cause damage to organs such as the liver, kidneys, adrenal glands or spleen, or may cause reproductive failure. Chemical contact can result in skin and eye irritation, inflammation, burns to mucous membranes, mouth and nares, or increased susceptibility to infection. Oil can also physically foul the baleen of mysticetes whales, which can inhibit feeding.
	• Response activities to contain and remove oil can impact marine mammals and sea turtles. The increased marine and air traffic associated with a large spill can disrupt foraging, habitat use, daily and migratory movements and behavior. The increased vessel traffic as mentioned above can increase risk of vessel strikes.
	• Oil spills can indirectly affect marine mammals and sea turtles by altering the marine ecosystem and the key features of their habitat such as contamination, shifts and reduction in prey biomass (Marine Mammal Commission 2011).
	• The impacts of recent oil spills on sea turtles has been documented. The veterinary and conservation and biology literature on these impacts should be reviewed by proponents of future project-specific EAs. For example, there is a special issue in Endangered Species Research on the effects of the Deepwater Horizon oil spill on sea turtles:
	  • Endangered Species Research Volume 33. http://www.int-res.com/abstracts/esr/v33/

Effects on Marine and Migratory Birds	• Marine birds are highly susceptible to oiling and extremely vulnerable to associated effects. Feathers readily absorb oil, decreasing their ability to insulate birds from the cold, and reduce their waterproofing and buoyancy abilities. Contact with a small amount of oil can lead to death through hypothermia and starvation, and birds can die from ingesting petroleum products while preening. • Nesting seabirds that have survived oil contamination generally exhibit decreased reproductive success. When oiled birds return to nests, they risk exposing eggs to oil and

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

	causing high mortality of embryos. Mortality and developmental defects in avian embryos exposed to even small quantities of oil (i.e., 1 to 20 µL) have been documented (Leighton 1993; Lee et al. 2015). • During certain times of year, large numbers of birds congregate on the waters' surface while migrating; if an oil or fuel spill were to occur in such a location at times when large numbers of birds have congregated, a global population of a species could be greatly impacted (DFO 2011a). Similarly, if a spill were to occur in proximity to the shoreline or if an offshore unmitigated spill were to migrate to the shoreline where large numbers of colonial seabirds and/or shorebirds have congregated, a global population of a species could be greatly impacted.

5.1.2 Mitigation and Planning Considerations

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

The SOCP is currently undergoing a detailed technical review. DFO's Canadian Science Acvisory Secretariat have published papers in 2015 and 2020 in support of this review which include recommendations for additional mitigative measures. Any new mitigation to be included in an updated SOCP will be established collaboratively among the various regulatory authorities and may include enhanced mitigation for specific species at risk.

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

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

Table 5.5 Mitigation and Planning Considerations for Species of Special Status

Seismic and Seabed Surveys	• Carefully plan project activities well in advance of operations to promote adherence (at a minimum) to the latest version of the SOCP. • Consider additional enhanced mitigation measures (beyond requirements of SOCP), as required, to minimize potential adverse effects to Species of Special Status. • Conduct detailed acoustic modelling as input to project-specific EA for seismic programs proposed in the Project Area; results may be used in determining appropriate safety zones for shutdown of seismic air source array and VSP testing. • Model TTS/PTS in project-specific EAs, using the most current scientific literature. • Establish a safety zone around the seismic air source array (with a minimum radius of 500 m, to be determined through modelling), to be monitored visually by a qualified Marine Mammal Observer and/or through passive acoustic monitoring (PAM) (in low visibility conditions). • Implement shutdown procedures (i.e., shutdown of seismic source array) if a marine mammal listed on Schedule 1 of SARA or any sea turtle is observed within the defined safety zone. • Enhanced mitigation may be required for seismic surveys (e.g., the 30- minute observation period outlined in the SOCP may be extended to 60 minutes to account for longer diving times) any time a beaked whale is observed during a survey. • Implement mitigation measures in a manner that intends to protect and avoid harming, killing or disturbing migratory birds. Refer to Environment Canada’s Avoidance Guidelines in planning and conducting activities, while assuring compliance with the MBCA, 1994 and with the SARA. • Conduct seabird monitoring using guidance from the Eastern Canadian Seabirds at Sea (ECSAS) Standardized Protocol for Pelagic Seabird surveys from Moving and Stationary Platforms (Gjerdrum et al. 2012b). • Reduce bird attraction by limiting high-intensity lighting, reducing horizontal light emissions, and reducing flaring, when safe to do so. • Additional mitigation for light reduction and seabird monitoring (included in the Regional Assessment of Offshore Oil and Gas Exploratory Drilling East of Newfoundland and Labrador) should be considered in future exploration projects on a case by case basis.

Table 5.5 Mitigation and Planning Considerations for Species of Special Status

Exploratory Drilling	• Conduct project-specific drill waste deposition modelling to predict extent of drilling mud and cuttings seabed deposition. • Season-specific acoustic modelling at the project level may be required (on a case by case basis) to evaluate potential adverse effects on marine mammals from drilling activity-associated sound. • Conduct pre-drilling ROV investigation to determine presence of corals, sponges, or other sensitive features as required by the CNSOPB. • Avoid areas with known aggregations of corals, sponges, and other sensitive features during drilling activities. • Refer to the Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada (ECCC 2016). • Additional mitigation for light reduction and seabird monitoring (included in the Regional Assessment of Offshore Oil and Gas Exploratory Drilling East of Newfoundland and Labrador) should be considered in future exploration projects on a case by case basis. • Develop an EPP for exploratory drilling activities, including selecting and screening chemicals to be discharged in accordance with the Offshore Chemical Selection Guidelines (NEB et al. 2009) and managing offshore waste discharges and emissions from the MODU and offshore supply vessels (OSVs) in accordance with the OWTG (NEB et al. 2010) and MARPOL, as applicable. • Adhere to Nova Scotia Offshore Petroleum Drilling and Production Regulations and associated Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017). • Implement best practices for bulk transfer and hose handling procedures. • Provide advanced notice of flaring during periods of migratory bird vulnerability and plans of the associated mitigation to prevent harm to, or killing of, migratory birds. • If flaring is required, the operator will discuss flaring plans with the CNSOPB including steps to reduce adverse effects on migratory birds. • Flaring events will be reduced to the extent feasible, in particular during nighttime and poor weather conditions, as well as during seasonal periods of bird vulnerability. • When flaring occurs, a dedicated Seabird Observer will monitor and document bird behaviour around the flare to access the effectiveness of flare shields and water curtains in mitigating flare-bird interactions, as applicable. • Conduct a post-drilling ROV survey to verify drill waste deposition modelling predictions (e.g., confirm that the muds and cuttings are within the predicted zone of influence).
Vessel Traffic	• Adhere to Transport Canada Guidelines for the Control of Ballast Water Discharge from Ships in Waters under Canadian Jurisdiction. • Routes of helicopters and vessels transiting to and from the offshore environment will use existing routes to the extent practical and avoid transiting near migratory bird nesting colonies. Appropriate flight altitudes and horizontal buffer zones will be established in accordance with ECCC's Avoidance Guidelines for seabird and waterbird colonies and will be followed except in helicopter emergency situations. • Track and adhere to seasonal vessel speed restrictions set by Transport Canada for the protection of North Atlantic Right Whales. • Refer to the Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada (ECCC 2016), as appropriate. • Follow Section 5 General Guidelines for Aquatic Species at Risk and Important Marine Mammal Areas in the Canadian Coast Guard's Annual NOTMAR.

Table 5.5 Mitigation and Planning Considerations for Species of Special Status

Well Abandonment	• Design wells and casings to facilitate effective mechanical cutting and removal of the wellhead, avoiding explosive means of separation where possible. • If use of explosives is necessary, follow the recommendations set out in the Guidelines for the use of Explosives in or near Canadian Fisheries Waters (Wright and Hopky 1998).
Accidental Events	• Conduct spill fate and behavior modelling as input to project-specific EA for drilling programs proposed in the Project Area. • Prepare project-specific NEBA/SIMA, as required. • Develop engineering design and process safety management protocols to prevent spills from occurring and/or reaching the marine environment including but not limited to secondary containment, inspection and maintenance, spill response kits, and blowout safeguards. • Implement Emergency and Oil Spill Response Plan accepted by the CNSOPB (with input from DFO, ECCC, and Parks Canada, as applicable), including emergency contingency measures and response plans for addressing significant weather scenarios. • Implement Wildlife Response Plan, developed in consultation with expert authorities and consistent with local/regional species expected to be encountered, for the protection, rescue, and rehabilitation of wildlife. • Use non-fluid filled streamers for seismic surveys, where possible. • Implement bulk transfer and hose handling procedures per best management practice. • In the event of a spill, develop an EEM Plan to address post-spill monitoring of effects, with the scope of the EEM Plan directly related to the severity of potential spills. • Use turtle guards on seismic arrays.

5.1.3 Data Gaps and Uncertainties

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

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

Continued research and wildlife monitoring during future oil and gas activities may further knowledge, particularly if monitoring surveys are standardized and data are shared for future use. The most relevant studies are those that are conducted while the species are exposed to actual seismic surveys. Future seismic surveys present a research opportunity to fill knowledge gaps regarding seismic sound and cetacean and sea turtle species at risk, and the use of a trained marine mammal observers onboard during seismic activities is particularly important.

There is a general lack of information regarding the deeper areas of the marine benthic environment on the Scotian Slope. As oil and gas lease areas off Eastern Canada are concentrated in the same regions as suitable / important / critical habitat for blue whales and other species of special status, evaluation of potential risks and impacts to these species should reference up-to-date information on presence and potential overlap with project activities (Moors-Murphy et al. 2018).

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

It is acknowledged that there is a need for more information related to the distribution and abundance for migratory birds in the Study Area, particularly during winter months and in the deep water (slope) habitats. Also, with respect migratory birds, there remains considerable uncertainty as to the the effects of lights on migratory birds and actual zone of influence of light on the attraction of migratory birds. There have been no studies undertaken on the maximum light detection distance or zone of disturbance for migratory birds.

With respect to effects of exploration activities on Species of Special Status, most of the data gaps and uncertainties are related to effects (and species thresholds) and monitoring of seismic sound. This gap in knowledge is widely recognized and seismic-related research is the focus of various research funding initiatives including the Exploration and Production (E&P) Sound and Marine Life Joint Industry Programme (JIP), Offshore Energy Research Association (OERA) and ESRF Program, including the following current projects (ESRF 2019):

- Assessment of the Potential Risks of Seismic Surveys to Affect Snow Crab Resources (2014-01S): Aims to investigate potential effects of seismic exploration activity on commercial snow crab catch rate using scientific measures of changes in crab behaviour (i.e., movement), commercial catchability, and physiological effects in response to seismic air gun operations.
- Acoustic Modeling and Monitoring on Canada’s East Coast (2014-02S): Recording the natural soundscape on Canada East Coast and studying seismic sound propagation to create new knowledge on the natural soundscape in the region, generate accurate models of the effects of seismic surveys, and validate particle motion models for seismic airguns.

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

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

While many potential offshore projects are temporary and transient, they should consider the ongoing effects of climate change with respect to design for increasing extreme metocean conditions as well as related changing biological and socionomic conditions that could occur within the temporal boundaries of future projects. Future projects and activities should consider the implications of climate change on a case by case basis. While climate change predictions are becoming more accurate, they are noted here as a subject for improved analysis as it evolves.

5.2 SPECIAL AREAS

Special Areas within the SEA Study Area are described in Section 3.2.8 and include the Northeast Channel Coral Conservation Area, the Fundian Channel/Browns Bank AOI, Corsair and Georges Canyon Conservation Area, the Emerald Bank Sponge Conservation Area, the Western/Emerald Banks Conservation Area (including the Haddock Box), as well as several areas of importance for fish conservation, critical habitats for the North Atlantic right whale and leatherback sea turtle (draft) (Figure 3.24), and six EBSAs (Figure 3.25). All Special Areas within this report have their own conservation needs. For example, some Special Areas are fisheries closure areas to help protect stocks or sensitive benthic habitat. While these designations indicate ecological sensitivities that should be considered, they do not necessarily dictate the same level of enhanced mitigation that may be applicable to critical habitat for endangered species.

As described in Section 3.2.8, DFO experts identified EBSAs along the Scotian Shelf to address conservation objectives in accordance with the *Oceans Act* (Horsman et al. 2011; Figure 3.25). These were identified based on a compilation of ecological and biological data, scientific expert opinion, and traditional knowledge that was solicited through efforts to support integrated ecosystem-based management efforts on the Scotian Shelf (Doherty and Horsman 2007; King et al. 2016). While the EBSAs do not necessarily have official protection under the *Oceans Act*, they are regions of ecological and biological significance. The identified EBSAs will be considered in a broad range of coastal and oceans management and planning processes in the Scotian Shelf, including in the design of a network of MPAs; however, not all EBSAs will be part of the MPA network (King et al. 2016). Management needs will be evaluated for each EBSA, wherein certain EBSAs or its parts may be protected as an MPA (or other spatial protection tool), and activity-specific mitigation measures may be developed for other EBSAs while some may not require any additional management measures (King et al. 2016).

5.2.1 Potential Effects on Special Areas

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

5.2.1.1 Seismic and Seabed Surveys

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

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

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

Effects on Areas of Significance for Fish and Invertebrates	• Seismic sound can affect the fitness and survival of fish and invertebrates at very close range (Section 5.1.1.1). • Horsman and Shackell (2009) provide an in-depth overview of important areas for fish on the Scotian Shelf; important larval areas for yellowtail flounder, witch flounder, silver hake, white hake, American plaice, Atlantic cod, haddock, mackerel, pollock, redfish, red hake, cusk, herring, Atlantic wolffish, and monkfish are located within the Study Area (Horsman and Shackell 2009). • Long-term and/or permanent effects (i.e., mortality) on larvae and eggs have been observed at close range, which may affect fish species even demersal species with pelagic larvae and eggs (e.g., redfish, American plaice, Atlantic cod).

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

Effects on Areas of Significance for Marine Mammals and Sea Turtles	• Section 5.1.1.1 describes potential effects of seismic sound on marine mammals and sea turtles. Although mysticetes (e.g., fin, blue, and North Atlantic right whales) are assumed to be sensitive to sound frequencies similar to those emitted by seismic surveys, odontocetes (e.g., Northern bottlenose whales) appear to be more sensitive, particularly within a 1-km radius of the array.
	• Low-frequency sound associated with seismic activity may interfere with vocalizations in areas of ecological importance and/or biological significance. Based on data on effects of sound pressure levels on cetaceans, an isopleth of 160 dBRMS has been identified for the inducement of behavioral responses (e.g., avoidance) and 180 dBRMS for the likely inducement of auditory damage and other physical injury (Compton et al. 2007). Acoustic modeling conducted for the Shelburne Basin 3D Seismic Survey Environmental Assessment (LGL 2013) predicted that sound pressure levels of 180 dBRMS could propagate approximately 1 km from the source, depending on water depth and season. Critical habitat for the endangered Northern bottlenose whale has been designated in the Gully and Shortland and Halimand Canyons to the east of the Study Area, although Northern bottlenose whale has been observed in the Study Area. Based on a systematic literature review and analysis, Gomez et al. (2016) noted that more severe behavioural responses were not consistently associated with higher received levels, indicating that generic multi-species received levels should not be exclusively relied upon for monitoring and regulation of acoustic effects from activities on cetacean behaviour.
	• The identified and protected Roseway Basin Critical habitat for the North Atlantic right whale is located within the Study Area. Depending on the proximity of the air gun array to the critical habitat and the timing of the survey, the quality of habitat could be degraded by underwater sound and disturbance effects could occur (e.g., displacement from feeding and socialization area), having potential effects on this population if mitigation measures (e.g., those contained in the SOCP) were not applied.
	• In 2018, DFO identified the Scotian Shelf and Slope Break (including the Gully) as “habitat important to the blue whale.” There is a possibility that blue whales may be encountered by Operators in the SEA Project Area, and that habitat features and attributes that are important to blue whales could be affected by exploration activities (DFO 2018c), particularly seismic surveys, if they are conducted during the summer months. The use of seismic survey using air gun arrays can affect functions, features or attributes of habitats important to blue whales. Interference with hearing and communication or alterations from normal behaviour acoustic disturbance resulting in loss of habitat availability or function.
	• Although monitoring of marine mammals was conducted during seismic programs in the vicinity of the Gully (Cochrane 2007; Gosselin and Lawson 2004; Lee et al. 2005; McQuinn and Carrier 2005; Potter et al. 2007; Thomsen et al. 2011), there remain data gaps regarding whale behavior in the presence of active seismic programs; therefore precautionary planning designated to protect cetaceans should be undertaken for seismic operations in the vicinity of the Special Areas.
	• Additional references provided by DFO pertaining to the effects of underwater noise on marine mammals include:
	    • Parks, S.E. and Clark, C.W. 2007. Acoustic communication: Social sounds and the potential impacts of noise. In The Urban Whale: North Atlantic right whales at the crossroads (pp. 310- 322). Harvard University Press, Cambridge, MA.
	    • Parks, S.E., Clark, C.W., and Tyack, P.L. 2007. Short-and long-term changes in right whale calling behavior: The potential effects of noise on acoustic communication. Journal of the Acoustical Society of America.122(6):3725-3731.
	    • Parks, S.E., Clark, C.W., Tyack, P.L. 2008. Long-and Short-Term Changes in Right Whale Acoustic Behavior in Increased Low-Frequency Noise. Bioacoustics. 17(1-3):179-180.

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

	◦ Parks, S.E., Urazghildiiev, I., and Clark, C.W. 2009. Variability in ambient noise levels and call parameters of North Atlantic right whales in three habitat areas. Journal of the Acoustical Society of America. 125(2):1230-1239. ◦ Parks, S.E., Johnson, M., Nowacek, D., and Tyack, P.L. 2011. Individual right whales call louder in increased environmental noise. Biology Letters. 7(1): 33-35. ◦ Parks, S.E., Groch, K., Flores, P., Sousa-Lima, R., and Urazghildiiev, I.R. 2016. Humans, fish, and whales: How right whales modify calling behavior in response to shifting background noise conditions. In The Effects of Noise on Aquatic Life II (pp. 809-813). Springer, New York, NY. ◦ Rolland, R.M., S.E. Parks, K. Hunt, M. Castellote, P.J. Corkeron, S.K. Wasser and S.D. Kraus. 2012. Evidence that ship noise increases stress in right whales. Proc. R. Soc. B. 279:2363–2368. • It is advised that future proponents review and consider these and other available references for future project-specific EAs, as applicable.
Effects on Sensitive Benthic Areas	• Special Areas with sensitive benthic habitat-forming species such as high-density coral and sponge (Vazella pourtalesi) conservation areas and overwintering areas for shellfish (e.g., Scotian Slope/Shelf Break EBSA 30, Emerald Basin) may be adversely affected by seabed surveys. • Seabed surveys involve localized disturbance of seabed substrate and benthos, using a variety of tools and techniques such as 2D high-resolution digital seismic (low-energy), multi-beam echo-sounders, and seabed core sampling (Hurley 2011). The most sensitive benthic communities are those with high vulnerability and low recovery rate (e.g., deep-sea coral and sponge communities) and the least sensitive benthic communities have a low vulnerability and high recovery rate, for example communities dominated by scavengers and mobile species (DFO 2005b; Burbidge 2011). • Seabed surveys that directly contact the seabed may impact benthic species and habitats through direct mortality, smothering or clogging of filter-feeding mechanisms and gills from local sedimentation (Järnegren et al. 2017; Lee et al. 2011). Irreversible damage including mortality to corals and sponges or other sensitive areas by removal of entire organisms or physical alteration may be caused by seabed surveys. • Seismic sound from seabed surveys may affect juvenile fish and invertebrates near the seabed (refer to Section 5.1.1.1).

5.2.1.2 Exploratory Drilling

Special Areas containing sessile benthic species (corals and sponges) and other benthic species (haddock, Atlantic cod, surf-clam, winter skate, and others) are more susceptible than pelagic species to effects from exploratory drilling (Hurley 2011). Effects could include direct physical impact or mortality; drilling mud and cuttings discharge can smother benthic species and result in toxic effects, causing acute and chronic long-term impacts such as reduced growth or reproductive potential (see Section 5.1.1.2). Effects of exploratory drilling may be of concern should activities occur in proximity to Special Areas that are important to marine or migratory birds and/or groundfish (e.g., the Haddock Box, Western/Emerald Banks Conservation Area). The Project Area overlaps with the Western/Emerald Banks Conservation Area. Given the area's importance and complex habitat (refer to Table 3.22), this overlap, and potential effects of exploration activities, will be a key focus of DFO's regulatory review of proposed oil and gas activities within the Project Area.

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

Table 5.7 Potential Effects of Exploratory Drilling on Special Areas

Effects on Benthic Species	• Special Areas with habitat-forming benthic species (e.g., Scotian Slope/Shelf Break EBSA 30, Emerald Basin, Corsair and Georges Canyons Conservation Area) are particularly vulnerable to adverse effects from exploratory drilling, given the potential effects noted in Section 5.1.1.2. • Significant mortality occurred in cold-water coral (Lophelia pertusa) larvae exposed for 24 hours to an increased drill cuttings sediment load (Järnegren et al. 2017). The larval cilia became clogged and prevented the larvae from swimming actively, which could have wider implications given that larvae of many species use cilia for swimming and feeding. The study concluded that while adult L. pertusa can survive (at least temporarily) under extreme sediment load, all or part of the cohort may be lost should cuttings release occur during larval development (Järnegren et al. 2017). • Exposure to barite (a primary component of WBM) has been shown to result in toxicity in deep-water sponges (Edge et al. 2016). • EEM programs at production drilling sites offshore Nova Scotia (Deep Panuke and SOEP) have consistently observed less adverse effects than predicted. No toxic responses (as demonstrated by amphipod mortality testing) have been observed at any site since 2003 (CNSOPB 2011). Of the 24 metal chemical test parameters monitored in sediment at SOEP, elevated concentrations were only detected for total petroleum hydrocarbon (TPH) and barium (from the drill muds and cuttings piles deposited on the seafloor), and these only extended out to 500 m and returned to baseline concentrations within four years post-drill (CNSOPB 2018). Relative to development drilling, exploratory drilling is generally considered to present less risk of impact to benthic species and habitats, with fewer associated activities, smaller seabed footprints and shorter timeframes. • Ecological changes from exposure to WBM were detected at Terra Nova up to 1-2 km from the discharge source, including enrichment effects on some tolerant taxa (e.g., polychaete family Phyllodocidae and bivalve family Tellinidae) and decreased abundance of sensitive taxa (e.g., polychaete families Orbiniidae and Paraonidae) (Paine et al. 2014).
Effects on Marine and Migratory Birds	• As described in Section 5.1.1.2, marine and migratory birds could interact with illuminated vessels or MODUs and become exposed to contaminants from waste disposal, operational discharges, and spills, or be incinerated by flaring (Hurley 2011; DFO 2011a). These interactions could be of particular concern should exploratory drilling be proposed within the vicinity of Special Areas such Fundian Channel/Browns Bank AOI and the Scotian Slope EBSA.
Effects on Fish and Invertebrates	• Underwater sound from exploratory drilling and DP thrusters (semi-submersibles or drill ships) may result in behavioural effects to fish and invertebrates, disrupting or dispersing spawning aggregations of fish (refer to Table 5.1 for potential effects of underwater sound on fish and invertebrates). These interactions could be of concern should exploratory drilling be proposed where underwater sound may propagate to Special Areas that provide important spawning and nursery habitat for fish (e.g., the Haddock Box, Western/Emerald Banks Conservation Area).
Effects on Marine Mammals	• Underwater sound from exploratory drilling and DP thrusters (semi-submersibles or drill ships) may result in behavioural effects to marine mammals such as temporary avoidance (see Section 5.1.1.2). These interactions could be of concern should exploratory drilling be proposed where underwater sound may propagate to Special Areas that provide important or critical habitat for marine mammals. Recent acoustic modelling for drilling programs offshore Nova Scotia suggested that underwater sound levels exceeding behavioural thresholds could extend over 150 km from the drill site in winter (BP 2016).

5.2.1.3 Vessel Traffic

The high volume of shipping activity and vessel traffic on the Scotian Shelf may result in effects on marine habitats and communities, including ship-source pollution, shipboard wastes, sound, and collisions between vessels and marine life (Burbidge 2011). Vessel traffic from oil and gas exploration activities is expected to be minimal, with minor associated environmental effects on Special Areas in the Study Area. However, potential vessel-related adverse effects to birds may particularly be of concern in Special Areas that are important to marine and migratory birds (e.g., the Scotian Slope EBSA, Brown's Bank EBSA, Fundian Channel/Browns Bank AOI). Refer to Section 5.1.1.3 for further details.

It is unlikely that routine oil and gas activities conducted offshore Nova Scotia have had substantive, population level effects on marine biota. By contrast, ship-source oil pollution is estimated to result in the oiling of thousands of seabirds annually in the region. More than 7,000 seabird corpses were recovered on Sable Island between 1993 and 2002 (Sable Island Bank region EEM program); 40% of birds had some oiling, mostly weathered crude and heavy fuel oil mixed with varying amounts of lubricants and diesels (Sable Island Green Horse Society 2004). None of the oil was attributable to either the SOEP or Deep Panuke projects. While primarily attributable to large ocean-going vessels rather than oil and gas exploration and development activities on the Scotian Shelf, this demonstrates the prevalence of hydrocarbon contamination and vulnerability of bird species in the area.

5.2.1.4 Well Abandonment

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

5.2.1.5 Accidental Events

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

All Special Areas in the SEA Study Area are vulnerable to potential effects that could result from a large accidental spill such as a subsea blowout of crude oil. As described in Section 5.1.1.5, oil spill trajectory modelling studies conducted for the Shelburne Basin Venture Exploration Project (RPS ASA 2014, cited in Shell 2014) and the Scotian Basin Exploration Project (BP 2016) conservatively predictthat an unmitigated well blowout scenario could result in surface oiling extending thousands of kilometres.

However, these modelling scenarios represent worst credible case scenarios and assume no spill response action is taken, aside from capping stack installation after 30 days.

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

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

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

5.2.2 Mitigation and Planning Considerations

Management planning by federal authorities for Special Areas, EBSAs and the MPA network is currently underway. Operators are advised to maintain regular communication with DFO to obtain up-to-date information when planning exploratory programs. It is further recommended to work collaboratively with DFO on mitigation measures regarding Special Areas identified in this report. When a project application is under review, the CNSOPB works closely with DFO to determine if enhanced mitigation for Special Areas is required. Parks Canada is also engaged with respect to potential effects from large spills on Parks assets such as Sable Island and Kejimkujik Seaside Adjunct. Mitigation measures are developed on a program-by-program basis depending on the location, species, and special areas present.

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

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

Seismic and Seabed Surveys	• Schedule surveys to reduce interaction with peak haddock spawning in the Western/Emerald Banks Conservation Area and the Haddock Box (March/April). • Potential avoidance (on a case by case basis) of intrusive seabed surveys in areas with known concentrations and/or high diversity of corals or sponges.
Exploratory Drilling	• Conduct underwater sound modelling to inform the analysis of effects of underwater sound on Special Areas. • Conduct pre-drilling ROV investigation to determine presence of corals, sponges, or other sensitive features. • Avoid areas with known aggregations of corals, sponges, and other sensitive features during drilling activities. • Conduct project-specific drill waste deposition modelling to predict extent of sediment deposition. • Conduct a post-drilling ROV survey to verify drill waste deposition modelling predictions (e.g., confirm that the muds and cuttings are within the predicted zone of influence). • Consider DFO's Sensitive Benthic Areas Policy (DFO 2009c) for activities in sensitive benthic areas; while intended for fisheries management, the policy describes protection mechanisms to protect these habitats. • Consider and evaluate technologies that may reduce the quantity of generated solids when drilling in areas with sensitive benthic species. • Adhere to the OWTG (NEB et al. 2010), Nova Scotia Offshore Drilling and Production Regulations (and associated guidelines), Offshore Chemical Selection Guidelines (NEB et al. 2009), and Environmental Protection Plan Guidelines (C-NLOPB et al. 2011).
Vessel Traffic	• Use existing vessel routes to the extent practical to avoid transiting near migratory bird nesting colonies. • Follow Section 5 General Guidelines for Aquatic Species at Risk and Important Marine Mammal Areas in the Canadian Coast Guard's Annual NOTMAR.
Well Abandonment	• Mitigation measures as described in Section 5.1.2 (Mitigation and Planning Considerations for Species of Special Status).
Accidental Events	• Mitigation measures as described in Section 5.1.2 (Mitigation and Planning Considerations for Species of Special Status).

5.2.3 Data Gaps and Uncertainties

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

A key source of uncertainty pertaining to the Special Areas VC is the ongoing management and planning processes for the Scotian Shelf and Slope, including the design of a network of MPAs. The new approach to marine conservation, including conservation standards to better conserve sensitive and important parts of our oceans was established in April 2019 by the Government of Canada. The new approach allows for continual growth of Canada's conservation network in the form of MPAs and OECMs. The management and standards associated with MPAs are described in 3.2.8. With respects to this SEA, although there are no MPAs in the Project Area, the Fundian Channel-Browns Bank Area of Interest (AOI) overlaps with the northwest corner of the Study Area. Should this AOI proceed to an MPA in the future, it is understood that certain activities, including oil and gas activities will be prohibited within the established boundaries of the MPA.

Further to the above policy standards, DFO recently released the draft approach to the 2020 Marine OECM Guidance for review by its regulatory partners. Ultimately, the guidance document will describe how OECM's are established as well as the governance structure and relevant authorities. It is understood that the guidance will be completed in early 2021.

Not all EBSAs will be part of the MPA network, the management needs for individual EBSAs are currently being assessed (King et al. 2016). EBSA management measures may include spatial management (MPA designation or other spatial protection tool) or activity-specific mitigations, while additional management measures may not be required in some EBSAs. When planning for offshore exploration programs, it is recommended that operators obtain up-to-date information from DFO on a regular basis and work collaboratively with the CNSOPB, DFO, ECCC and Parks Canada (as applicable) on mitigation measures for Special Areas.

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

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

Other data gaps and uncertainties related to species of special status and other assemblages that are found within Special Areas are noted in Section 5.2.3.

5.3 FISHERIES

5.3.1 Potential Effects on Fisheries

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

5.3.1.1 Seismic and Seabed Surveys

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

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

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

Table 5.9 Potential Effects of Seismic and Seabed Surveys on Fisheries

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

Table 5.9 Potential Effects of Seismic and Seabed Surveys on Fisheries

Behavioural Effects of Fisheries Resources	• Seismic exposure may result in behavioural effects on fish and invertebrates (see Species of Special Status, Section 5.1.1.1). • Effects of seismic surveys on invertebrate and fish behavior (e.g., startle response, changes in swimming speed and direction, and changes in vertical distribution (Worcester 2006) may affect catchability. • No evidence of reduced catch or abundance of invertebrates following seismic activities, and conflicting evidence for fish, with studies showing increased, decreased or unchanged catches (Carroll et al. 2017). • Scare effects can entail catch reductions that will vary from species to species and between various types of fishing gear (Dalen et al. 2007). Depending on the relative location of the seismic survey air gun, the fish species being harvested, and the fishing gear, effects on fish behavior can vary. • Gausland (2003) reported higher catches in the immediate track of a seismic survey where bottom trawling was used. Løkkeborg et al. (2009) demonstrated that differences in species reactions with Greenland halibut, redfish and ling increasing their level of swimming activity, thus making them more liable to be taken in gillnets and reducing efficiency of longline catch. • No literature has been found documenting major startle or movement responses in crustaceans exposed to seismic sound (Payne et al. 2008). Catch rates are less likely to be affected for sedentary benthic species (e.g., lobster) as these are not likely to disperse (DFO 2011a). No measurable change in catch rates was observed during a study of effects of 2D seismic surveys on snow crab catch rates along the Newfoundland Grand Banks (Morris et al. 2018). • Parry and Gason (2006) investigated the effects of seismic exploration on catch per unit effort (CUPE) of rock lobster and found no evidence of declining catch rates in the weeks or years following any of the 33 seismic surveys conducted in western Victoria, Australia from 1978 to 2004.
Gear Loss and Damage	• Damage to fishing gear or vessels can occur as a result of physical contact with seismic vessels and equipment. • Fixed gear (e.g., crab pots, lobster traps, longlines, gill nets) generally poses a greater potential for conflict with seismic surveys since it is difficult to detect and can be set out over long distances in the water (LGL 2005a). • Groundfish and pelagic longline fisheries can have gear that can extend more than 60 km in length behind the vessel. Pelagic longline gear is free floating for up to 12 hours at a time. Both seismic and longline fishing activities result in large areas of influence associated with each activity as well as the turning radii associated with each type of vessel. Changing wind, waves and tides can also result in considerable drift of longline fishing gear (DFO 2011a). There have been no seismic/longline gear entanglements offshore Nova Scotia to date.haveMobile gear (e.g., trawls, seines), towed behind vessels, and pelagic rod and reel fisheries have a lower risk of conflict since the activity is more visible and seismic survey ships and fishing vessels can communicate with each other and exchange information about operating areas and activities (LGL 2005b). • The path and length of time of possible interaction between seismic vessels and fisheries will be increased should WAZ seismic surveys be employed (i.e., multiple seismic vessels used in parallel to tow sound arrays, resulting in a much greater vessel footprint). These seismic programs also run for longer periods of time compared to traditional 2D and 3D seismic programs.

5.3.1.2 Exploratory Drilling

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

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

Table 5.10 Potential Effects of Exploratory Drilling on Fisheries

Physiological and Behavioural Effects on Fisheries Resources	• Metals and organic compounds in drilling muds (including WBM) may accumulate in tissues, reducing growth and reproduction, tainting exposed organisms (for human consumption) and/or bioaccumulating (passing up the food chain and impacting predator species), even at relatively low concentrations (Lee et al. 2011). • Laboratory studies have linked prolonged exposure of bentonite and barite to sublethal effects affecting scallop growth and reproduction at bentonite concentrations as low as 2 ppm (Cranford and Gordon 1992; Cranford et al. 1999; Barlow and Kingston 2001). However, these studies did not account for active wind and tidal mixing and changes in biophysical benthic conditions. • Laboratory studies involving exposure of snow crabs (Andrews et al. 2004) and lobster (Hamoutene et al. 2004) demonstrated minor metabolic differences between experimental and control group individuals, neither of which would be expected to impact fisheries success. It is noted that all these experiments involved exposure concentrations much higher than would be realized in an open-ocean environment where drilling fluids and cuttings would be diluted and dispersed. • Concentrations of drilling mud constituents and metals were monitored in clams near exploratory drill rigs in cold-water environments (Neff 2010). Metals concentrations in quahogs (Arctica islandica) collected from surface sediments near drilling rigs on Georges Bank were in the normal range for bivalve mollusks and there was not a significant difference in the concentration of any metal in the clams from the reference and rig sites Phillips et al. 1987; Neff 2010). The concentration of PAHs was measured in tissues of invertebrates and fish species in a drilling area in the Alaskan Beaufort Sea; no regional differences in PAH levels in amphipod, clam (Astarte montagui and Cyrtodaria kurriana), and fish tissues were observed (Neff et al. 2009; Neff 2010). No effects on fishing success in the Study Area are anticipated due to routine drilling discharges. • Benthic habitat monitoring as part of the SOEP EEM found no obvious effect on fauna or habitat beyond the drill waste piles. Each year since 1998 the EEM program has demonstrated an increase in biomass and potential growth related to maturing communities of marine species (CNSOPB 2011). Taint and body burden monitoring demonstrated no tainting effects between the 250 m and 1000 m sampling sites. Tainting was only encountered once in Jonah crabs collected directly from the platform structure at Venture (within safety zone). The results of the SOEP EEM program are consistent with EEM programs conducted elsewhere in Atlantic Canada (e.g., Hibernia, White Rose, Terra Nova), concluding no significant effects on fish health and fish habitat. Fisheries are therefore not likely to be affected by routine drilling discharges. • Underwater sound from exploratory drilling and DP thrusters may result in behavioural effects to fish and invertebrates (refer to Table 5.1 for potential effects of underwater sound on fish and invertebrates).

Table 5.10 Potential Effects of Exploratory Drilling on Fisheries

Loss of Access	• Safety zones are established to prevent damage to oil and gas infrastructure, reduce likelihood and effects of environmental incidents, and maintain the safety and security of industry personnel (Stantec 2010). However, they may also represent lost fishing opportunity, particularly for sedentary species (e.g., surf clam) or migratory species with a well-defined area and timing. Fisheries that are concentrated within specific areas on the Scotian Shelf (e.g., red hake, silver hake, offshore lobster) would be most affected by an exclusion zone. Any drilling program activities that displace fishing activity in these concentrated areas will result in a temporary direct loss of access to the fishery. Commercial fishers cannot move to alternative fishing grounds if exploration activities prevent them from accessing key fishing locations. Restrictions on invertebrate, pelagic or demersal fishing activity in certain areas can also potentially result in overcrowding of other areas and can potentially affect net income of commercial fishers. • Drilling programs generally last up to 120 days, during which time access to marine space by fishers or other ocean users is excluded from a 500 m radius (0.8 km2) safety exclusion zone around the drilling project. A larger exclusion zone may be in effect for certain fisheries (e.g., longline), to ensure gear does not drift into drilling rigs (Thomson et al. 2000). • Loss of access associated with a given exploration or delineation drilling program is anticipated to be minimal; however, cumulative loss of access due to several drilling (and production activity where applicable) programs may result in a displacement and demonstrated financial loss to fishing interests. There are typically no more than two exploratory wells drilled per parcel and ELs generally last for five years; however, should concurrent programs be proposed in areas of key fishing grounds, timing of fishing seasons and scheduling of drilling programs will be an important consideration.

5.3.1.3 Vessel Traffic

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

5.3.1.4 Well Abandonment

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

5.3.1.5 Accidental Events

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

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

5.3.2 Mitigation and Planning Considerations

Table 5.11 summarizes mitigation and planning considerations for Fisheries for each of the key exploration activities. These mitigation measures for Fisheries are intended to supplement more generally protective measures referenced in Section 5.1.2 and 5.2.2. To minimize duplication, applicable mitigation measures from previous sections are not repeated here. Engagement with the CNSOPB and stakeholders (e.g., commercial fishers) early in project planning is crucial to mitigating effects of exploration activities on fisheries and other ocean users. This mitigation also addresses potential conflicts with ocean research and military training activities.

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

Seismic and Seabed Surveys	• Schedule surveys to minimize interaction with peak haddock spawning in the Western/Emerald Banks Conservation Area and the Haddock Box (March/April). In addition, adherence to the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound and the Marine Environment is required. This document prohibits seismic activity on known spawning grounds during known spawning times (DFO 2007c). • Fisheries Liaison Officer (FLO) familiar with Nova Scotia offshore fisheries to be present on the seismic survey vessel(s) to communicate with fishing vessels in the area and to avoid potential conflict with fishing activities/gear. For conventional (single vessel) seismic programs FLOs may be trained as marine wildlife observers and perform both tasks. Consult with expert departments to establish the qualifications for trained wildlife observers prior to commencing work. • Adhere to the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017). • Issue Navigational Warnings (NAVWARNs) on location and scheduling of survey activities.

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

	• Commence seismic data acquisition only if survey area is confirmed to be clear of fixed fishing gear (e.g., lobster traps) or floating longline gear (e.g., for large pelagics such as tuna and swordfish). • Consult with key organizations representing fishing interests (including commercial and Indigenous fisheries) in the area during the EA planning stage and just prior to commencement of any work to coordinate seismic program activities with the fishing industry and to reduce potential conflict with fishing activity during peak fishing times. • Consult with DFO to on the survey area and timing to reduce potential for conflict with research vessel program plans. • Consult with DND on the survey areas and timing to reduce the potential for conflict with exercises and/or training.
Exploratory Drilling	• Issue NAVWARNs on location and scheduling of drilling activities. • Consult with key organizations representing fishing interests (including commercial, Aboriginal and recreational) in the area during the EA planning stage.
Vessel Traffic	• Use of common routes by supply vessels and alternate routes around key fishing grounds particularly when fishing is at its peak. • Follow Section 5 General Guidelines for Aquatic Species at Risk and Important Marine Mammal Areas in the Canadian Coast Guard's Annual NOTMAR.
Well Abandonment	• If regulatory approval is being sought to abandon the wellhead on the seafloor, consult with fisheries interests and other ocean users to confirm lack of interaction with fishing gear.
Accidental Spills	• Establish ongoing communication with key fisheries stakeholders and other ocean users in the event of a spill and during spill response activities, including but not limited to issuance of a NAVWARN/NOTMAR. • Adhere to Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017).

5.3.3 Data Gaps and Uncertainties

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

6.0 POTENTIAL EFFECTS OF THE ENVIRONMENT ON EXPLORATION ACTIVITIES

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

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

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

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

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

Ice

Sea ice typically forms in the western and northern coastal zones of the Gulf of St. Lawrence during December; by the end of January the sea ice starts to flow through the Cabot Strait under the influence of surface currents and wind (refer to Figure 3.2). Some years, ice, as a mixture of drift ice and locally formed ice, may extend as far as Halifax and to the southwest towards Sable Island, although this is rare. The spring breakup of ice normally commences in March and recedes to patches within the Gulf of St. Lawrence by mid-April. In severe years, ice may stay longer on the Scotian Shelf until May or June. If ice does migrate to the Scotian Shelf, it is not anticipated to result in substantial operational issues (CAPP 2012).

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

Fog

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

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

	Visibility (hours with)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<1 km	45.8	52.1	77	107.7	166.6	205.2	215.6	127.3	35.3	28.5	32.5	28.6
1-9 km	179.9	147.8	140.3	158.1	1158.8	153.2	183.7	175.7	122.1	106.9	132.5	144.1
>9 km	518.3	477.8	526.7	454.2	418.6	361.6	344.8	441.1	562.6	608.6	555	571.4

Note: Visibility in kilometres (km) is the distance at which objects of suitable size can be seen and identified.
Source: Environment Canada 2012a

Seismic Events and Tsunamis

The Scotian Shelf is an area of known seismic activity with recorded earthquakes, and fault zones occurring on the Shelf. While the area is seismically active (refer to Figure 3.10), events tend to be of a low magnitude. Given the short duration of exploration activities the probability of a significant seismic event or tsunami occurring during an exploration program is low. Guidance on planning and designing for seismic activity and other geological instabilities can be found in the American Petroleum Institute's design document Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design (API 2005).

Hurricanes, Wind and Extreme Weather Events

The Scotian Shelf lies in the path of occasional hurricanes and tropical storms that travel up the eastern coast of North America in the late summer and fall. These large storm events pose many risks to exploration activities including reduced visibility, increased wave height, increased wind speeds and heavy precipitation. Winter storm events are also an important consideration as they have the potential to add significant weight to any equipment or vessels very quickly in the form of ice or snow.

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

Marine Life

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

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

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

Climate Change

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

Sediment and Seafloor Stability

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

Summary

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

7.0 POTENTIAL CUMULATIVE EFFECTS

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

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

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

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

Table 7.1 Potential Cumulative Environmental Interactions

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

Table 7.1 Potential Cumulative Environmental Interactions

Past, Present and Likely Future Projects and Activities	Status in SEA Study Area	VC			Potential Cumulative Environmental Interactions
		Species of Special Status	Special Areas	Fisheries	
Oil and Gas Production Projects (including development and decommissioning)	There are currently no active oil and gas production projects in the Study Area. Gas production has ceased at SOEP and Deep Panuke and decommissioning activities are underway and expected to be completed by 2021. There are not likely to be any new production projects in the SEA Study Area in the foreseeable future.	✓	✓	✓	Attraction of migratory birds and/or fish due to lighting (including flaring) and effluent discharges Lethal and sublethal effects (e.g., smothering, toxicity, reduced growth or reproductive potential) on marine fish from operational discharges (i.e., drill mud and cuttings, produced water) Change in benthic habitat due to deposition of drill muds and cuttings and/or installation of infrastructure (e.g., subsea systems) Underwater sound emissions resulting in physical and/or behavioural effects on marine fish, mammals, sea turtles and migratory birds Interference with fisheries and other ocean uses (e.g., loss of access due to safety zone) Vessel collision with marine mammals or sea turtles resulting in physical injury or mortality to individuals Risk of accidental hydrocarbon releases from vessel resulting in injury or mortality to marine fish, mammals, sea turtles and migratory birds; degradation of habitat quality of special areas; and/or fouling of fishing gear
Fisheries	Fisheries have occurred in the SEA Study Area for hundreds of years and are expected to continue. Groundfish, pelagic and shellfish fisheries can occur year-round in the Study Area, although there are specific areas (e.g., Sambro Bank and Emerald Basin Sponge Conservation Areas, Western / Emerald Banks Conservation Area, the Haddock Box) where certain fisheries are prohibited.	✓	✓	✓	Direct mortality of targeted fisheries species and bycatch species through harvesting Entrapment and entanglement of mammals, sea turtles, and marine birds in fishing gear resulting in physical injury or mortality Change in benthic habitat (including potential loss of corals and sponges) due to bottom contact fishing Vessel collision with marine mammals or sea turtles resulting in physical injury or mortality to individuals Attraction of migratory birds to lighting potentially resulting in strandings Air emissions and effluent discharges from vessel Risk of accidental hydrocarbon releases from vessel resulting in injury or mortality to marine fish, mammals, sea turtles and migratory birds; degradation of habitat quality of special areas; and/or fouling of fishing gear

Table 7.1 Potential Cumulative Environmental Interactions

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

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

The CNSOPB is responsible for authorizing all petroleum related activities in the Canada-Nova Scotia offshore and therefore has the authority to reduce spatial and temporal overlap of activities and associated environmental effects.

Depending on industry interest, future Call for Bids may result in new ELs being issued within the project area. Therefore, these areas provide a reasonable indication of potential locations for future geophysical/geotechnical programs as well as exploration drilling programs. Other ocean uses, including fishing, shipping, marine research surveys and military activities are expected to continue in the future as they have been occurring in the SEA Study Area.

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

8.0 CONCLUSIONS AND RECOMMENDATIONS

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

This SEA is intended to contribute to, but not replace, project-specific EAs/IAs that will be required of proponents in consideration of the specific aspects of their projects and activities, timing of those activities and specific aspects of local conditions within the authorized exploration lease areas.

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

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

Exploration Activity	Proposed Mitigation Measure
Seismic and Seabed Surveys	• Carefully plan project activities well in advance of operations to ensure adherence (at a minimum) to the latest version of the SOCP. Consideration of additional enhanced mitigation measures (beyond requirements of SOCP), as required, to minimize potential adverse effects to species of special status. • Conduct detailed acoustic modelling as input to project-specific EA for seismic programs proposed in the Project Area; results may be used in determining appropriate safety zones for shutdown of seismic air source array and VSP testing. • Model TTS/PTS in project-specific EAs, using the most current scientific literature. • Use trained wildlife observers, with experience in identifying (visually and acoustically) all marine mammals that occur in the Study Area, to visually monitor and record marine mammal, sea turtle and marine bird interactions and help enforce safe operating distances. Consult with expert departments to establish the qualifications for trained wildlife observers prior to commencing work. • Establish a safety zone around the seismic air source array (with a minimum radius of 500 m, to be determined through modelling), to be monitored visually by a qualified Marine Mammal Observer and/or through PAM (in low visibility conditions). • Implement shutdown procedures (i.e., shutdown of seismic source array) if a marine mammal listed on Schedule 1 of SARA or any sea turtle is observed within the defined safety zone. • Enhanced mitigation may be required for seismic surveys (e.g., the 30- minute observation period outlined in the SOCP may be extended to account for longer diving times) any time a beaked whale is observed during the course of a survey. • Implement mitigation measures in a manner that intends to protect and avoid harming, killing or disturbing migratory birds. Refer to Environment Canada's Avoidance Guidelines in planning and conducting activities, while assuring compliance with the MBCA, 1994 and with the SARA. • Consider conducting seabird monitoring following the Eastern Canadian Seabirds at Sea (ECSAS) Standardized Protocol for Pelagic Seabird surveys from Moving and Stationary Platforms (Gjerdrum et al. 2012b).

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

Exploration Activity	Proposed Mitigation Measure
	• Reduce bird attraction by limiting high-intensity lighting, where safe to do so; reducing horizontal light emissions; and minimizing flaring, particularly during drizzle and fog. • Additional mitigation for light reduction and seabird monitoring (included in the Regional Assessment of Offshore Oil and Gas Exploratory Drilling East of Newfoundland and Labrador) should be considered in future exploration projects on a case by case basis. • As per the SOCP, schedule surveying to minimize interaction with peak haddock spawning in the Western/Emerald Banks Conservation Area and the Haddock Box (March/April). • Potential avoidance (on a case by case basis) of intrusive seabed surveys in areas with known concentrations and/or high diversity of corals or sponges. • FLO familiar with Nova Scotia offshore fisheries to be present on the seismic survey vessel(s) to communicate with fishing vessels in the area and to avoid potential conflict with fishing activities/gear. For conventional (single vessel) seismic programs FLOs may be trained as marine wildlife observers and perform both tasks. Consult with expert departments to establish the qualifications for trained wildlife observers prior to commencing work. • Adhere to the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017). • Issue NAVWARN on location and scheduling of survey activities. • Commence seismic data acquisition only if survey area is confirmed to be clear of fixed fishing gear (e.g., lobster traps) or floating longline gear (e.g., for large pelagics such as tuna and swordfish). • Consult with key organizations representing fishing interests (including commercial and Aboriginal fisheries) in the area during the EA planning stage and just prior to commencement of any work to coordinate seismic program activities with fishing industry and to reduce potential conflict with fishing activity during peak fishing times. • Consult with DFO on survey area and timing to reduce potential for conflict with research vessel program plans. • Consult with DND on survey areas and timing to reduce potential for conflict with exercises and/or training.
Exploratory Drilling	• Conduct underwater sound modelling to inform the analysis of effects of underwater sound on Special Areas. • Conduct project-specific drill waste deposition modelling to predict extent of drilling mud and cuttings seabed deposition. • Season-specific acoustic modelling at the project level may be required (on a case by case basis) to evaluate potential adverse effects on marine mammals from drilling activity-associated sound. • Conduct pre-drilling ROV surveys to determine presence of corals, sponges, or other sensitive features as required by the CNSOPB. • Avoid areas with known aggregations of corals, sponges, and other sensitive features during drilling activities. • Refer to guidance in the Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada (ECCC 2016). • Develop an EPP for exploratory drilling activities, including selecting and screening chemicals to be discharged in accordance with the Offshore Chemical Selection Guidelines (NEB et al. 2009) and managing offshore waste discharges and emissions from the MODU and OSVs in accordance with the OWTG (NEB et al. 2010) and MARPOL, as applicable.

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

Exploration Activity	Proposed Mitigation Measure
	• Adhere to Nova Scotia Offshore Petroleum Drilling and Production Regulations and associated Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017). • Implement best practices for bulk transfer and hose handling procedures. • Provide advanced notice to the CNSOPB of flaring during periods of migratory bird vulnerability and plans of the associated mitigation to prevent harm to, or killing of, migratory birds. • Conduct a post-drilling ROV survey to verify drill waste deposition modelling predictions (e.g., confirm that the muds and cuttings are within the predicted zone of influence). • Issue NAVWARN on location and scheduling of drilling activities. • Consult with key organizations representing fishing interests (including commercial, Indigenous and recreational) in the area during the EA planning stage.
Vessel and Helicopter Traffic	• Adhere to Transport Canada Guidelines for the Control of Ballast Water Discharge from Ships in Waters under Canadian Jurisdiction. • Use existing vessel routes to the extent practical to avoid transiting near migratory bird nesting colonies. • Follow Section 5 General Guidelines for Aquatic Species at Risk and Important Marine Mammal Areas in the Canadian Coast Guard's Annual NOTMAR. • Use of common routes by supply vessels and alternate routes around key fishing grounds, particularly when fishing is at its peak.
Well Abandonment	• Design wells and casings to facilitate effective mechanical cutting and removal of the wellhead, avoiding explosive means of separation where possible. • If use of explosives is necessary, follow the recommendations set out in the Guidelines for the use of Explosives in or near Canadian Fisheries Waters (Wright and Hopky 1998). • If regulatory approval is being sought to abandon the wellhead on the seafloor, consult with fisheries interests and other ocean users to confirm lack of interaction with fishing gear.
Accidental Spills	• Conduct spill fate and behavior modelling as input to project-specific EA for drilling programs proposed in the Project Area. • Prepare project-specific NEBA/SIMA, as required. • Engineering design and process safety management protocols to prevent spills from occurring and/or reaching the marine environment including but not limited to secondary containment, inspection and maintenance, spill response kits, and blowout safeguards. • Implement Emergency and Oil Spill Response Plan accepted by the CNSOPB (with input from DFO, ECCC and Parks Canada, as applicable) to address spill prevention and response. • Develop emergency contingency measures and response plans for addressing significant weather scenarios. • Use non-fluid filled streamers for seismic surveys, where possible. • Implement bulk transfer and hose handling procedures per best management practice. • Develop an EEM Plan to address post-spill monitoring of effects, with the scope of the EEM Plan directly related to the severity of potential spills. • Establish ongoing communication with key fisheries stakeholders and other ocean users in the event of a spill and during spill response activities, including but not limited to issuance of a NAVWARN/NOTMAR. • Adhere to Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017); Canada-Nova Scotia Offshore Petroleum Financial Requirements Regulations (Federal); the Canada-Nova Scotia Offshore Petroleum Financial

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

Exploration Activity	Proposed Mitigation Measure
	Requirements Regulations (Provincial); and the Guidelines Respecting Financial Responsibility Requirements for Work or Activity in the Newfoundland and Canada-Nova Scotia Offshore Areas (December 2000).

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

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

- Consult the Legislation and Regulatory Instruments and Activity Authorizations sections of the CNSOPB website.
- Plan for regulatory compliance, including knowing the applicable acts and regulations and tracking evolving legislation (e.g., new federal *Impact Assessment Act* and *Canadian Navigable Waters Act*, amended *Fisheries Act*).
- Conduct an EIS (*Impact Assessment Act*) and/or EA (CNSOPB) based on project-specific guidelines issued by the Impact Assessment Agency of Canada (formerly the CEA Agency) and/or CNSOPB and plan for associated timelines.
- Plan and conduct early engagement with Indigenous groups, stakeholders (e.g., fishers), and regulators.
- Engagement with Indigenous groups and consultation with stakeholders will play an important role in mitigating environmental effects, identifying key issues to be addressed in the EIS/EA, and demonstrating diligence during the regulatory review process. In particular, it is expected that information will be gathered on Indigenous fisheries during project-specific assessments.
- Consult relevant sections of IAAC and/or CNSOPB-issued Scoping Documents and Operator EIS/EAs and Information Requests prepared for past seismic and exploratory drilling programs (available from the CNSOPB Public Registry Archive and former CEA Agency Registry websites).
- Consult DFO's "Projects Near Water" website for information regarding DFO's regulatory review process (http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html).

- Reference updated information as applicable in project-specific EAs. Review and incorporate the latest information on the existing environment within the SEA Study Area and the most recent scientific literature, particularly related to current data gaps and emerging issues.
- Conduct site-specific acoustic and spill fate modelling for project-specific EAs for exploration projects proposed in SEA Project Area and implement mitigation and monitoring plans as applicable.
- Consult with the CNSOPB, DFO and Parks Canada (where applicable) to assess risk of adverse effects to Species of Special Status and Special Areas and work collaboratively on potential project-specific mitigation measures.
- Carefully plan project activities well in advance of operations to ensure adherence (at a minimum) to the latest version of the SOCP and consider adherence to the SOCP as the minimum requirement. Additional mitigation may be specified on a project-specific basis, particularly with respect to reducing potential adverse effects to species of special status. CNSOPB will work in collaboration with DFO to identify and develop enhanced mitigation requirements beyond the SOCP, as required.
- Apply industry standard best practices in all aspects of project planning and design.
- Maintain regular communication with DFO regarding management planning for Special Areas, EBSAs and the MPA network, which is currently underway, to obtain up-to-date information in planning exploratory programs.
- Design project-specific EEM and observation programs for species of special status, where warranted, such that they may be used to increase knowledge and scientific understanding, particularly where data can be collected and analyzed using standardized methods.

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

Figure 3.11 – Baleen Whale Sightings in the Study Area

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Palka, D. 2013. NEFSC Aerial Survey - Experimental 2002. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/107) on 2020-01-24.

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Figure 3.14 – Toothed Whale Sightings in the Study Area

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Josephson, B. 2015. AMAPPS Northeast Aerial Cruise Summer 2011. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1233) on 2020-01-24.

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Figure 3.21 – Seal Sightings in the Study Area

Boisseau, O. 2014. Visual sightings from Song of the Whale 1993-2013. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1158) on 2020-01-24.

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Kenney, R. 2013. BLM CETAP AIR Sightings. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/283) on 2020-01-24.

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Palka, D. 2013. NEFSC 1999 aj9902. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/300) on 2020-01-24.

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Palka, D. 2013. NEFSC Harbor Porpoise 1991. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/288) on 2020-01-24.

Figure 3.22 – Sea Turtle Sightings in the Study Area

Boisseau, O. 2014. Visual sightings from Song of the Whale 1993-2013. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1158) on 2020-01-24.

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Diaz, G. 2011. NOAAs Southeast Fishery Science Center (SEFSC) Fisheries Log Book System (FLS) Commercial Pelagic Logbook Data. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/103151495) on 2020-01-24 and originated from iOBIS (http:www.iobis.org).

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Kenney, R. 2013. BLM CETAP AIR Sightings. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/283) on 2020-01-24.

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Palka, D. 2013. Harbor Porpoise Survey 1992 (AJ92-01). Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/302) on 2020-01-24.

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Palka, D. 2013. NEFSC Mid-Atlantic Marine Mammal Abundance Survey 2004. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/396) on 2020-01-24.

Palka, D. 2013. NEFSC Survey 1998 2. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/62) on 2020-01-24.

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9.3 PERSONAL COMMUNICATION

Campbell, A. 2019. Fisheries and Oceans Canada.

Gjerdrum, C. 2012. Canadian Wildlife Service, Environment Canada. November 2012.

McDonald, E. 2020. Canada Nova Scotia Offshore Petroleum Board. May 2020.

Oldford, G. 2013. Fisheries and Oceans Canada. Cetacean and Sea Turtle Sighting Data. August 2013.

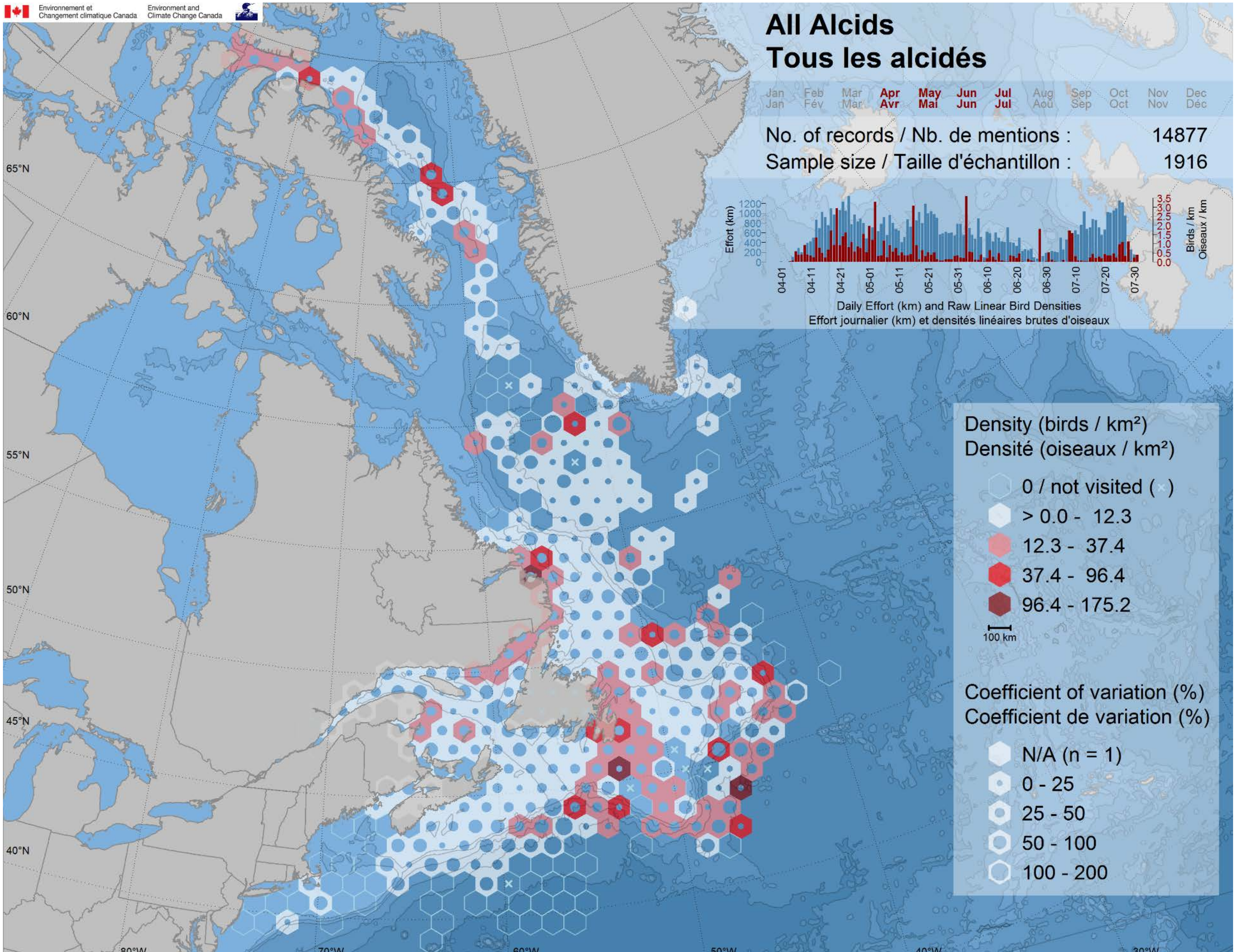
APPENDIX A

Indigenous and Stakeholder Comments and CNSOPB Response Table

APPENDIX B

Marine Bird Seasonal Density Maps

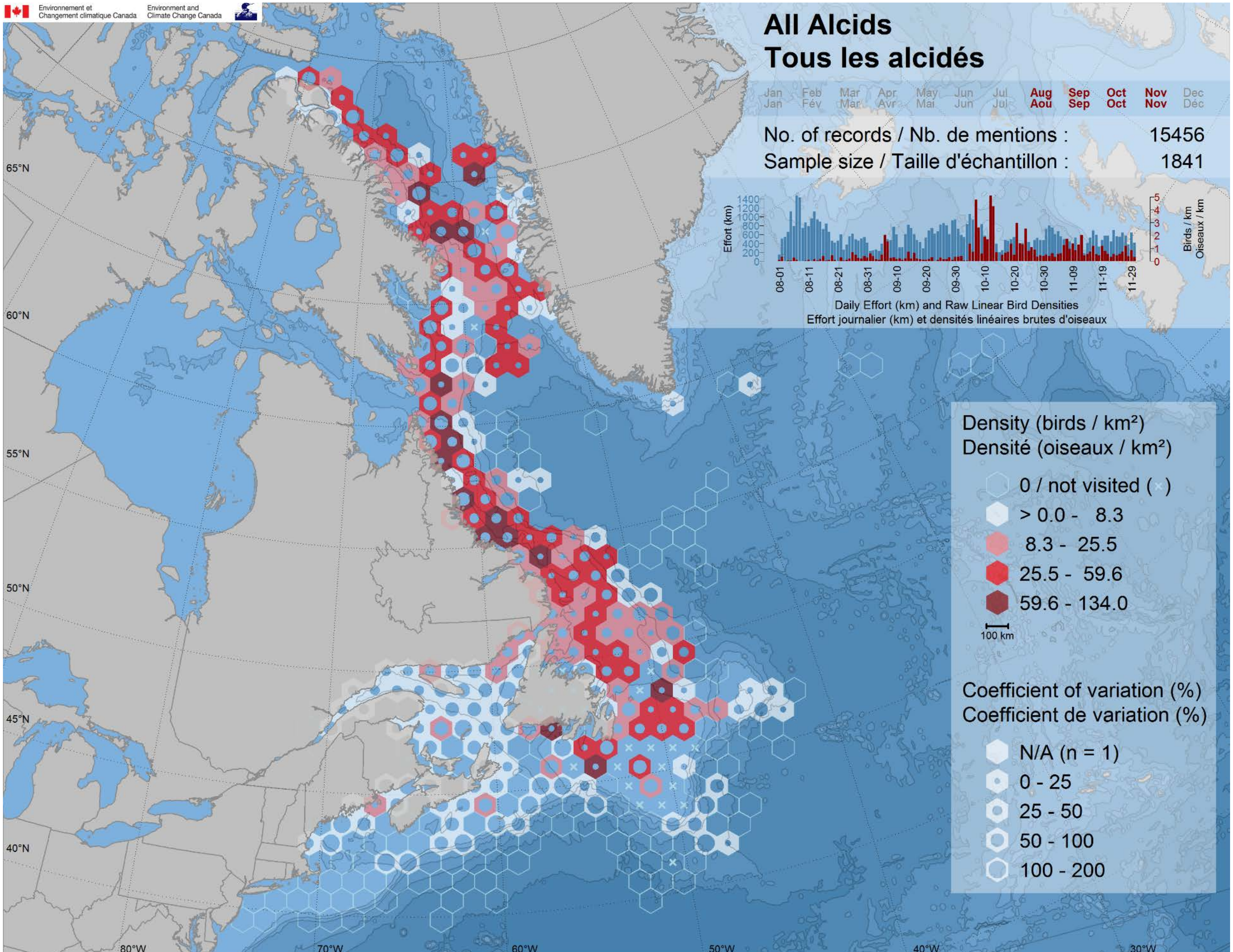
ALCIDS



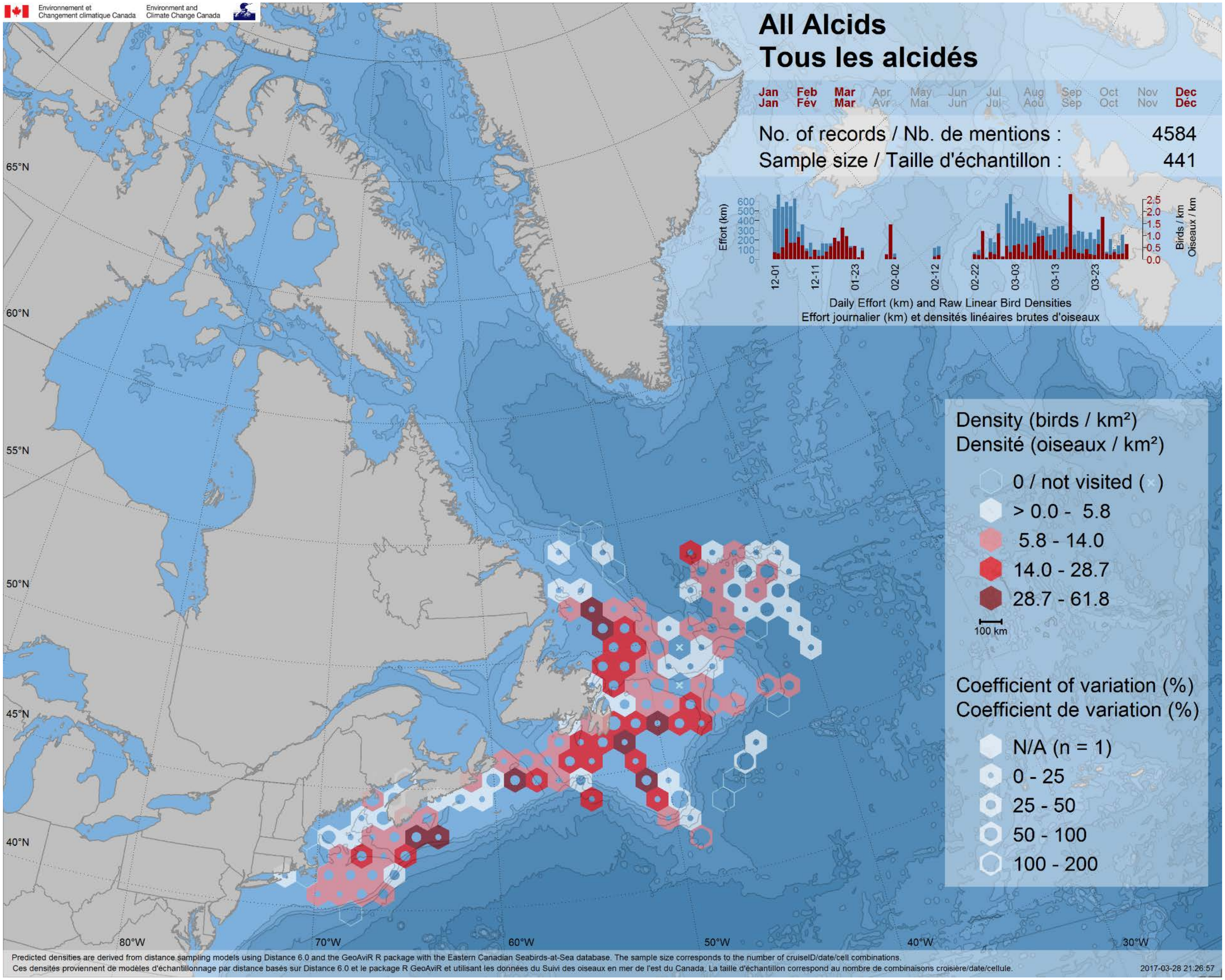
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.

Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.

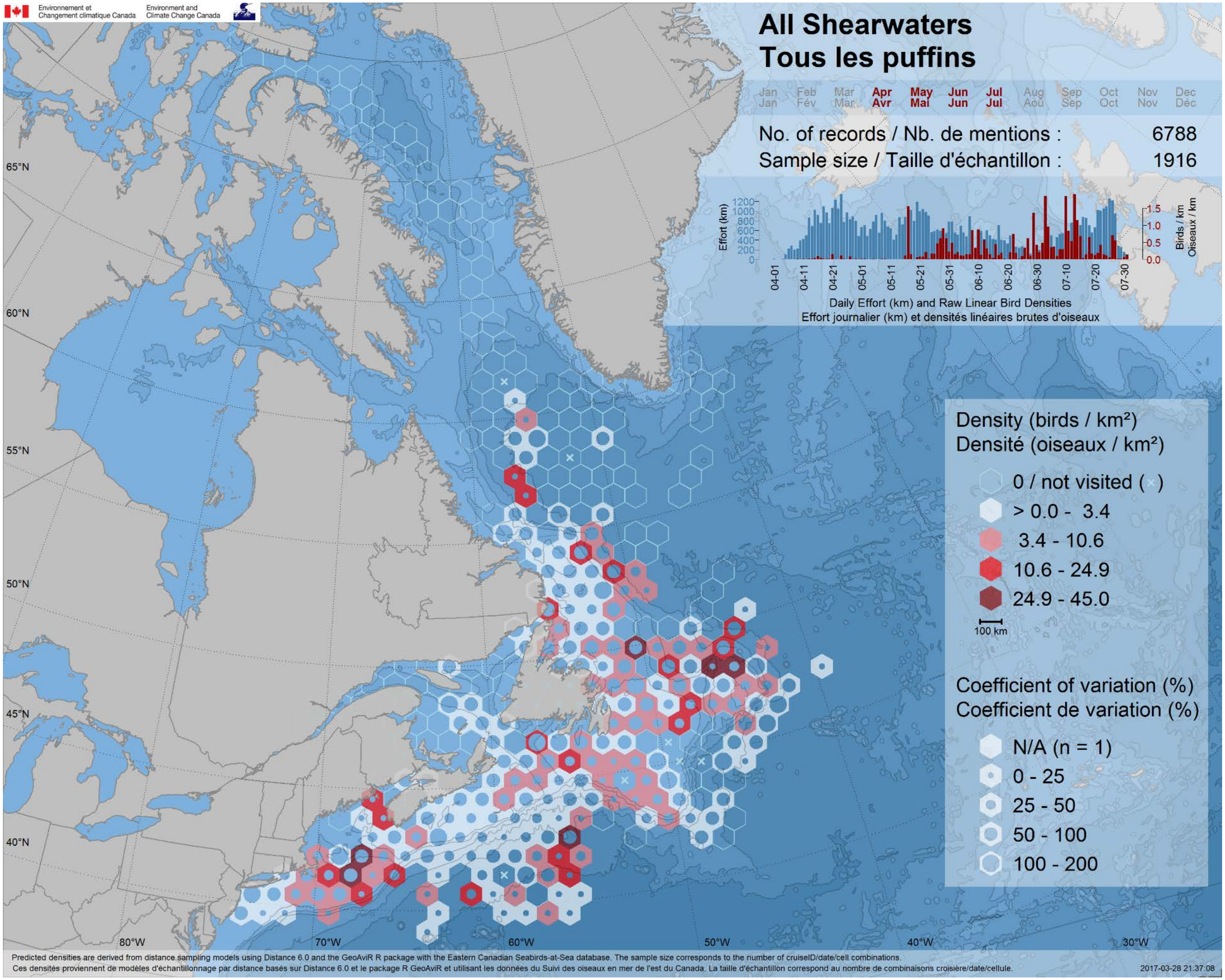
2017-03-28 21:25:18



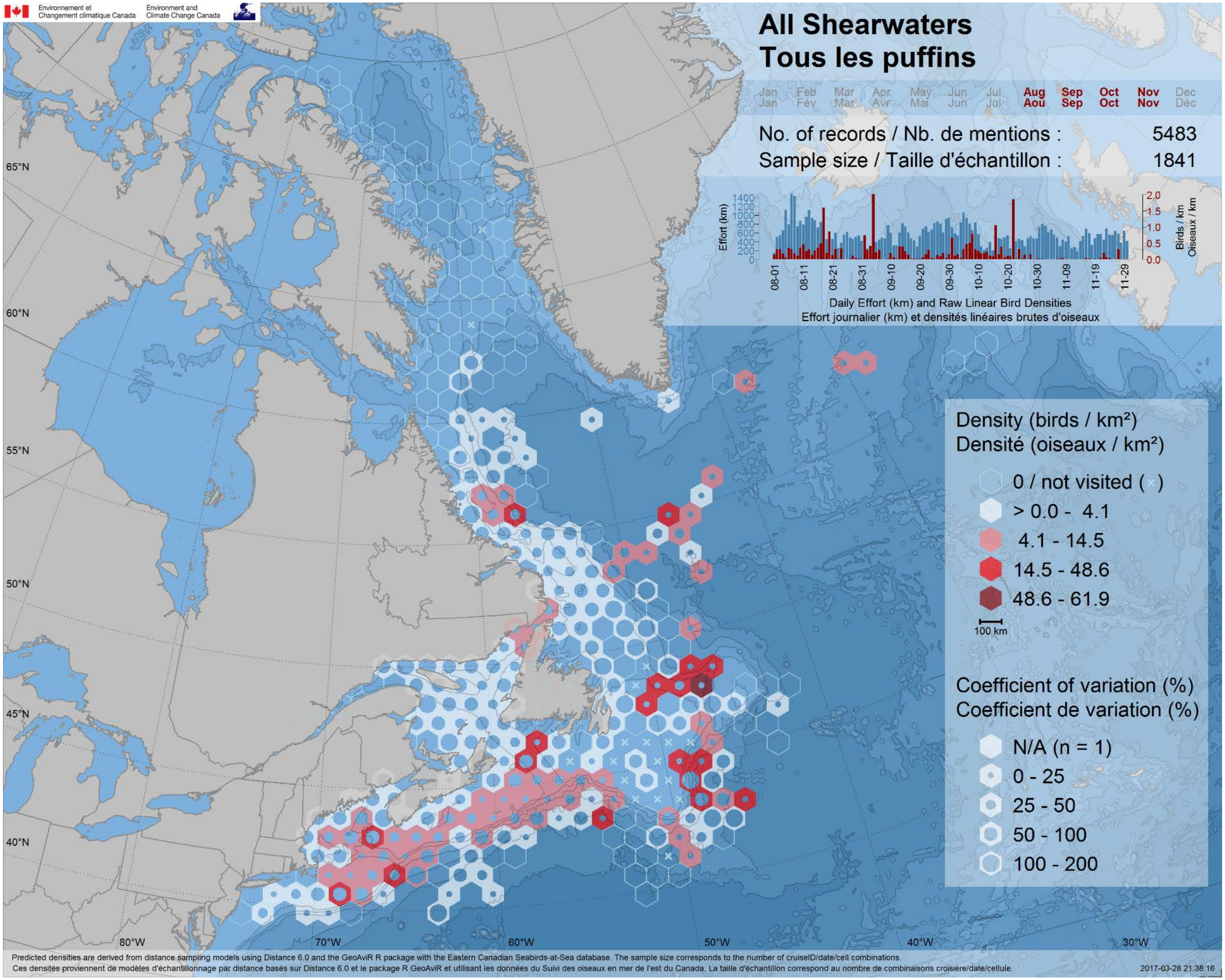
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule. 2017-03-28 21:26:14

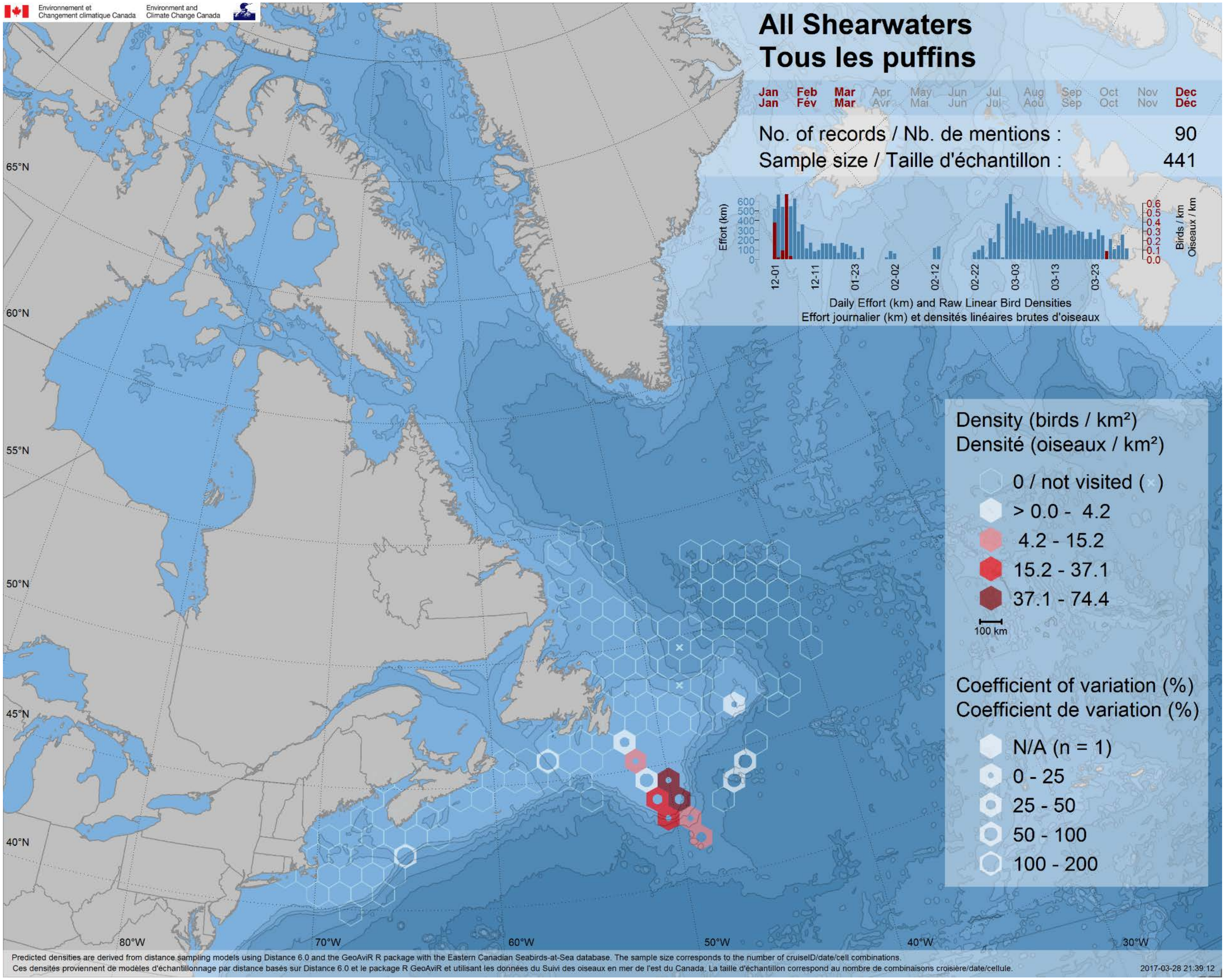

Environnement et Changement climatique Canada
Environment and Climate Change Canada
All Alcids
Tous les alcidés
Jan Jan
Feb Fév
Mar Mar
Apr Avr
May Mai
Jun Jun
Jul Jul
Aug Aoû
Sep Sep
Oct Oct
Nov Nov
Dec Déc
No. of records / Nb. de mentions : 4584
Sample size / Taille d'échantillon : 441
Effort (km)
Birds / km
Oiseaux / km
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited (×)
> 0.0 - 5.8
5.8 - 14.0
14.0 - 28.7
28.7 - 61.8
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 21:26:57

SHEARWATERS



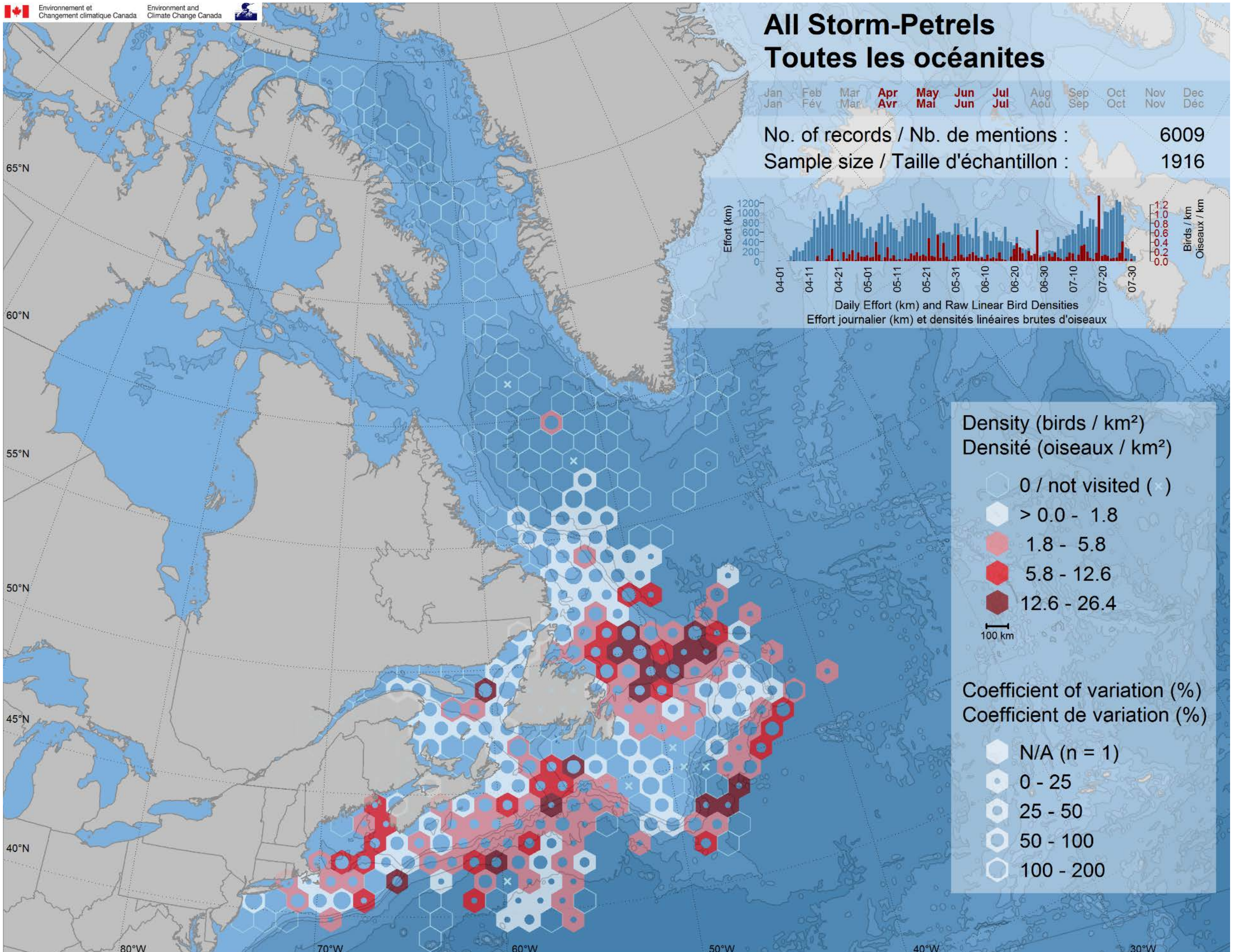
Environnement et Changement climatique Canada
Environment and Climate Change Canada
All Shearwaters
Tous les puffins
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Jan Fév Mar Avr Mai Jun Jul Aoû Sep Oct Nov Déc
No. of records / Nb. de mentions : 6788
Sample size / Taille d'échantillon : 1916
Effort (km)
Birds / km
Oiseaux / km
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited (×)
> 0.0 - 3.4
3.4 - 10.6
10.6 - 24.9
24.9 - 45.0
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 21:37:08


Environnement et Changement climatique Canada
Environment and Climate Change Canada
All Shearwaters
Tous les puffins
Jan Jan
Feb Fév
Mar Mar
Apr Avr
May Mai
Jun Jun
Jul Jul
Aug Aou
Sep Sep
Oct Oct
Nov Nov
Dec Déc
No. of records / Nb. de mentions : 5483
Sample size / Taille d'échantillon : 1841
Effort (km)
Birds / km
Oiseaux / km
08-01 08-11 08-21 08-31 09-10 09-20 09-30 10-10 10-20 10-30 11-09 11-19 11-29
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited (×)
> 0.0 - 4.1
4.1 - 14.5
14.5 - 48.6
48.6 - 61.9
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 21:38:16



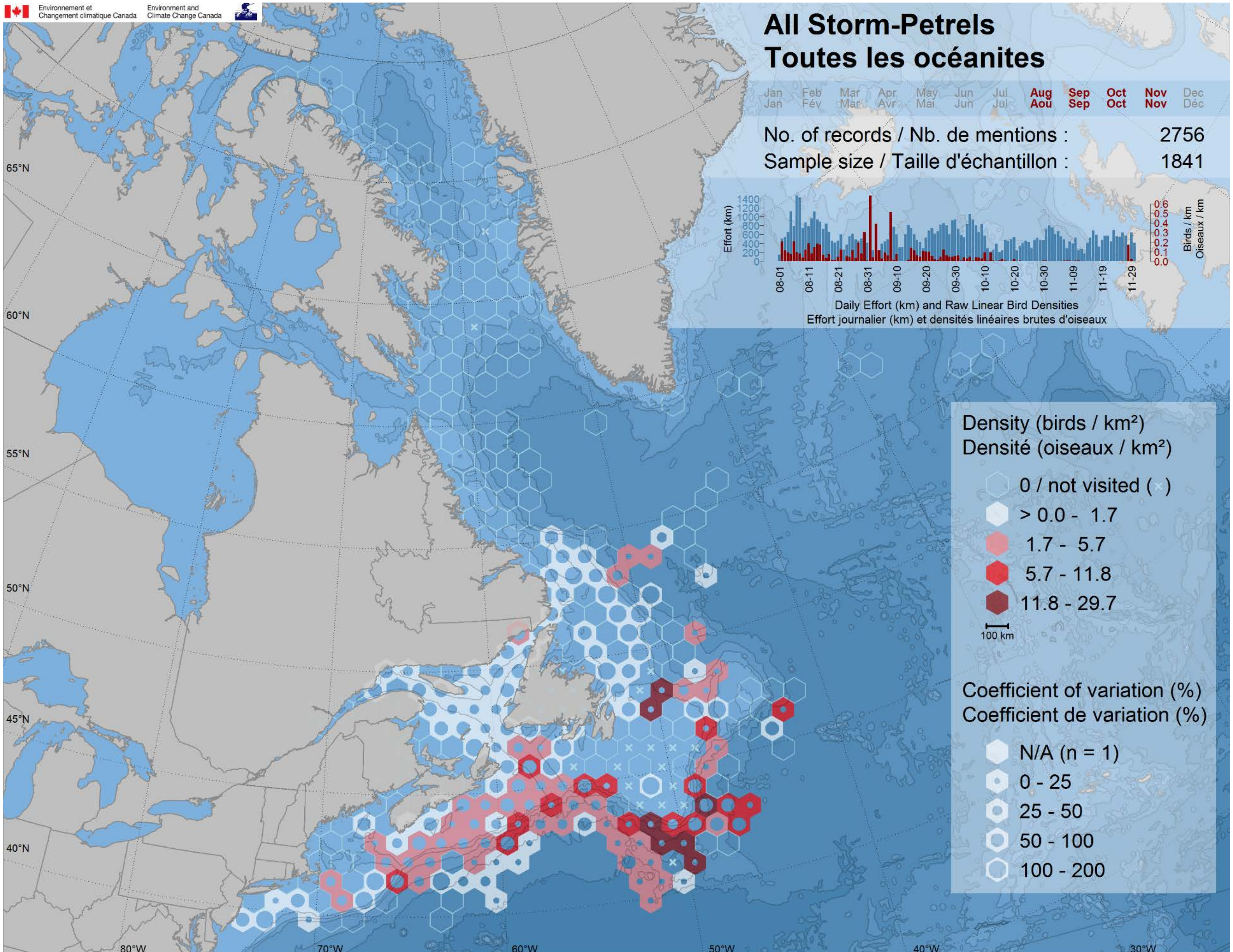
Environnement et Changement climatique Canada
Environment and Climate Change Canada
All Shearwaters
Tous les puffins
Jan Jan Feb Fév Mar Mar Apr Avr May Mai Jun Jun Jul Jul Aug Aoû Sep Sep Oct Oct Nov Nov Dec Déc
No. of records / Nb. de mentions : 90
Sample size / Taille d'échantillon : 441
Effort (km)
Birds / km
Oiseaux / km
12-01
12-11
01-23
02-02
02-12
02-22
03-03
03-13
03-23
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited (×)
> 0.0 - 4.2
4.2 - 15.2
15.2 - 37.1
37.1 - 74.4
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 21:39:12

STORM-PETRELS



Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.

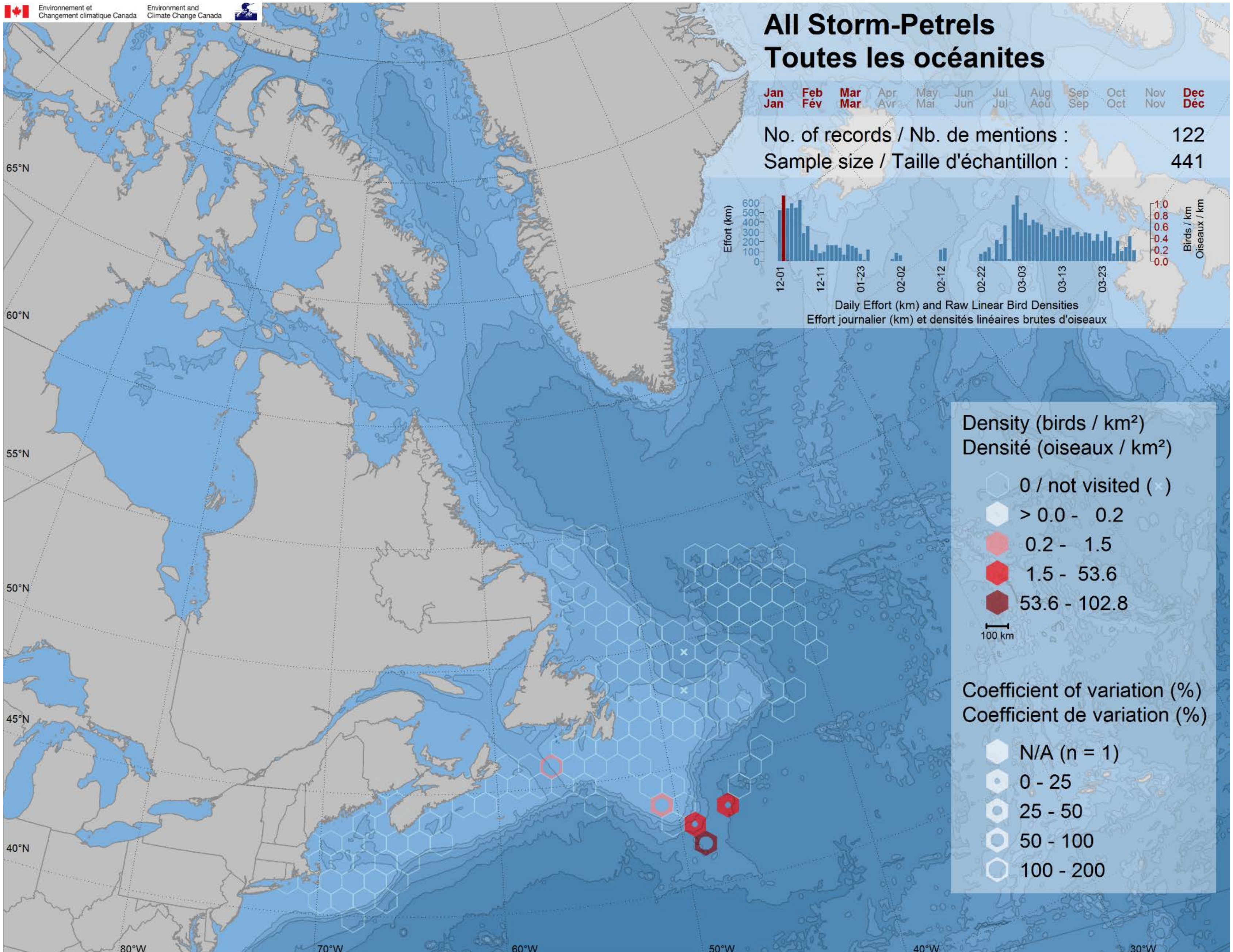
2017-03-28 21:43:51



Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.

Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.

2017-03-28 21:45:03

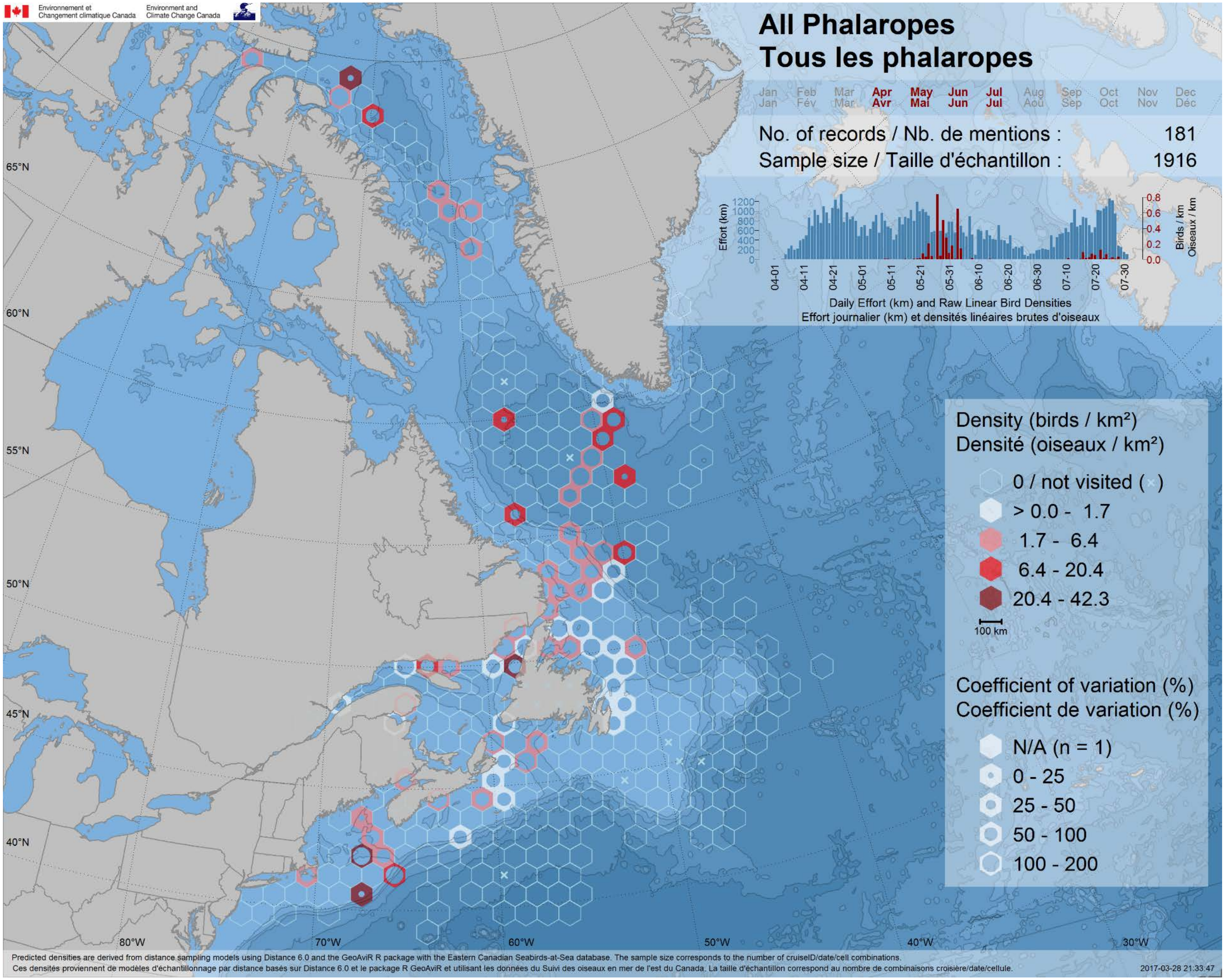


Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.

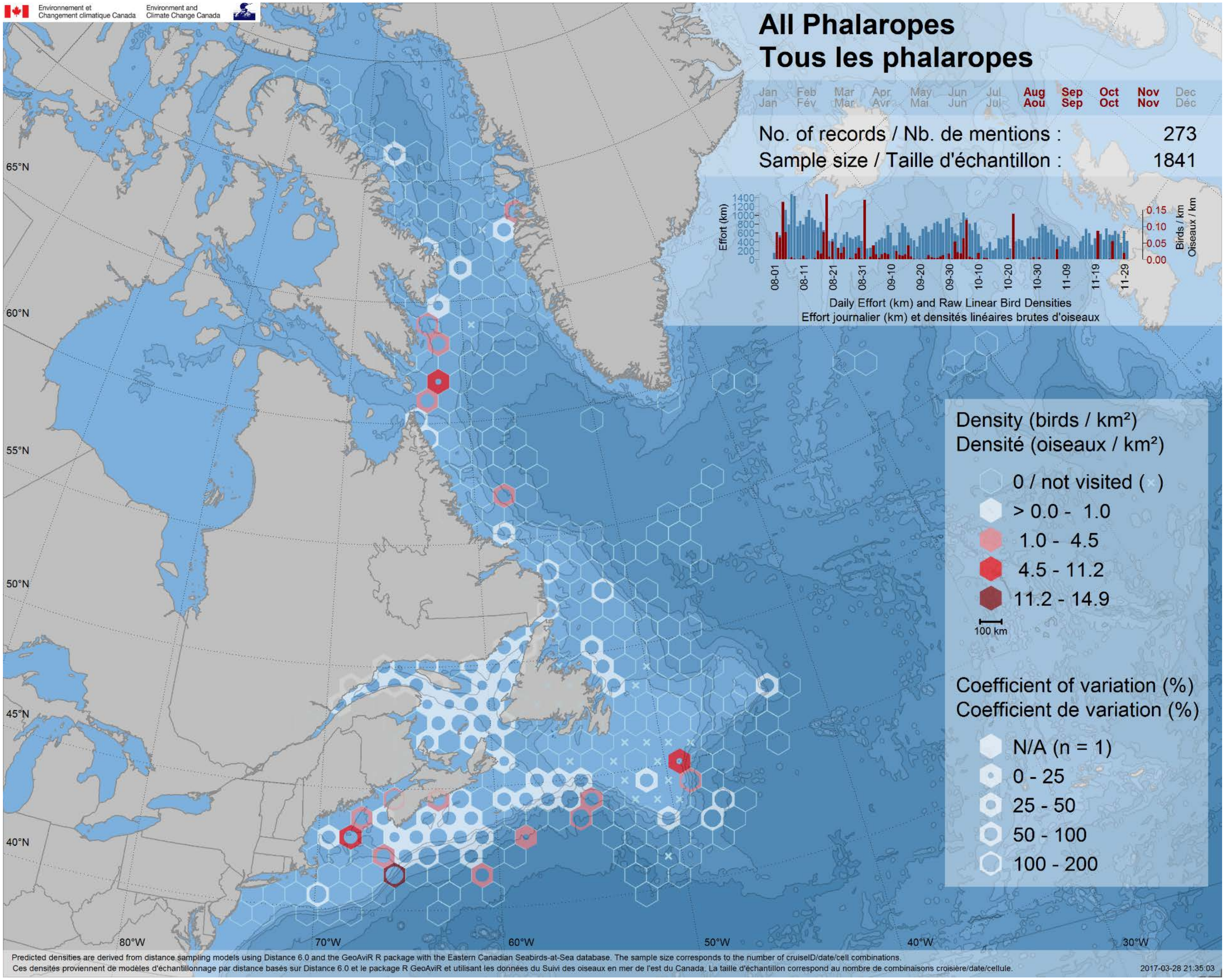
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.

2017-03-28 21:46:00

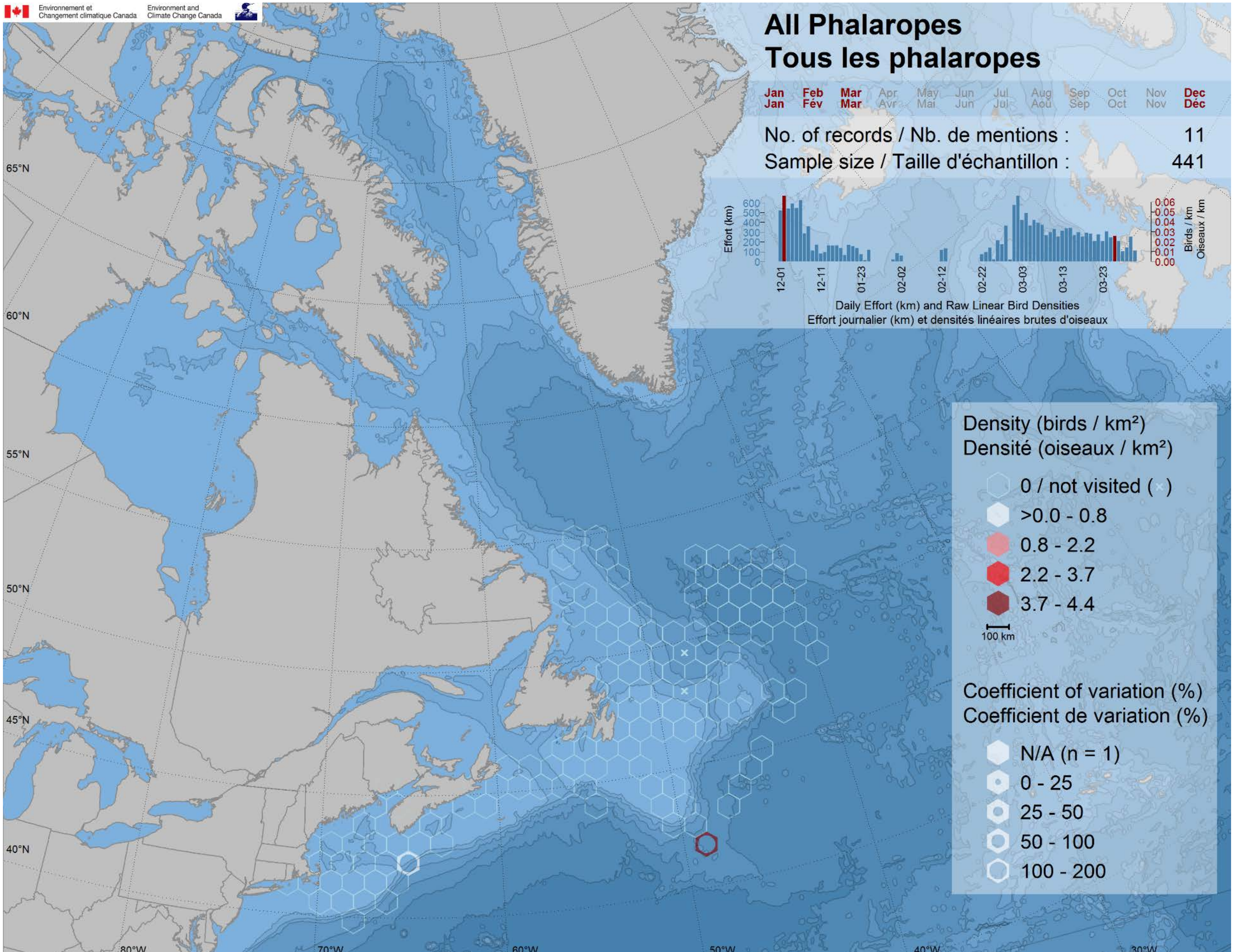
PHALAROPES



Environnement et Changement climatique Canada
Environment and Climate Change Canada
All Phalaropes
Tous les phalaropes
Jan Jan
Feb Fév
Mar Mar
Apr Avr
May Mai
Jun Jun
Jul Jul
Aug Aoû
Sep Sep
Oct Oct
Nov Nov
Dec Déc
No. of records / Nb. de mentions : 181
Sample size / Taille d'échantillon : 1916
Effort (km)
Birds / km
Oiseaux / km
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited (×)
> 0.0 - 1.7
1.7 - 6.4
6.4 - 20.4
20.4 - 42.3
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 21:33:47

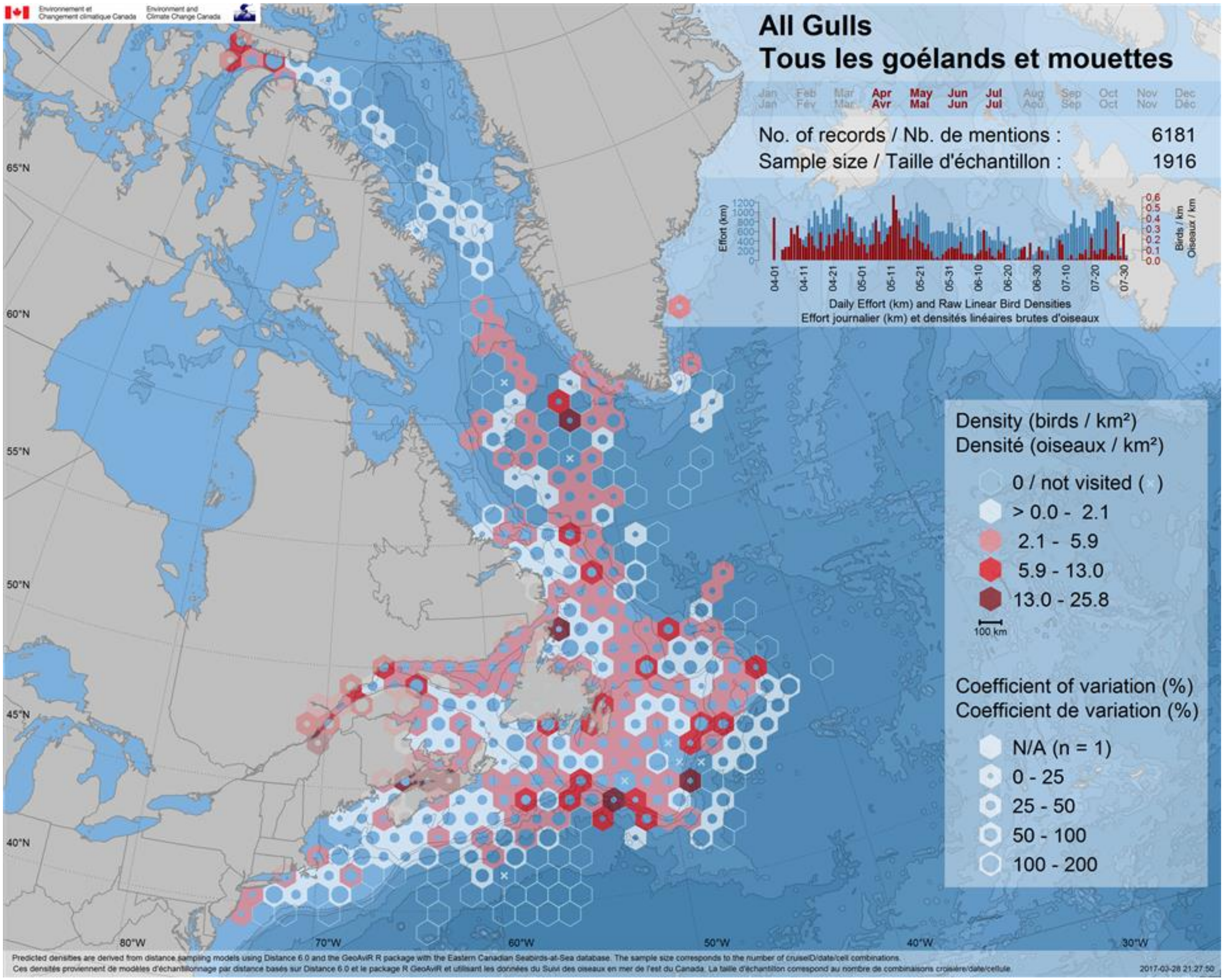


Environnement et Changement climatique Canada
Environment and Climate Change Canada
All Phalaropes
Tous les phalaropes
Jan Jan
Feb Fév
Mar Mar
Apr Avr
May Mai
Jun Jun
Jul Jul
Aug Aou
Sep Sep
Oct Oct
Nov Nov
Dec Déc
No. of records / Nb. de mentions : 273
Sample size / Taille d'échantillon : 1841
Effort (km)
Birds / km
Oiseaux / km
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited (×)
> 0.0 - 1.0
1.0 - 4.5
4.5 - 11.2
11.2 - 14.9
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 21:35:03

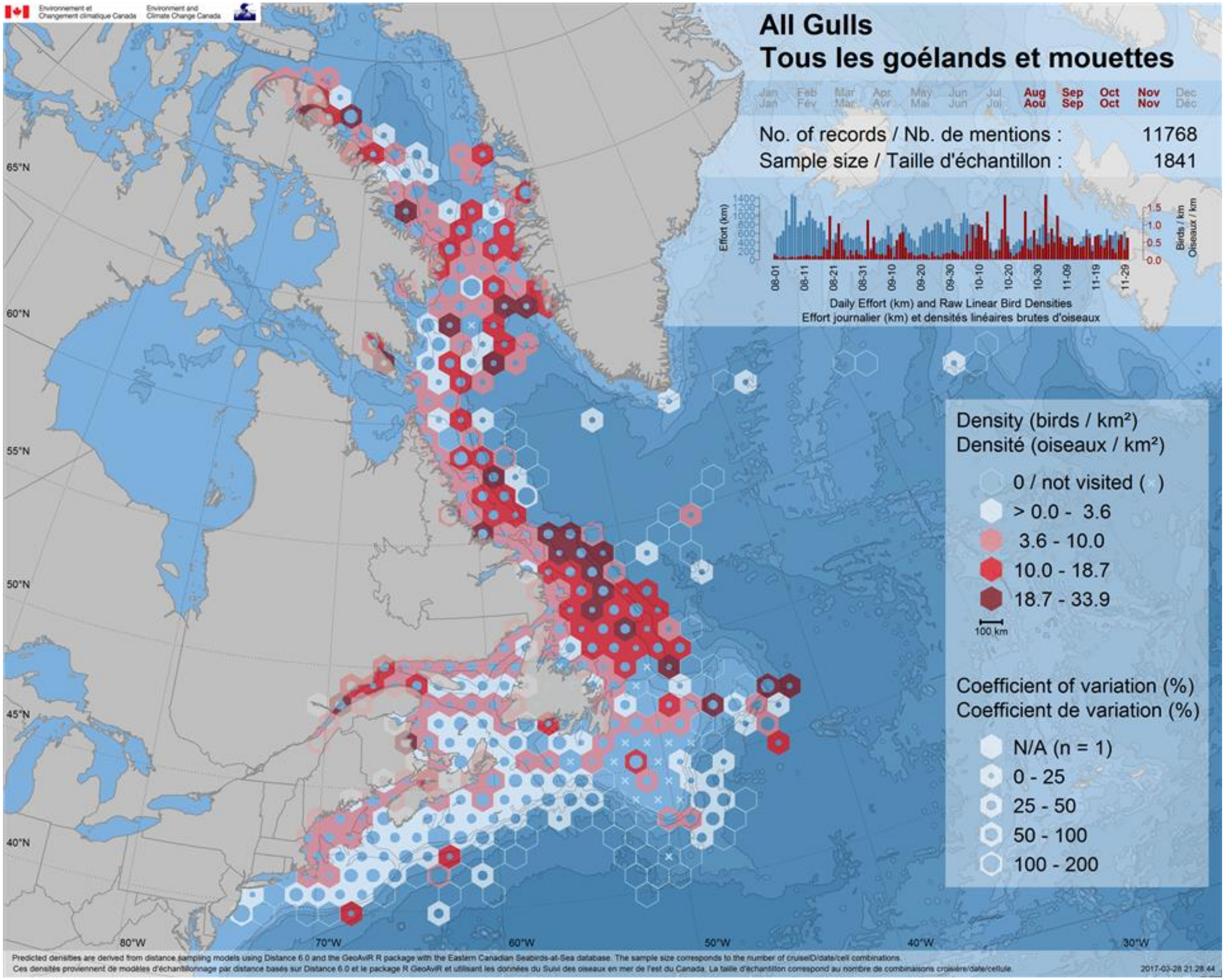


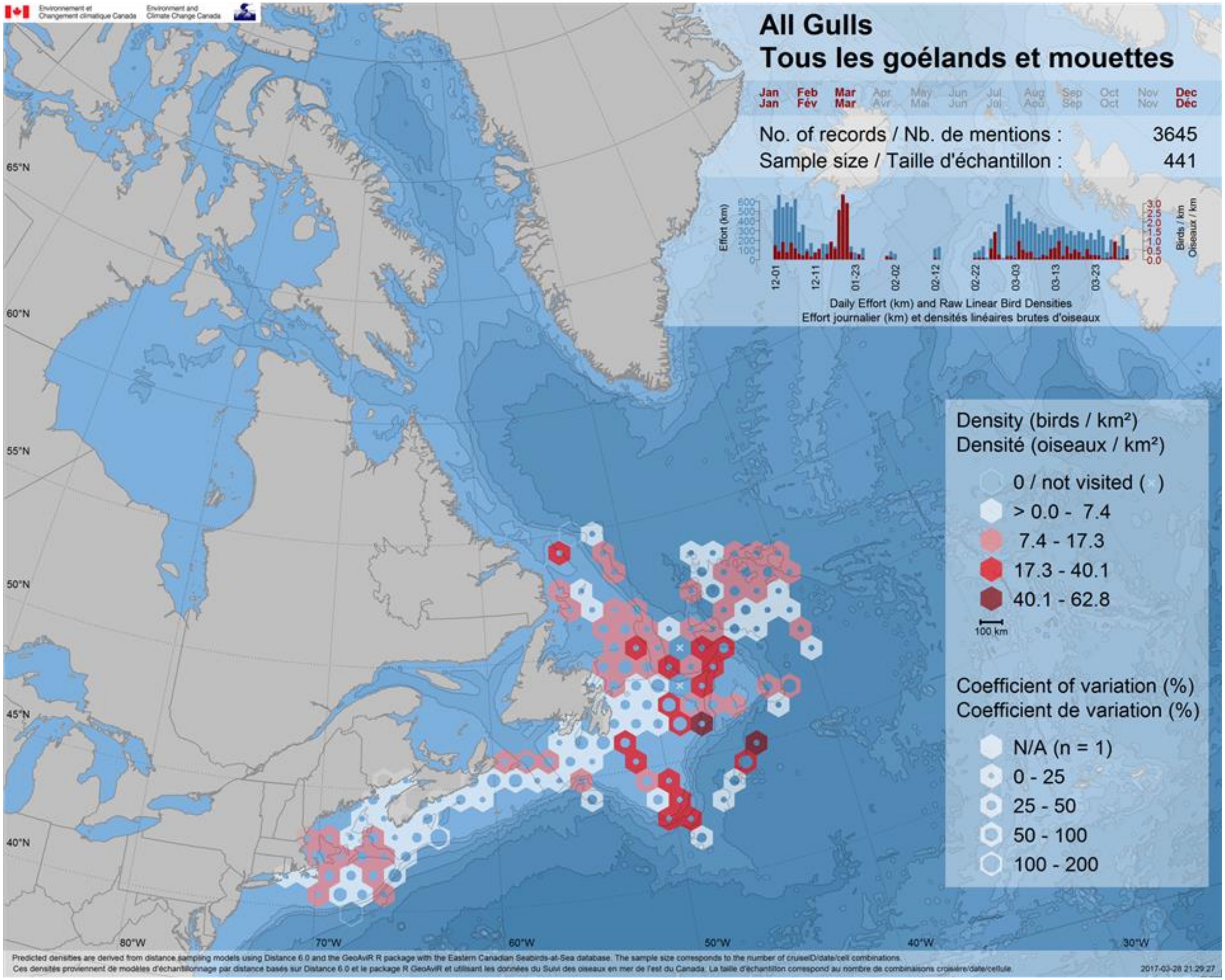
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 21:36:00

GULLS

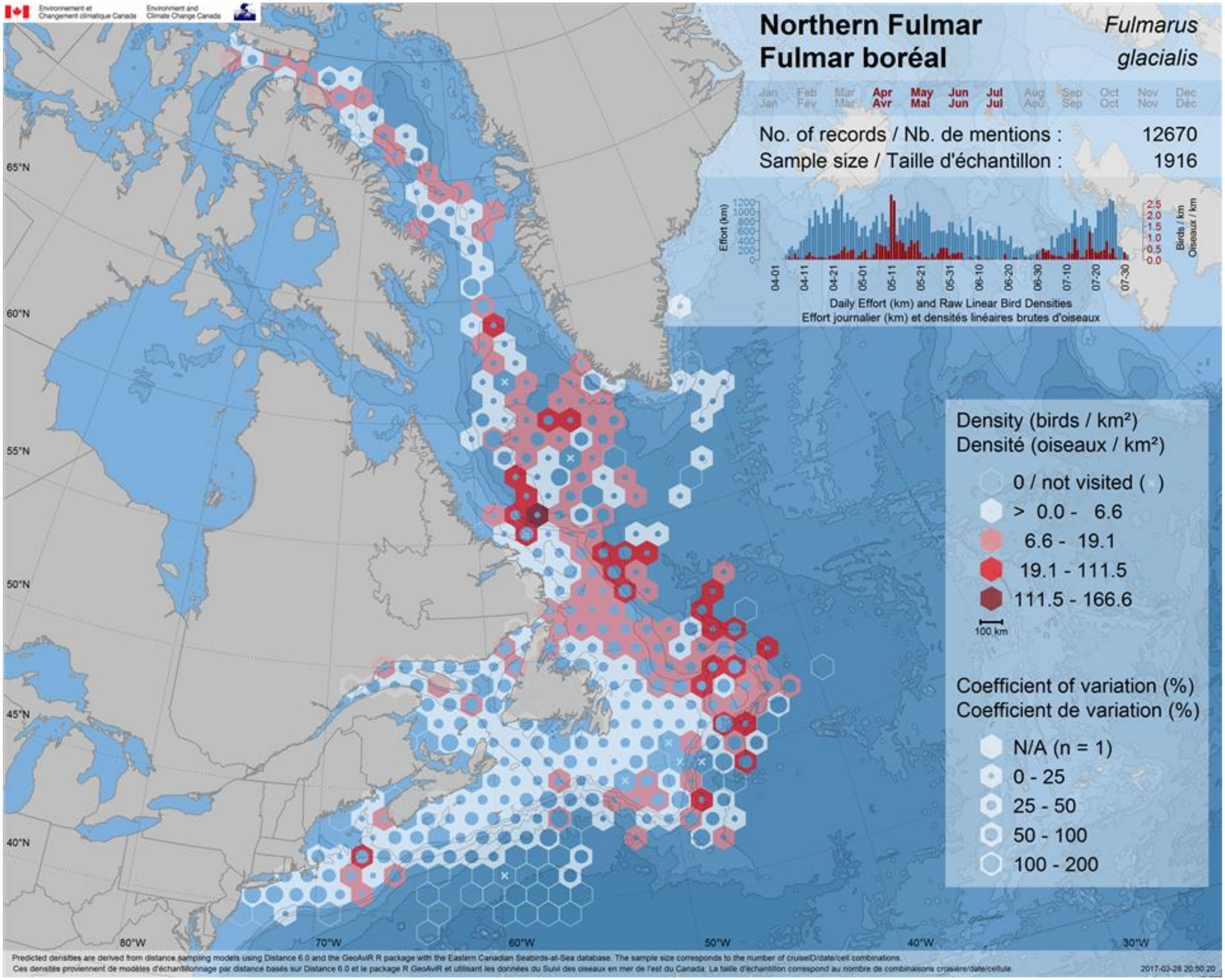


Environnement et Changement climatique Canada
Environment and Climate Change Canada
All Gulls
Tous les goélands et mouettes
Jan Jan
Feb Fév
Mar Mar
Apr Avr
May Mai
Jun Jun
Jul Jul
Aug Aoû
Sep Sep
Oct Oct
Nov Nov
Dec Déc
No. of records / Nb. de mentions : 6181
Sample size / Taille d'échantillon : 1916
Effort (km)
Birds / km
Oiseaux / km
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited ( )
> 0.0 - 2.1
2.1 - 5.9
5.9 - 13.0
13.0 - 25.8
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 21:27:50

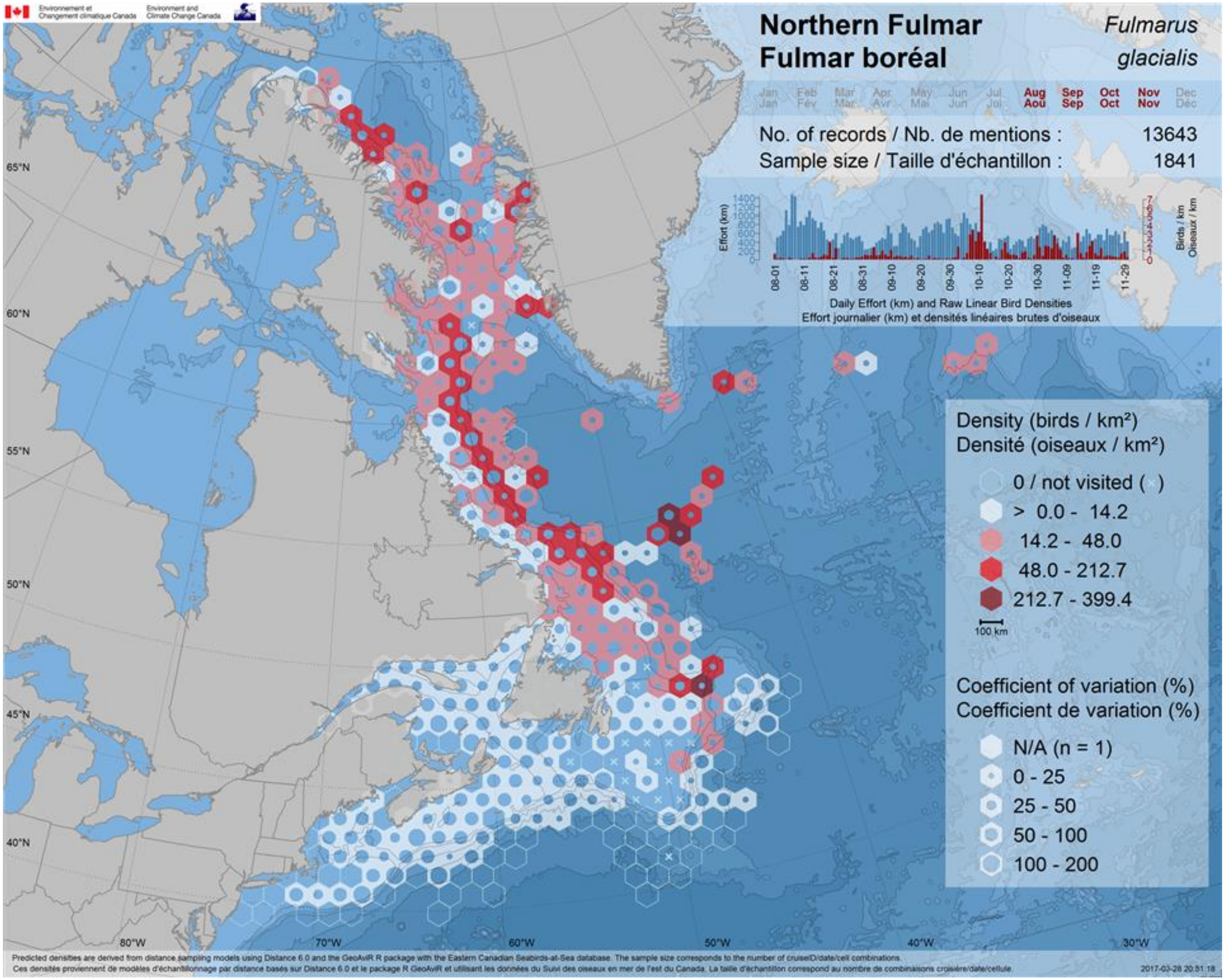

Environnement et Changement climatique Canada
Environment and Climate Change Canada
All Gulls
Tous les goélands et mouettes
Jan Jan
Feb Fév
Mar Mar
Apr Avr
May Mai
Jun Jun
Jul Jul
Aug Aoû
Sep Sep
Oct Oct
Nov Nov
Dec Déc
No. of records / Nb. de mentions : 11768
Sample size / Taille d'échantillon : 1841
Effort (km)
Birds / km
Oiseaux / km
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited ( )
> 0.0 - 3.6
3.6 - 10.0
10.0 - 18.7
18.7 - 33.9
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 21:28:44

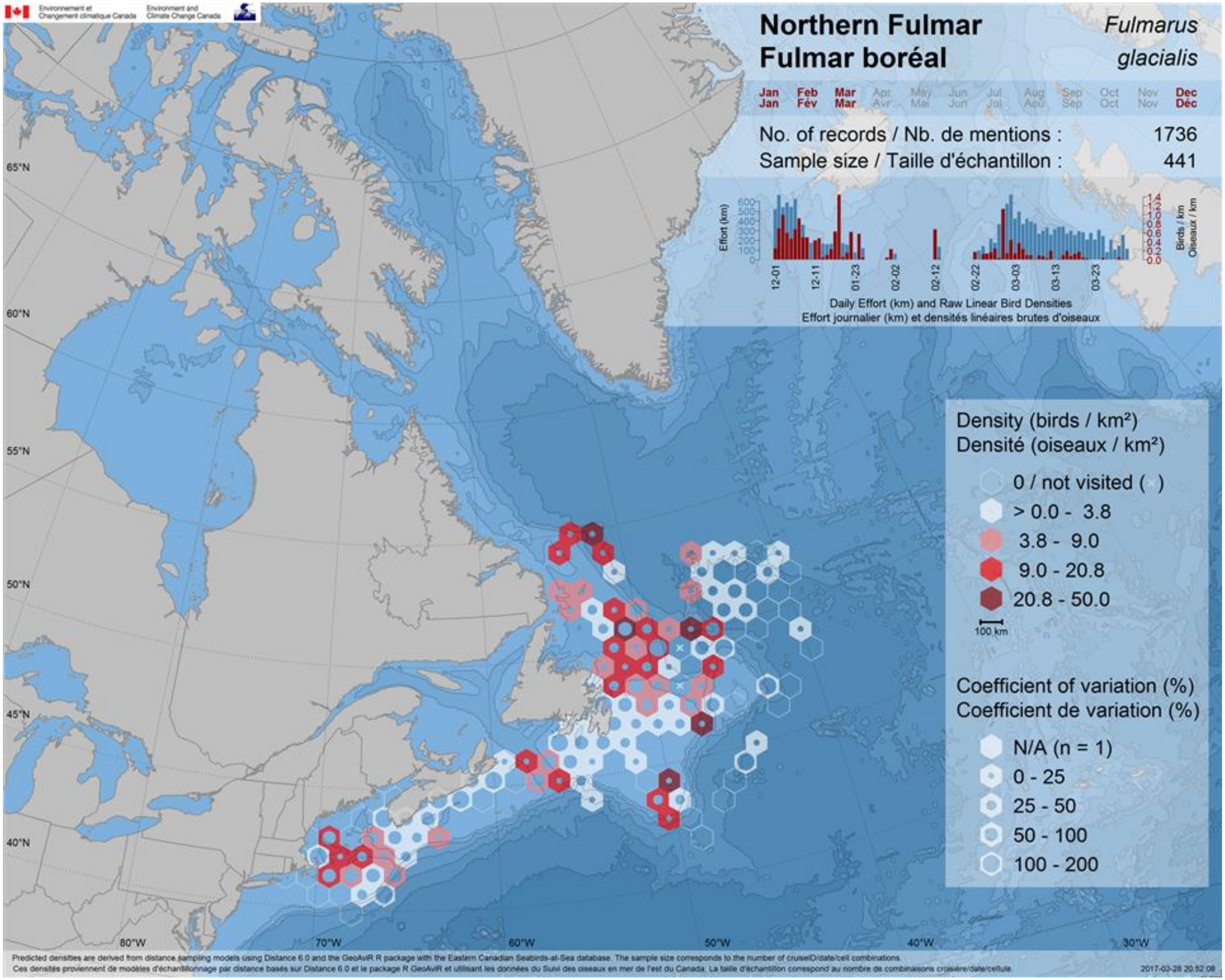

Environnement et Changement climatique Canada
Environment and Climate Change Canada
All Gulls
Tous les goélands et mouettes
Jan Jan
Feb Fév
Mar Mar
Apr Avr
May Mai
Jun Jun
Jul Jui
Aug Aoû
Sep Sep
Oct Oct
Nov Nov
Dec Déc
No. of records / Nb. de mentions : 3645
Sample size / Taille d'échantillon : 441
Effort (km)
Birds / km
Oiseaux / km
12-01
12-11
01-23
02-02
02-12
02-22
03-03
03-13
03-23
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited ( )
> 0.0 - 7.4
7.4 - 17.3
17.3 - 40.1
40.1 - 62.8
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 21:29:27

NORTHERN FULMAR



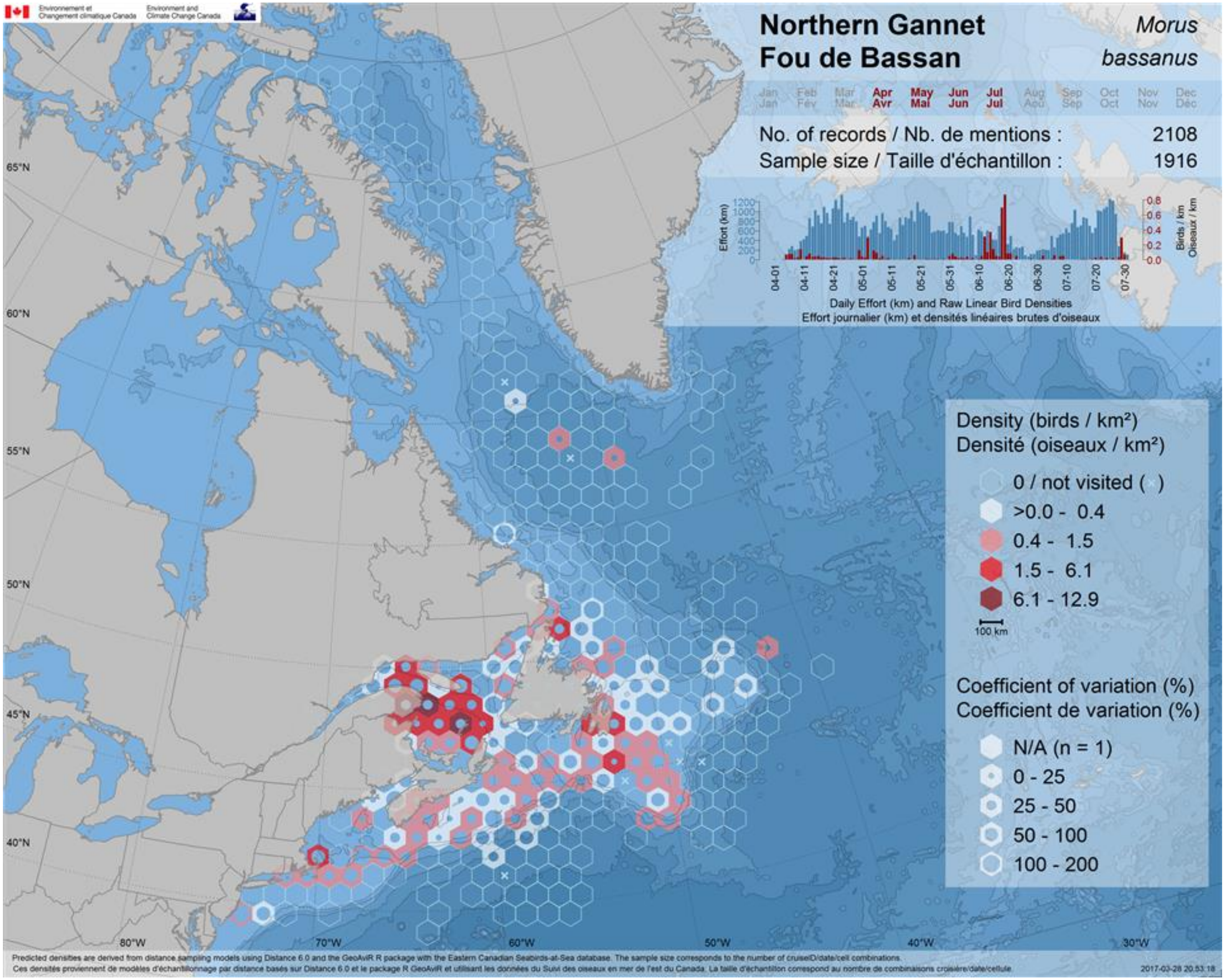
Environnement et Changement climatique Canada
Environment and Climate Change Canada
Northern Fulmar
Fulmar boréal
Fulmarus glacialis
Jan Jan Feb Fév Mar Mar Apr Avr May Mai Jun Jun Jul Jul Aug Aoû Sep Sep Oct Oct Nov Nov Dec Déc
No. of records / Nb. de mentions : 12670
Sample size / Taille d'échantillon : 1916
Effort (km)
Birds / km Oiseaux / km
04-01 04-11 04-21 05-01 05-11 05-21 05-31 06-10 06-20 06-30 07-10 07-20 07-30
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited ( )
> 0.0 - 6.6
6.6 - 19.1
19.1 - 111.5
111.5 - 166.6
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 20:50:20

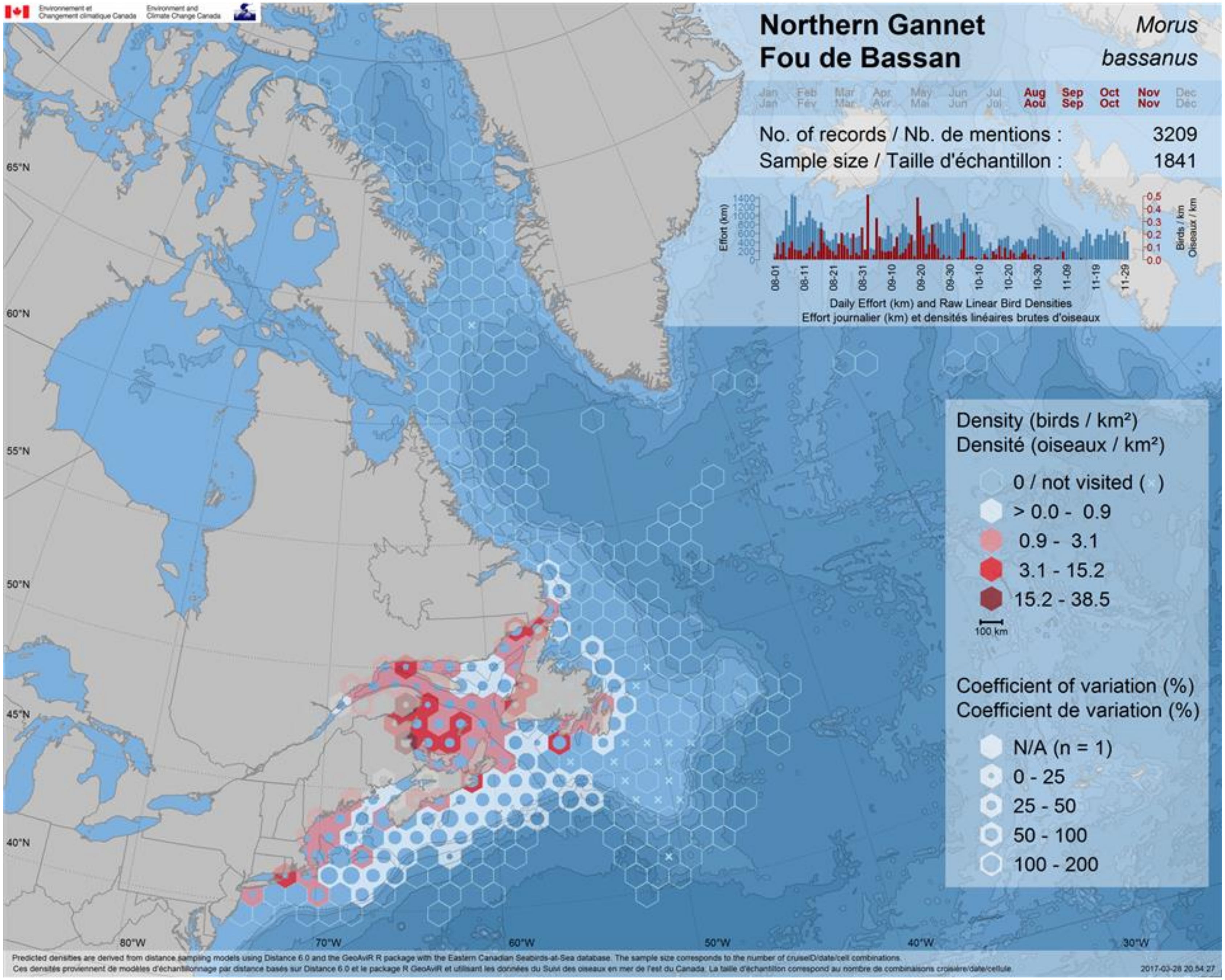

Northern Fulmar
Fulmar boréal
Fulmarus glacialis
Jan Jan Feb Fév Mar Mar Apr Avr May Mai Jun Jun Jul Jul Aug Aoû Sep Sep Oct Oct Nov Nov Dec Déc
No. of records / Nb. de mentions : 13643
Sample size / Taille d'échantillon : 1841
Effort (km)
Birds / km
Oiseaux / km
08-01
08-11
08-21
08-31
09-10
09-20
09-30
10-10
10-20
10-30
11-09
11-19
11-29
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited ( )
> 0.0 - 14.2
14.2 - 48.0
48.0 - 212.7
212.7 - 399.4
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 20:51:18



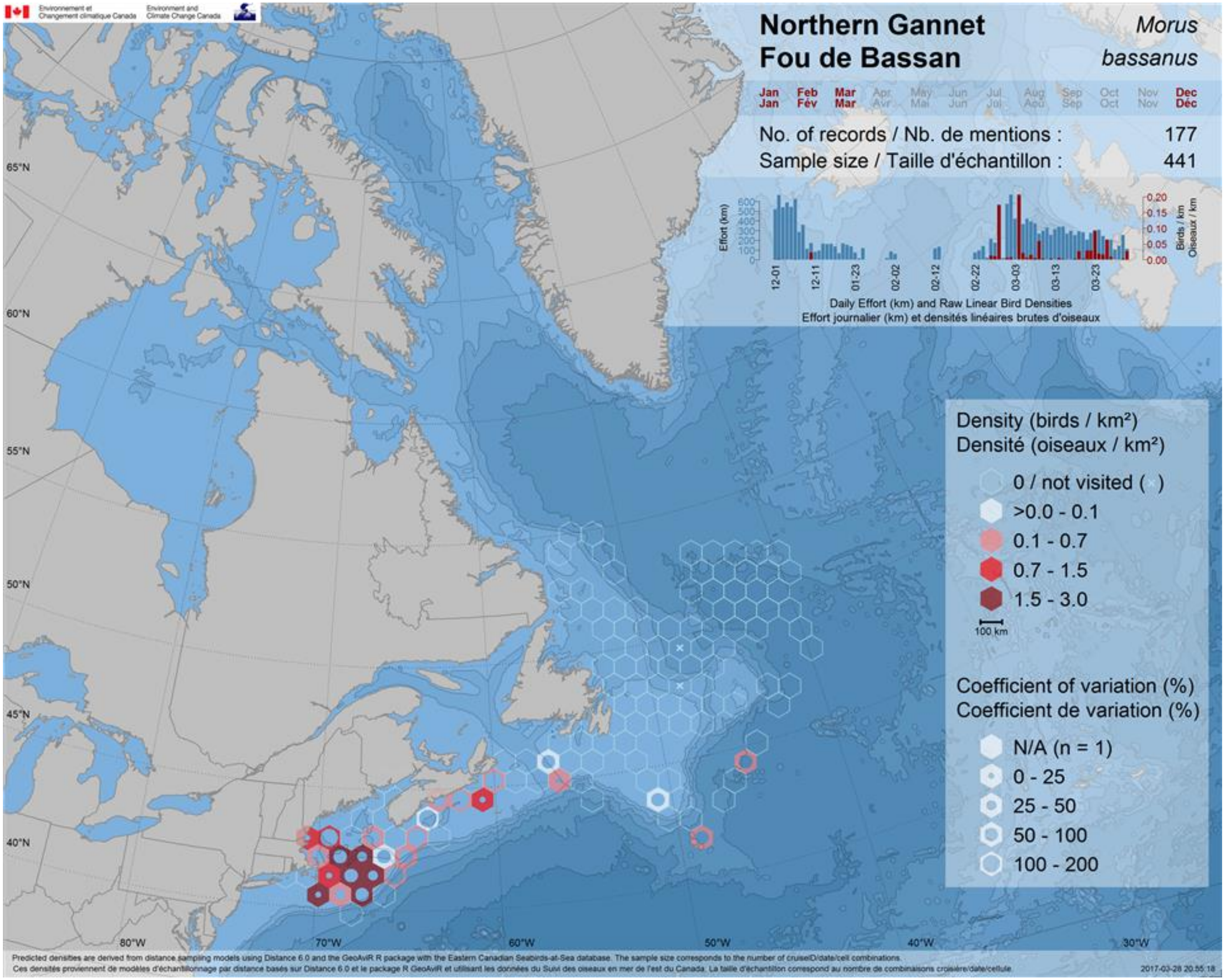
Environnement et Changement climatique Canada
Environment and Climate Change Canada
Northern Fulmar
Fulmar boréal
Fulmarus glacialis
Jan Jan
Feb Fév
Mar Mar
Apr Avr
May Mai
Jun Jun
Jul Jui
Aug Aoû
Sep Sep
Oct Oct
Nov Nov
Dec Déc
No. of records / Nb. de mentions : 1736
Sample size / Taille d'échantillon : 441
Effort (km)
Birds / km
Oiseaux / km
12-01
12-11
01-23
02-02
02-12
02-22
03-03
03-13
03-23
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited ( )
> 0.0 - 3.8
3.8 - 9.0
9.0 - 20.8
20.8 - 50.0
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 20:52:08

NORTHERN GANNET


Northern Gannet
Fou de Bassan
Morus bassanus
Jan Jan Feb Fév Mar Mar Apr Avr May Mai Jun Jun Jul Jul Aug Aoû Sep Sep Oct Oct Nov Nov Dec Déc
No. of records / Nb. de mentions : 2108
Sample size / Taille d'échantillon : 1916
Effort (km)
Birds / km
Oiseaux / km
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited ( )
>0.0 - 0.4
0.4 - 1.5
1.5 - 6.1
6.1 - 12.9
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 20:53:18



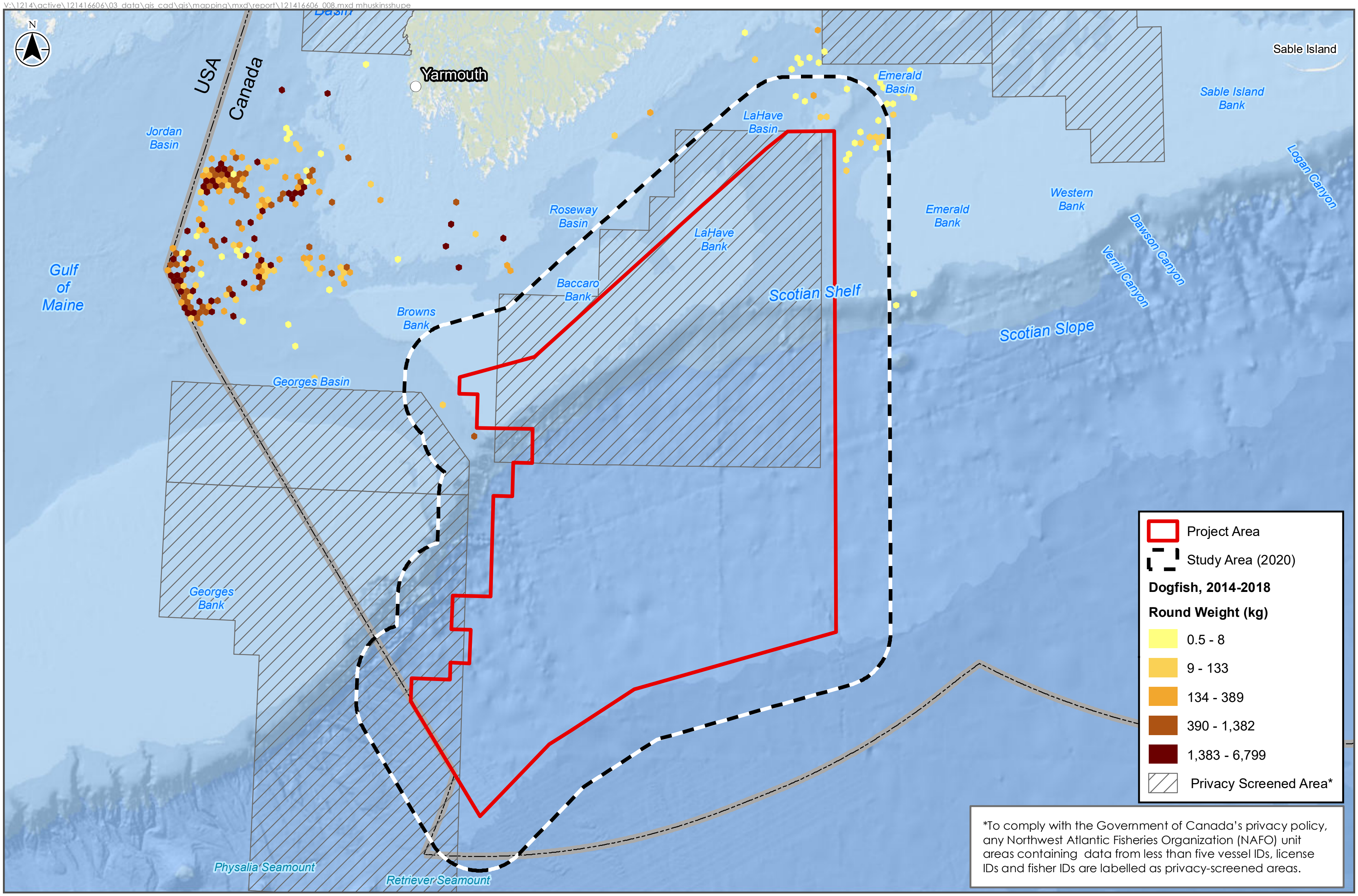
Environnement et Changement climatique Canada
Environment and Climate Change Canada
Northern Gannet
Fou de Bassan
Morus bassanus
Jan Jan
Feb Fév
Mar Mar
Apr Avr
May Mai
Jun Jun
Jul Jul
Aug Aoû
Sep Sep
Oct Oct
Nov Nov
Dec Déc
No. of records / Nb. de mentions : 3209
Sample size / Taille d'échantillon : 1841
Effort (km)
Birds / km
Oiseaux / km
08-01
08-11
08-21
08-31
09-10
09-20
09-30
10-10
10-20
10-30
11-09
11-19
11-29
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited ( )
> 0.0 - 0.9
0.9 - 3.1
3.1 - 15.2
15.2 - 38.5
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 20:54:27


Environnement et Changement climatique Canada
Environment and Climate Change Canada
Northern Gannet
Fou de Bassan
Morus bassanus
Jan Jan
Feb Fév
Mar Mar
Apr Avr
May Mai
Jun Jun
Jul Jul
Aug Aoû
Sep Sep
Oct Oct
Nov Nov
Dec Déc
No. of records / Nb. de mentions : 177
Sample size / Taille d'échantillon : 441
Effort (km)
Birds / km
Oiseaux / km
12-01
12-11
01-23
02-02
02-12
02-22
03-03
03-13
03-23
Daily Effort (km) and Raw Linear Bird Densities
Effort journalier (km) et densités linéaires brutes d'oiseaux
Density (birds / km²)
Densité (oiseaux / km²)
0 / not visited ( )
>0.0 - 0.1
0.1 - 0.7
0.7 - 1.5
1.5 - 3.0
100 km
Coefficient of variation (%)
Coefficient de variation (%)
N/A (n = 1)
0 - 25
25 - 50
50 - 100
100 - 200
65°N
60°N
55°N
50°N
45°N
40°N
80°W
70°W
60°W
50°W
40°W
30°W
Predicted densities are derived from distance sampling models using Distance 6.0 and the GeoAviR R package with the Eastern Canadian Seabirds-at-Sea database. The sample size corresponds to the number of cruiseID/date/cell combinations.
Ces densités proviennent de modèles d'échantillonnage par distance basés sur Distance 6.0 et le package R GeoAviR et utilisant les données du Suivi des oiseaux en mer de l'est du Canada. La taille d'échantillon correspond au nombre de combinaisons croisière/date/cellule.
2017-03-28 20:55:18

APPENDIX C

Landings Values per NAFO Unit
and Composite Fishery Landings Maps (Figures C.1-C.28)

V:\1214\active\121416606\03_data\gis_cad\gis\mapping\mxd\report\121416606_008.mxd mhuskinsshupe



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

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

0 25 50 75
Kilometres

NAD 1983 UTM Zone 20N

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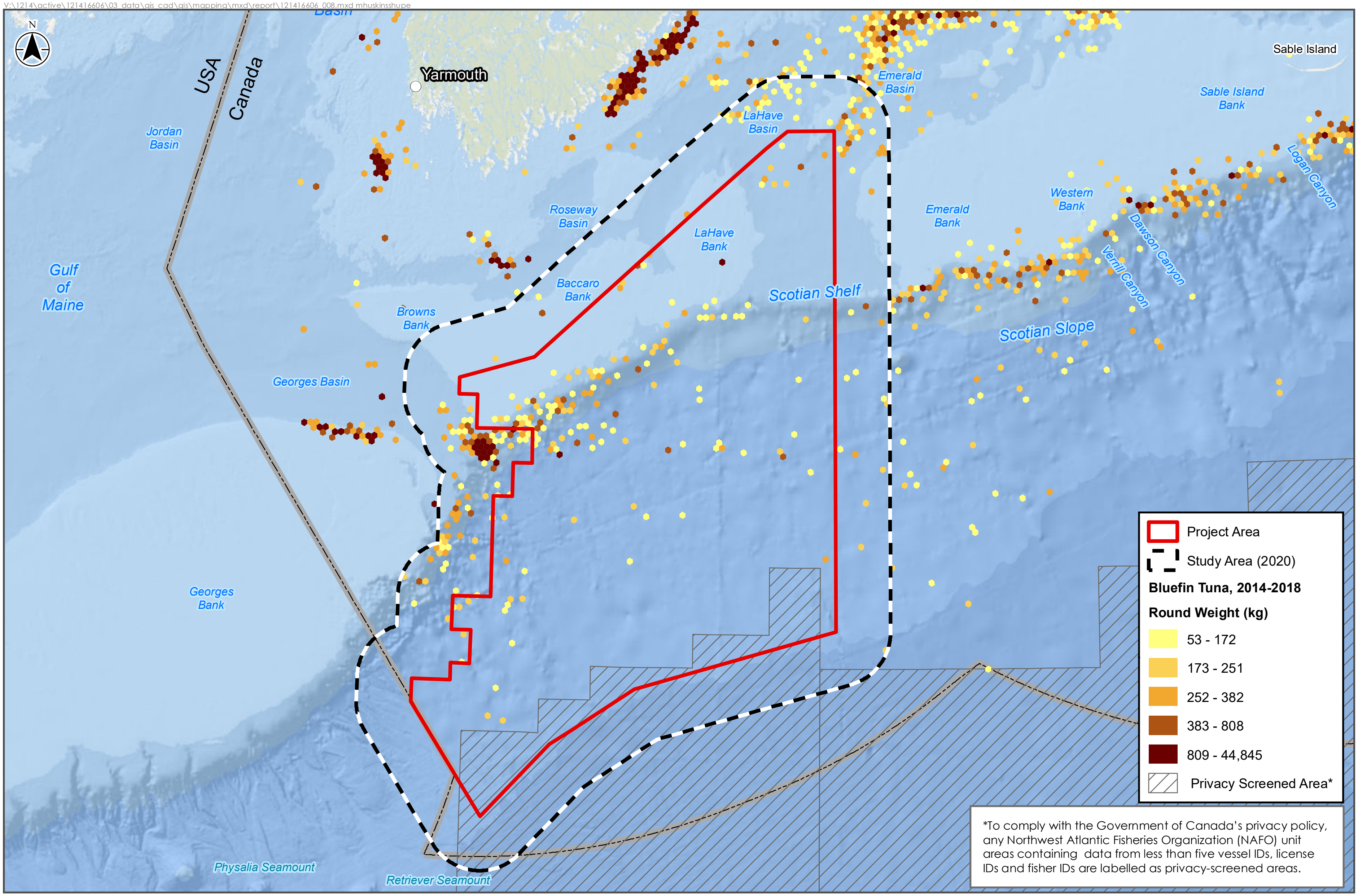
121416606_008

Dogfish Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.1

V:\1214\active\121416606\03_data\gis_cad\gis\mapping\mxd\report\121416606_008.mxd mhuskinsshupe



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

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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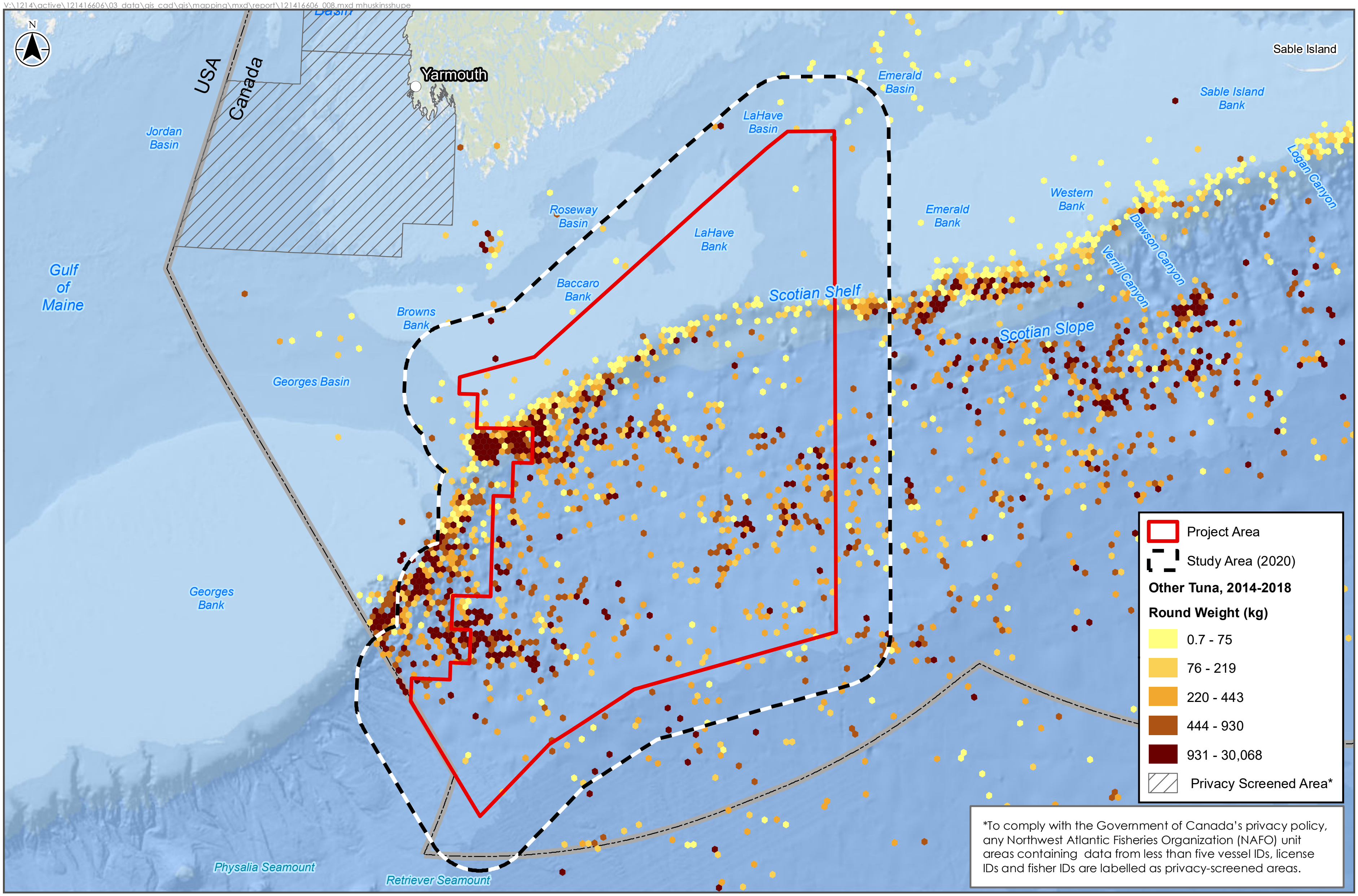
Bluefin Tuna Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.2



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

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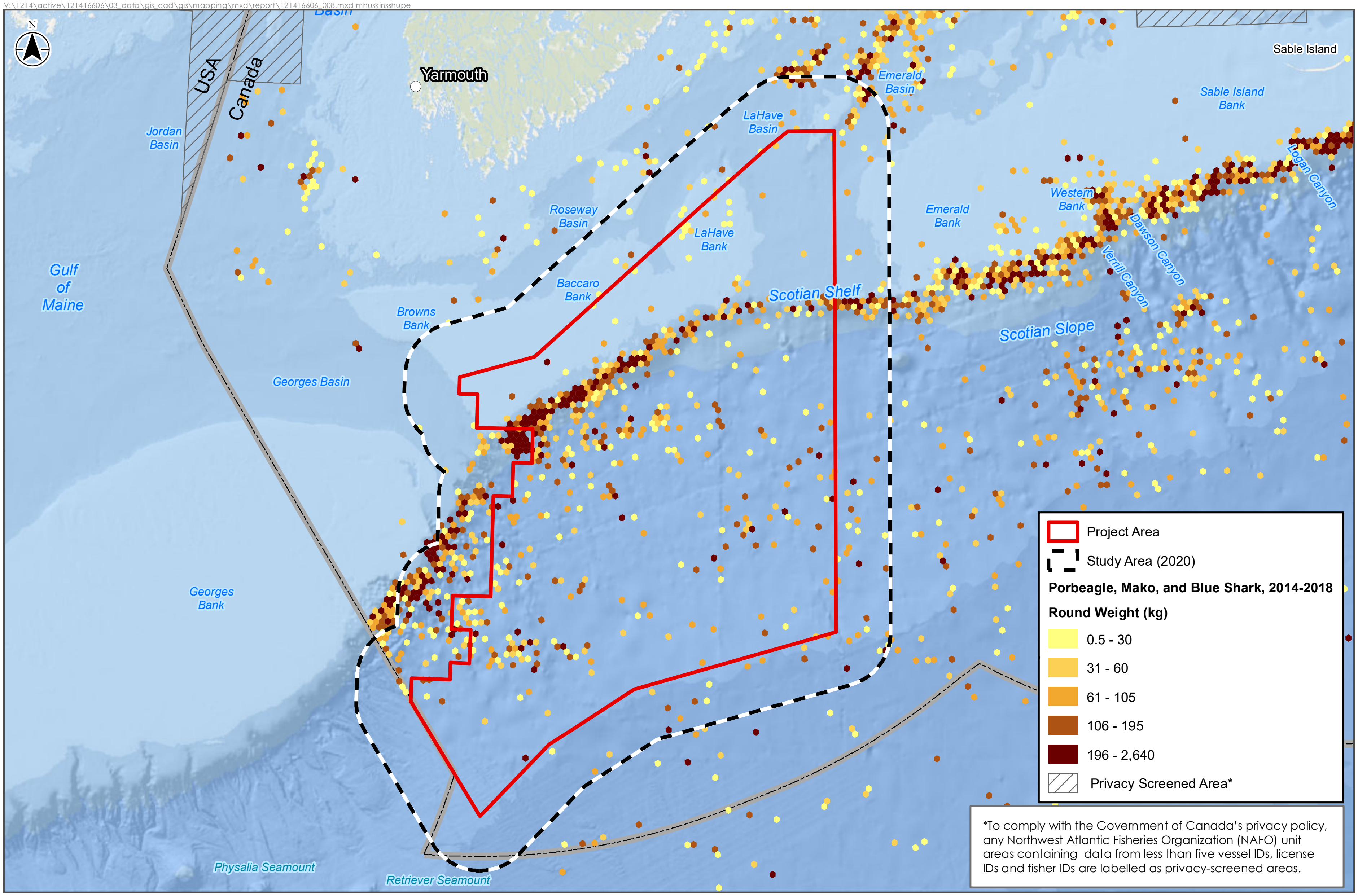
Other Tuna Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.3



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

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Porbeagle, Mako, Blue Shark Landings
Composite Landings (kg) per 10 km² hexagon

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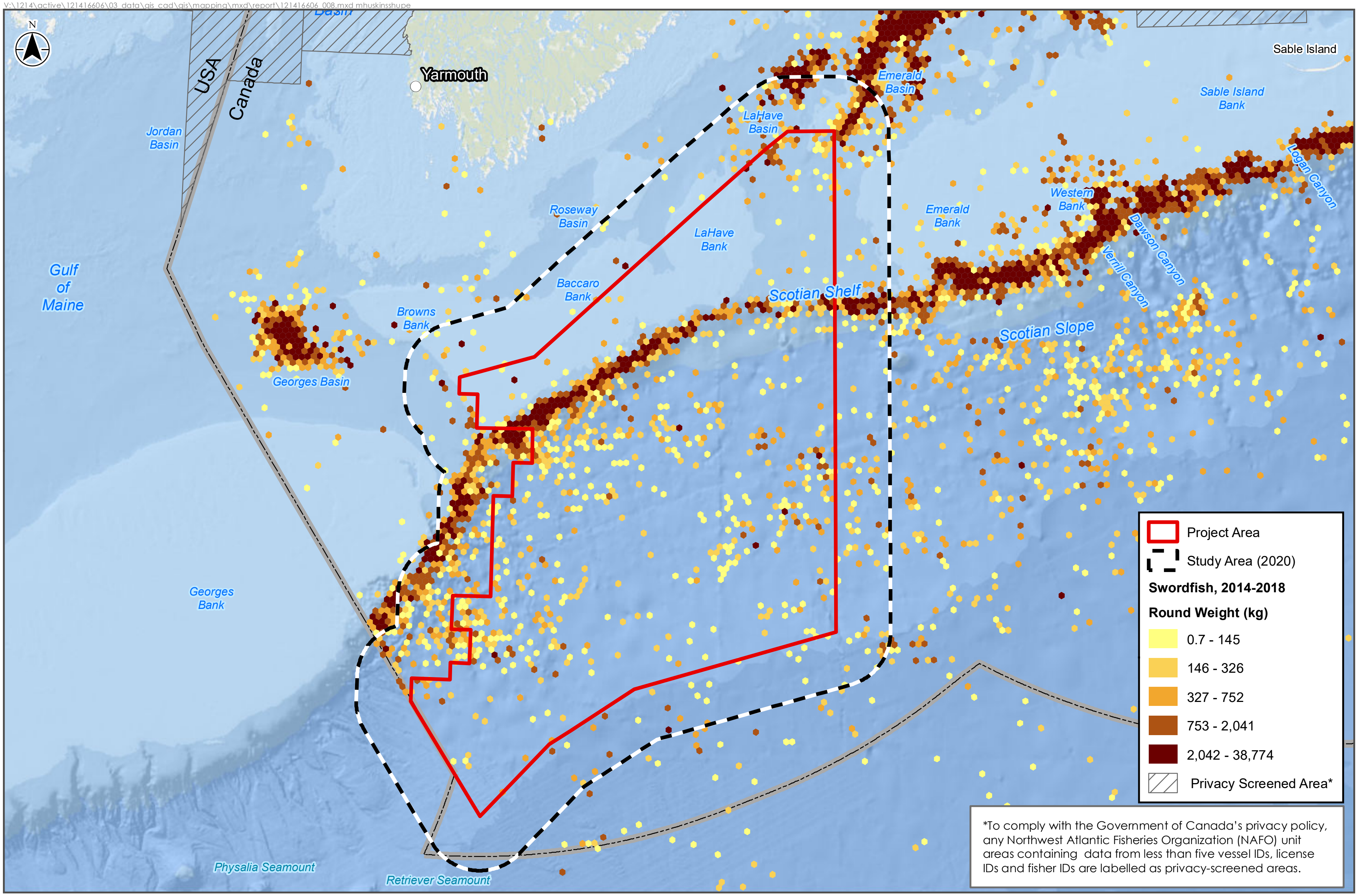
121416606_008

Figure C.4



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

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

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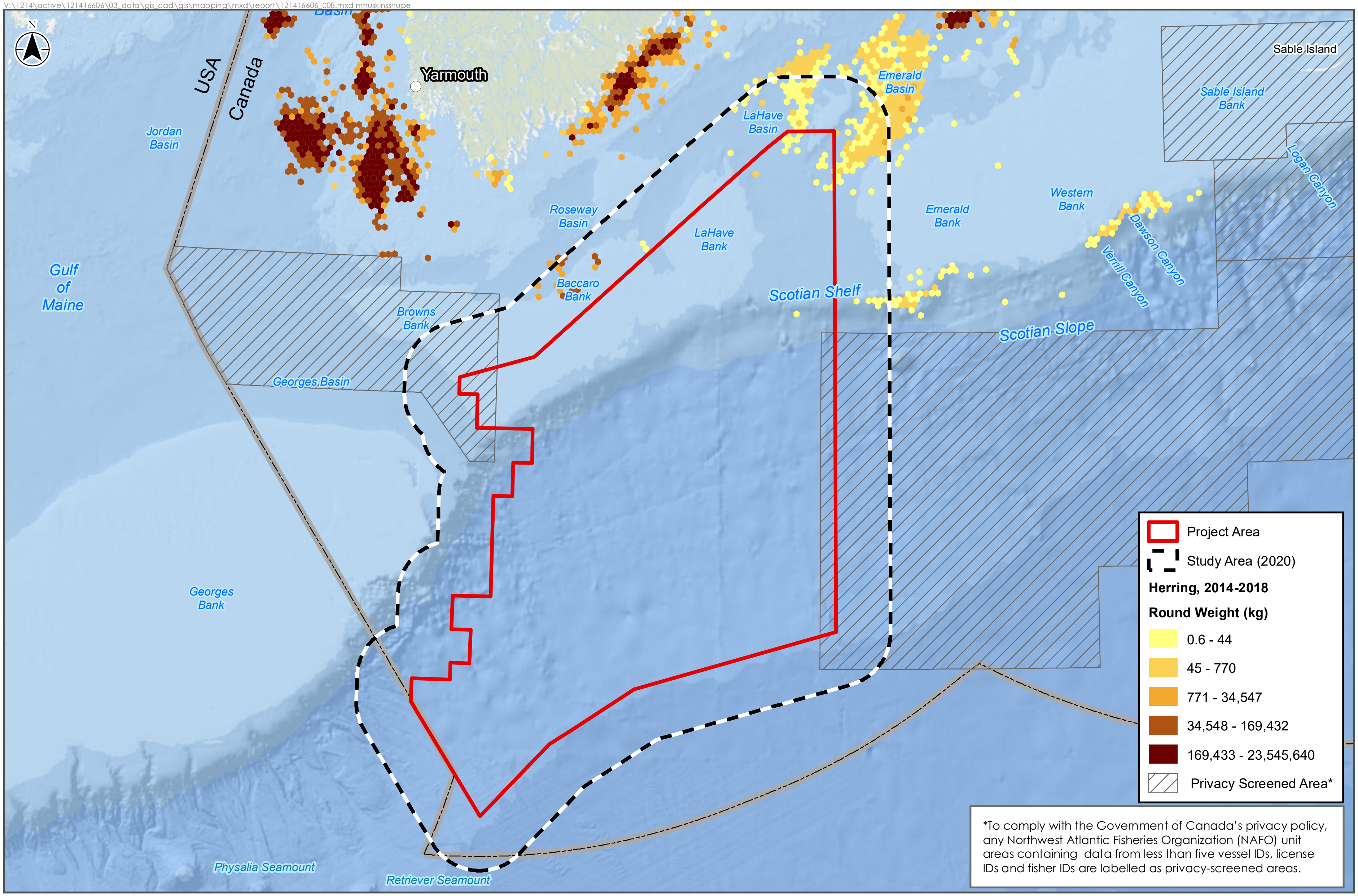
121416606_008

Swordfish Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.5

V:\1214\active\121416606\03_data\gis_cad\gis\mapping\mxd\report\121416606_008.mxd mhuskinsshupe



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

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

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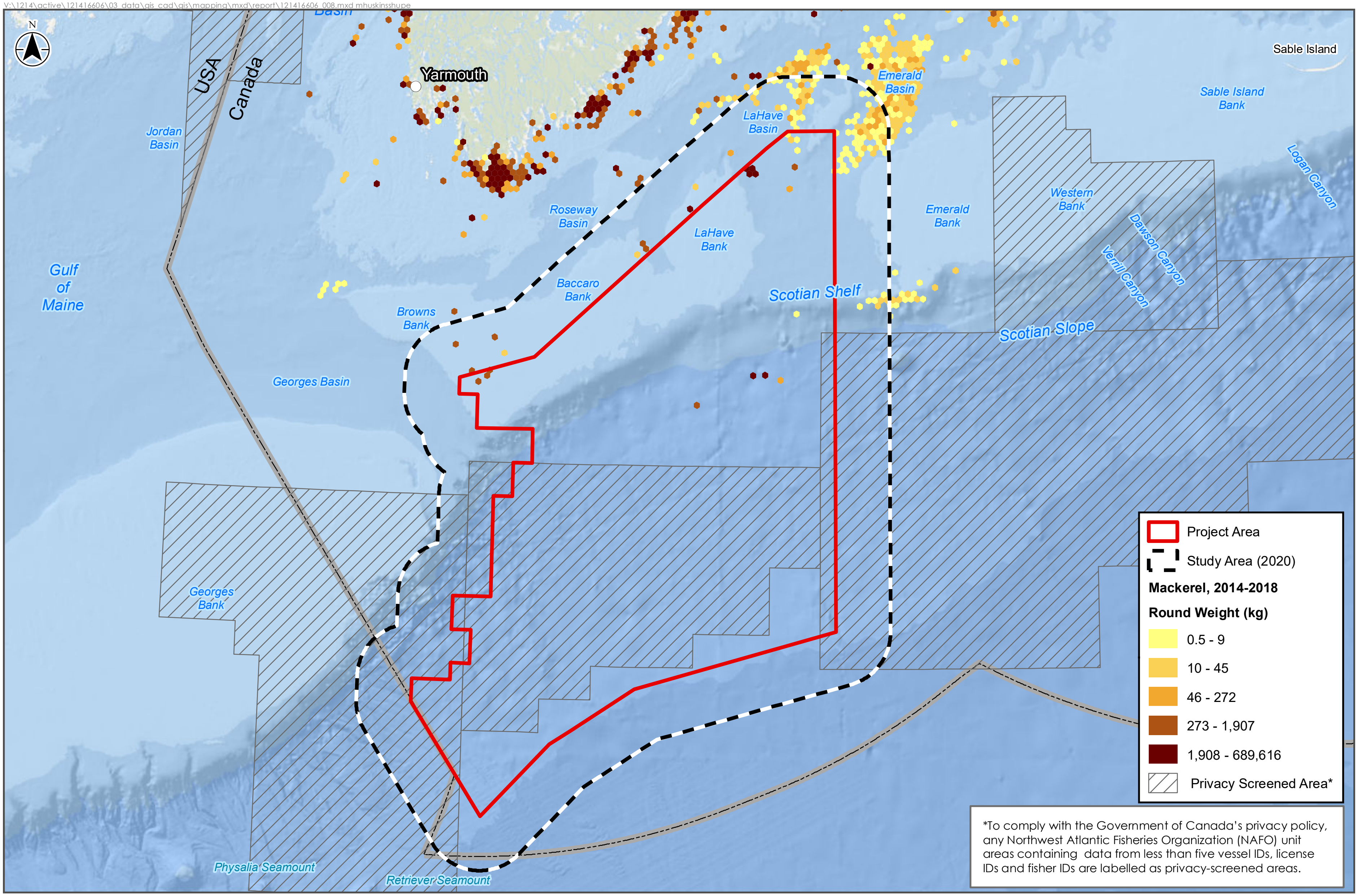
121416606_008

Herring Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.6



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

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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Mackerel Landings
Composite Landings (kg) per 10 km² hexagon

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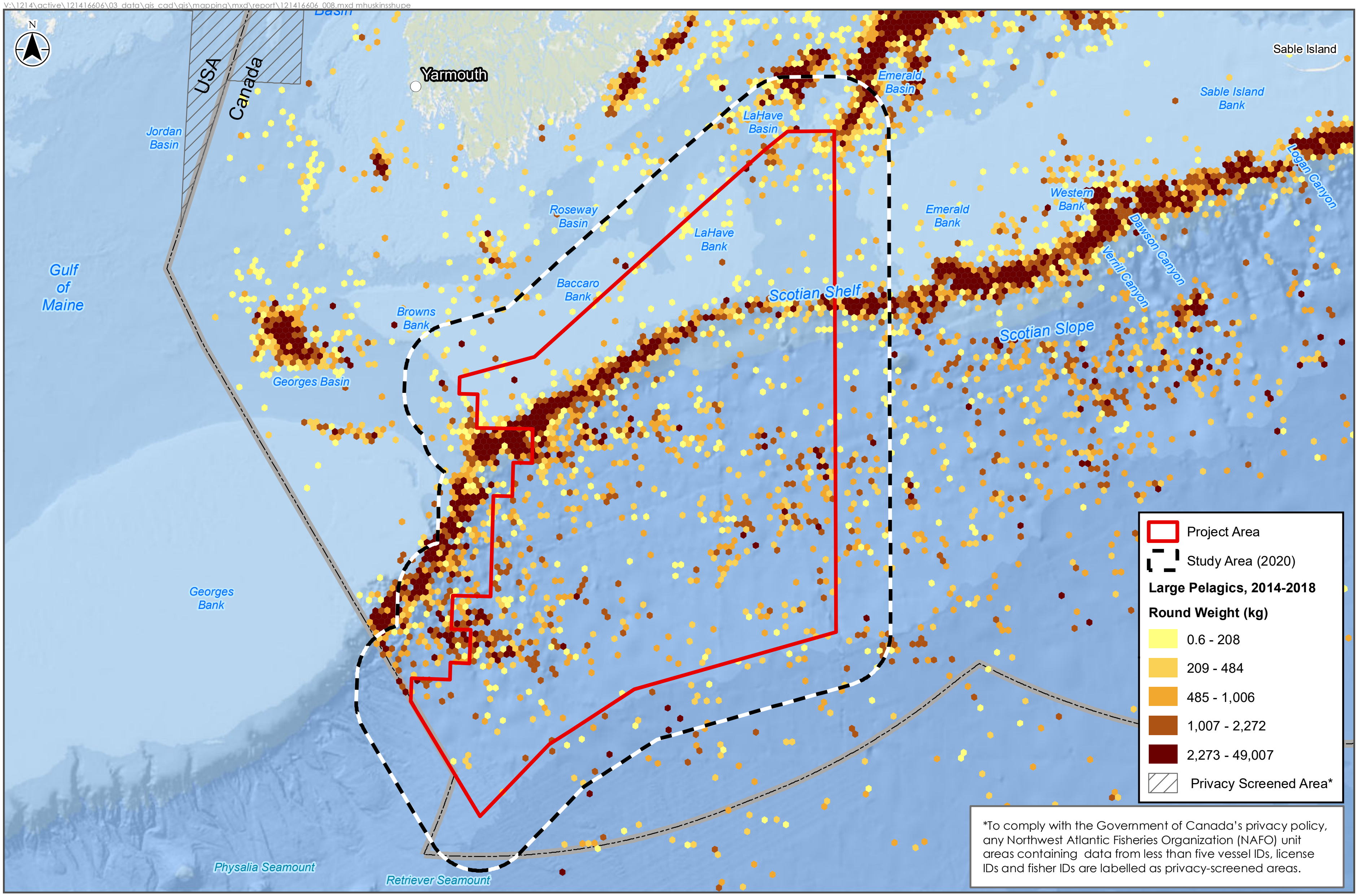
121416606_008

Figure C.7



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

NAD 1983 UTM Zone 20N

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0 25 50 75
Kilometres

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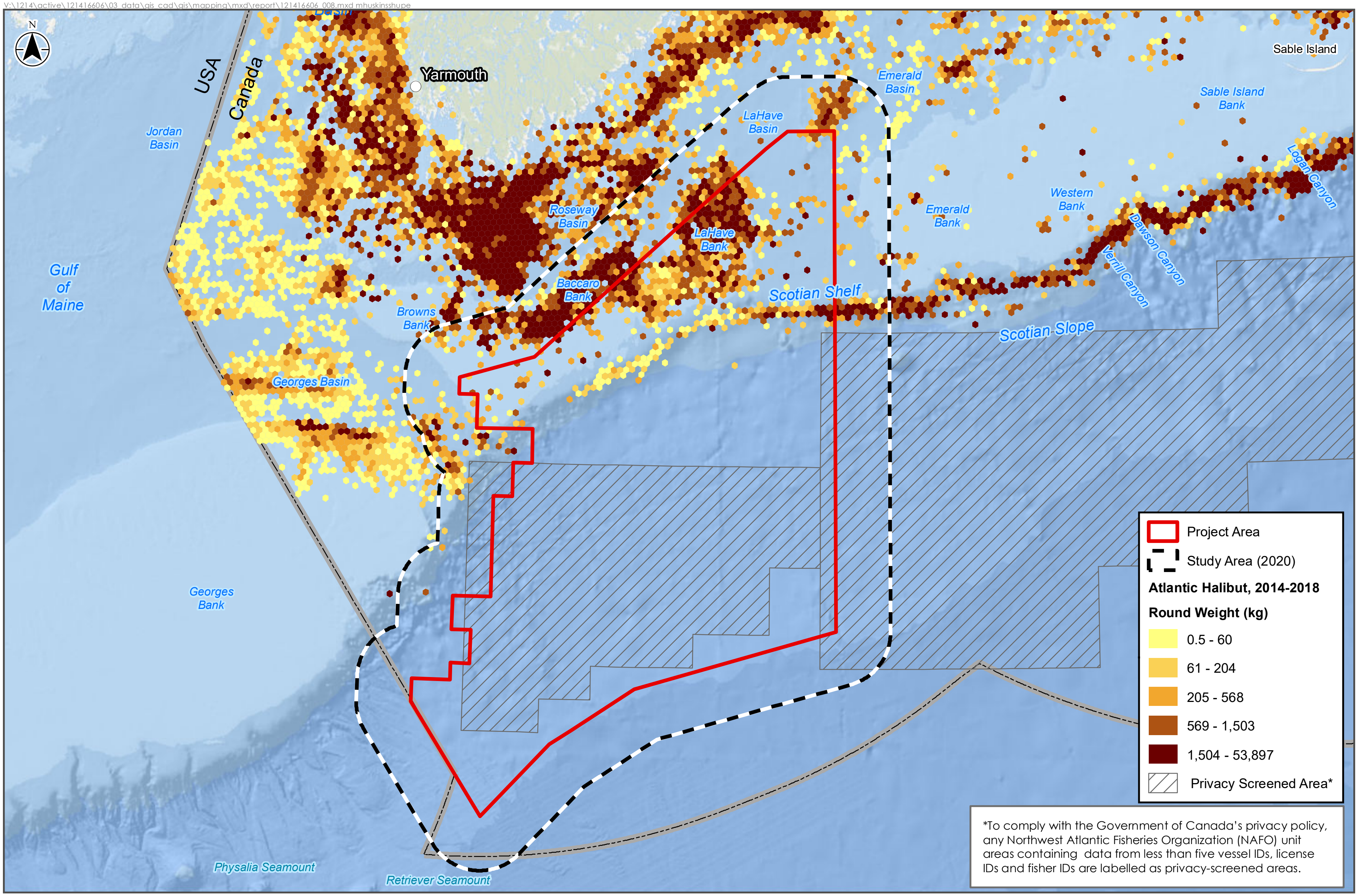
121416606_008

Large Pelagics Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.8



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

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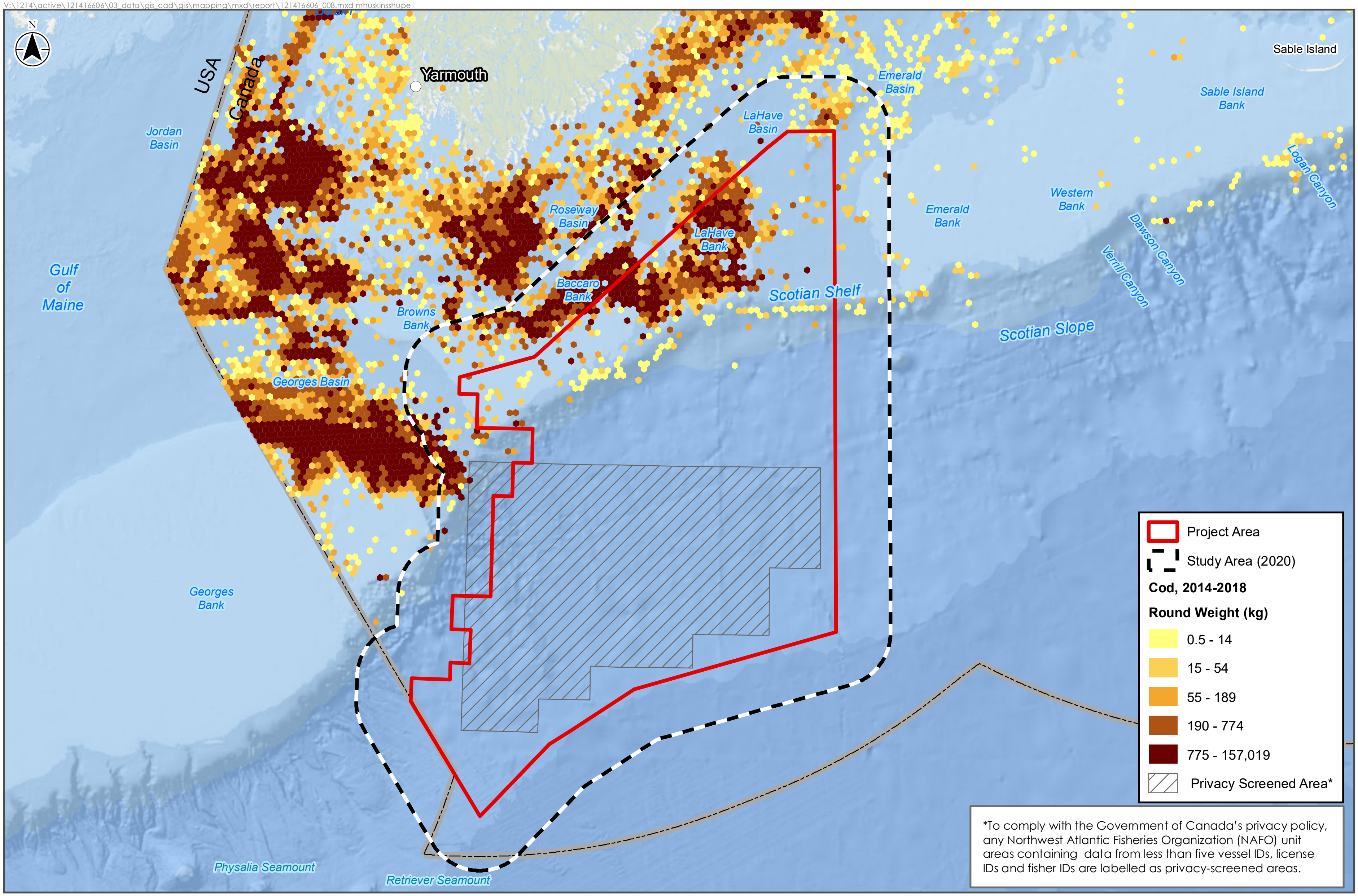
121416606_008

Atlantic Halibut Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.9

V:\1214\active\121416606\03_data\gis_cad\gis\mapping\mxd\report\121416606_008.mxd mhuskinsshupe



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

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0 25 50 75
Kilometres

NAD 1983 UTM Zone 20N

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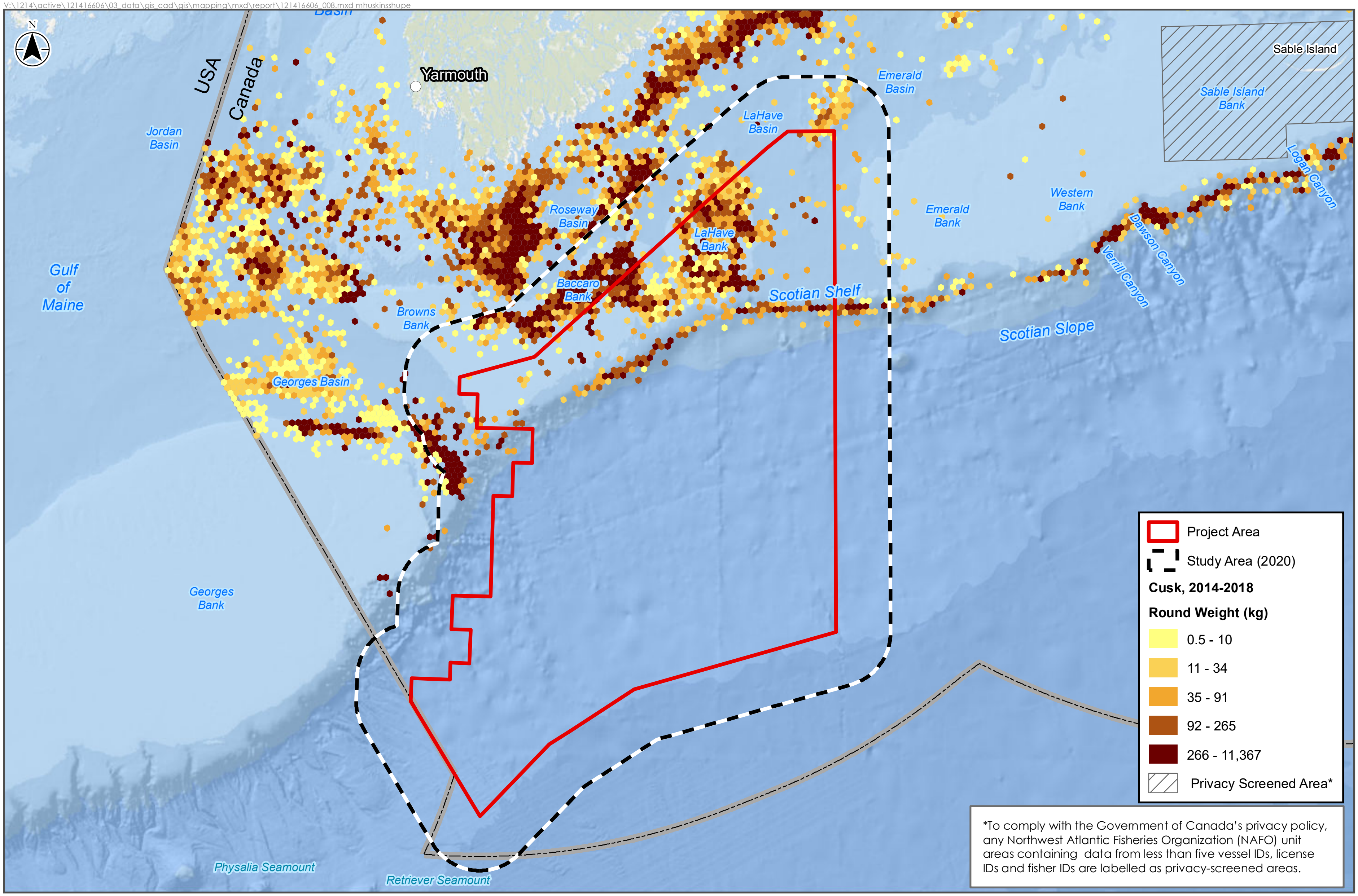
121416606_008

Cod Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.10

V:\1214\active\121416606\03_data\gis_cad\gis\mapping\mxd\report\121416606_008.mxd mhuskinsshupe



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

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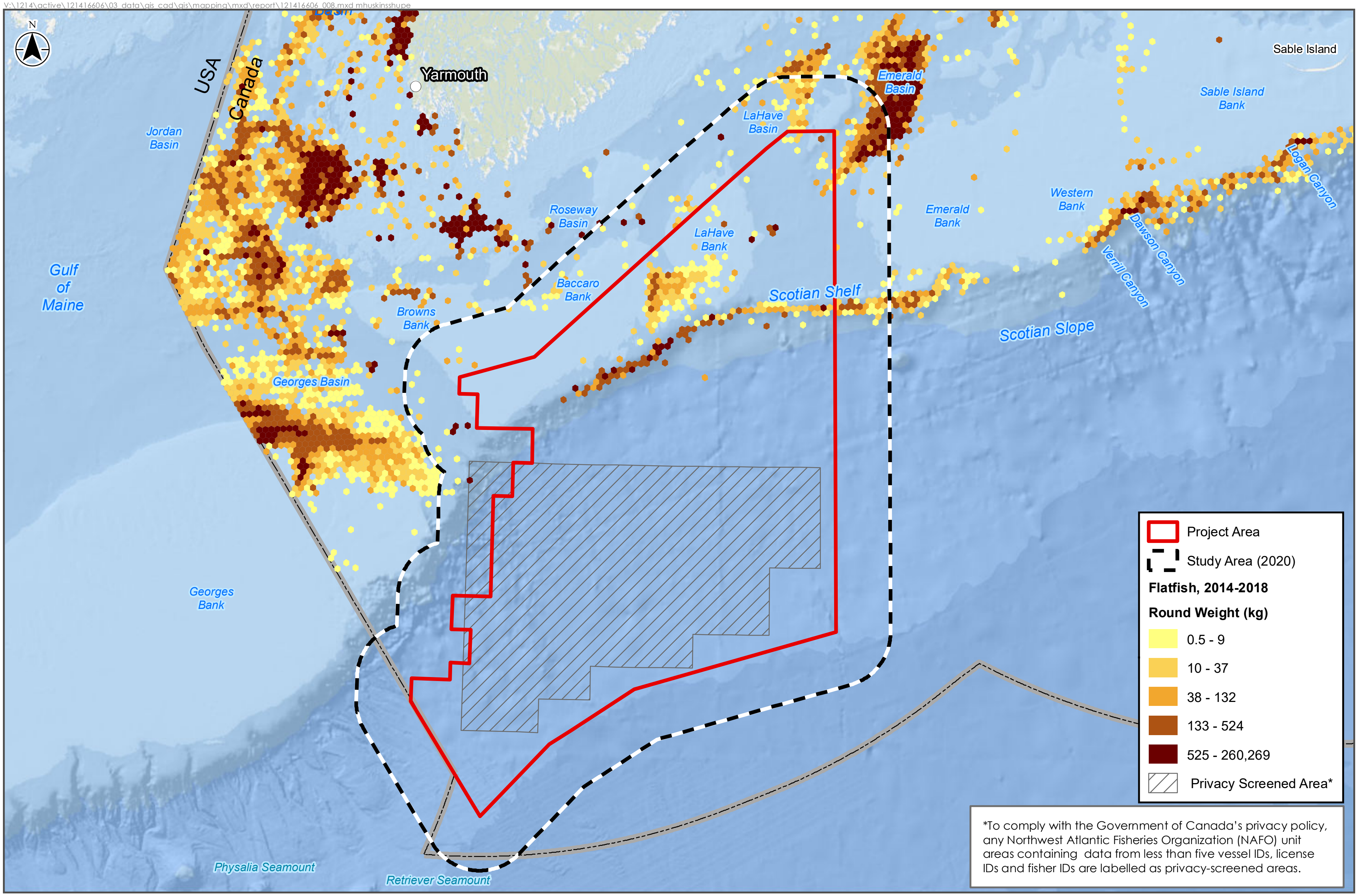
Cusk Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.11

V:\1214\active\121416606\03_data\gis_cad\gis\mapping\mxd\report\121416606_008.mxd mhuskinsshupe



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

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0 25 50 75
Kilometres

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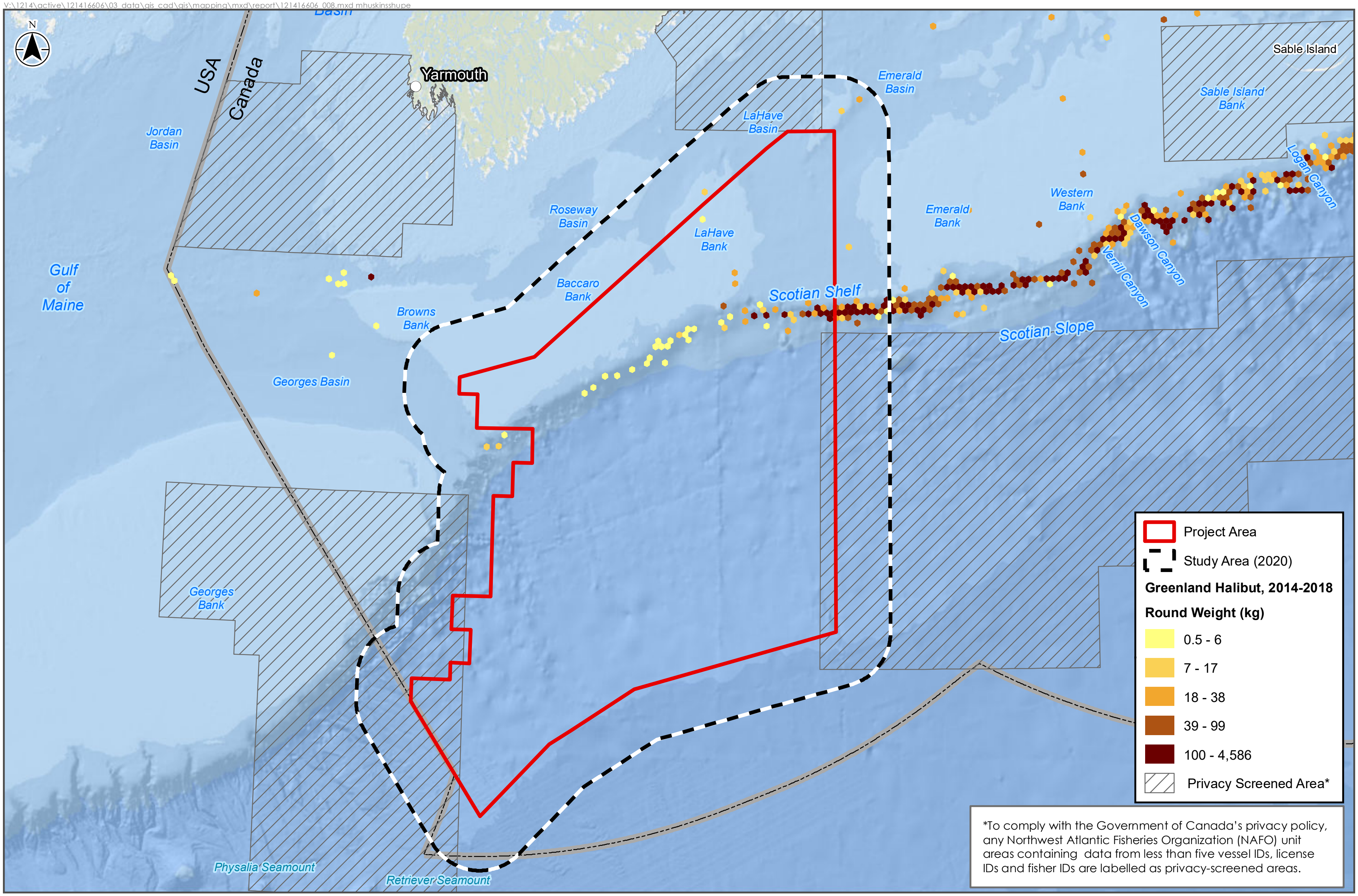
Flatfish Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.12



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

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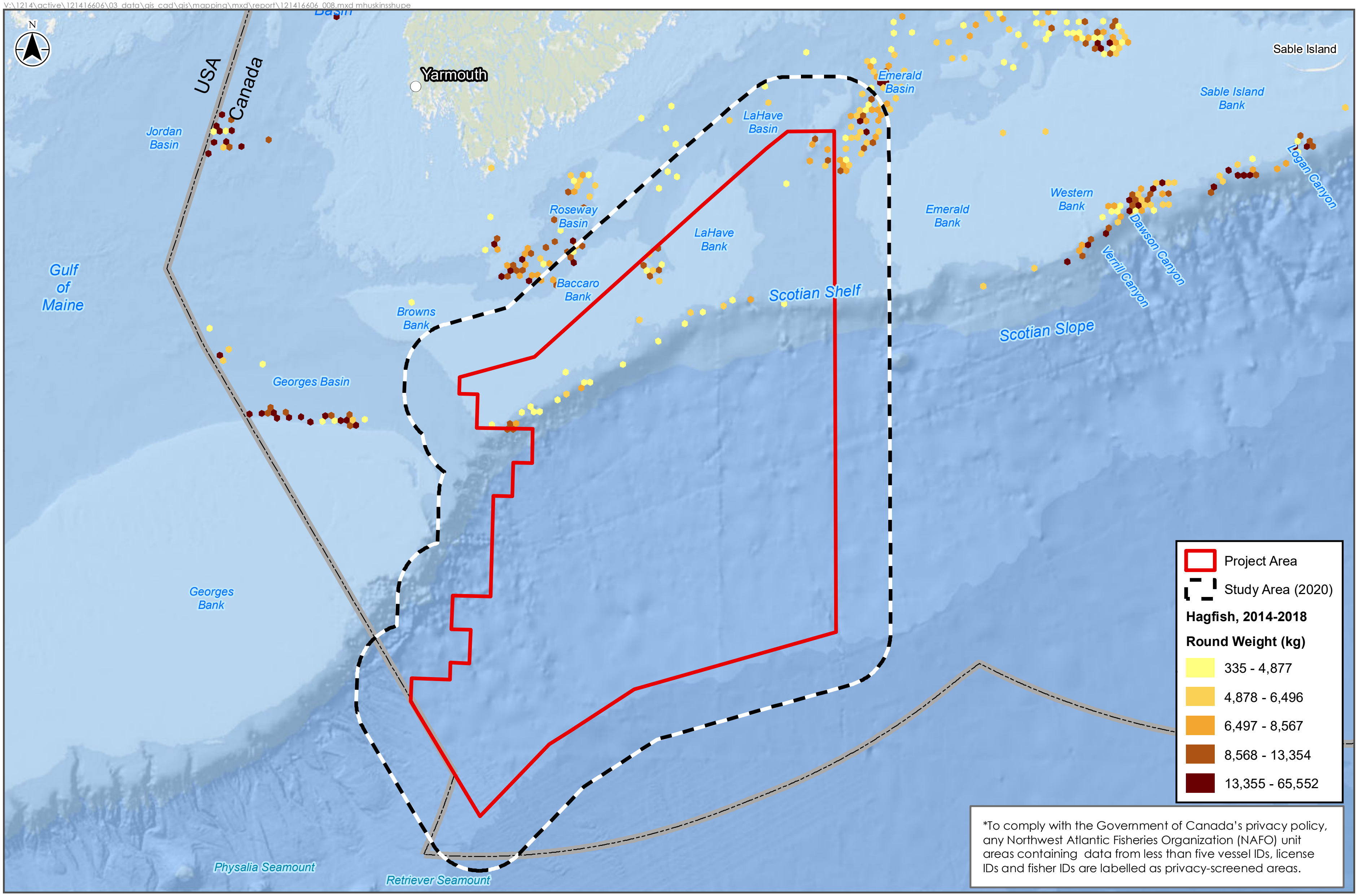
Greenland Halibut Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.13



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

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Hagfish Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.14

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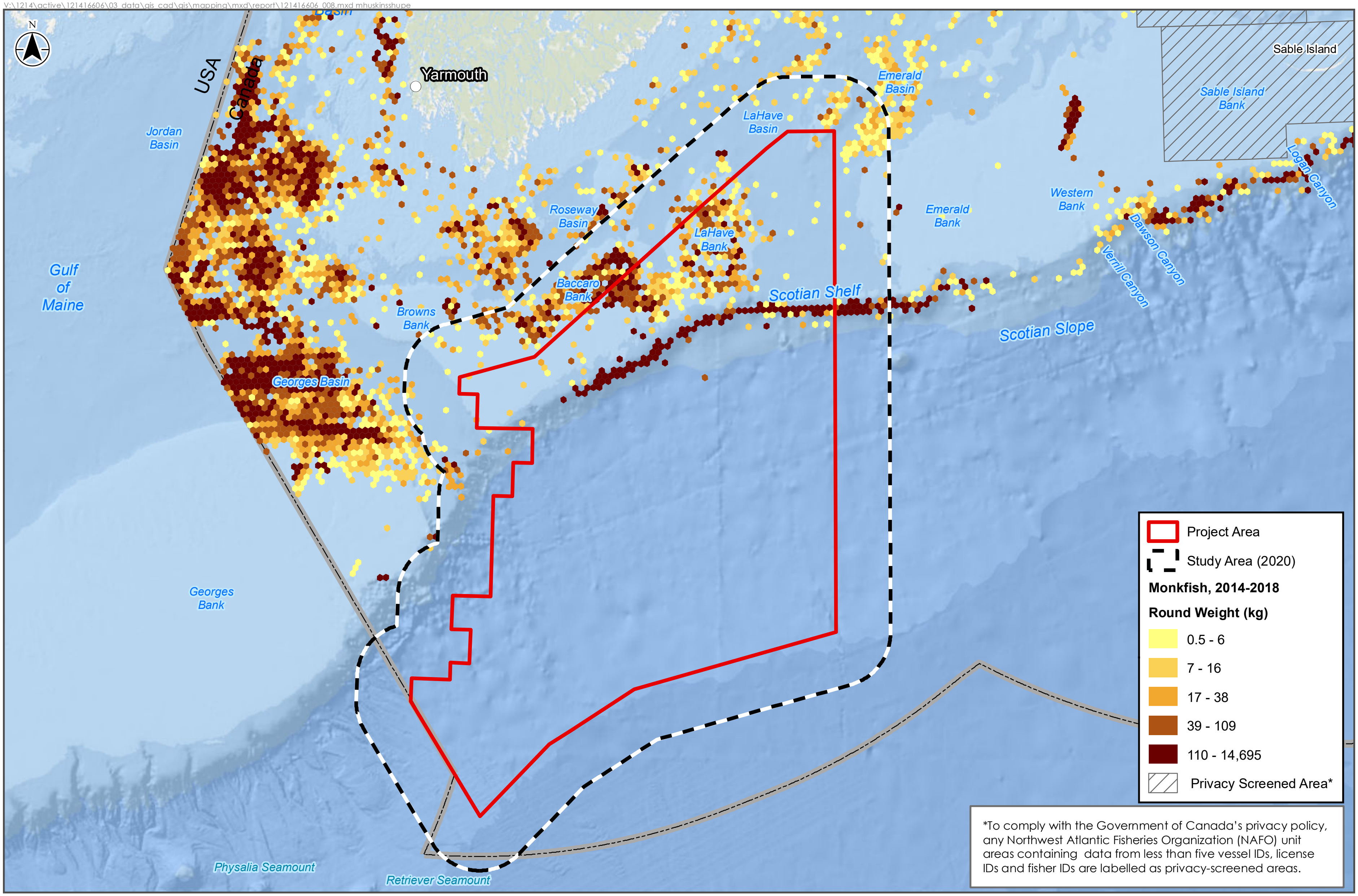

Sources: Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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

0 25 50 75
Kilometres

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Monkfish Landings
Composite Landings (kg) per 10 km² hexagon

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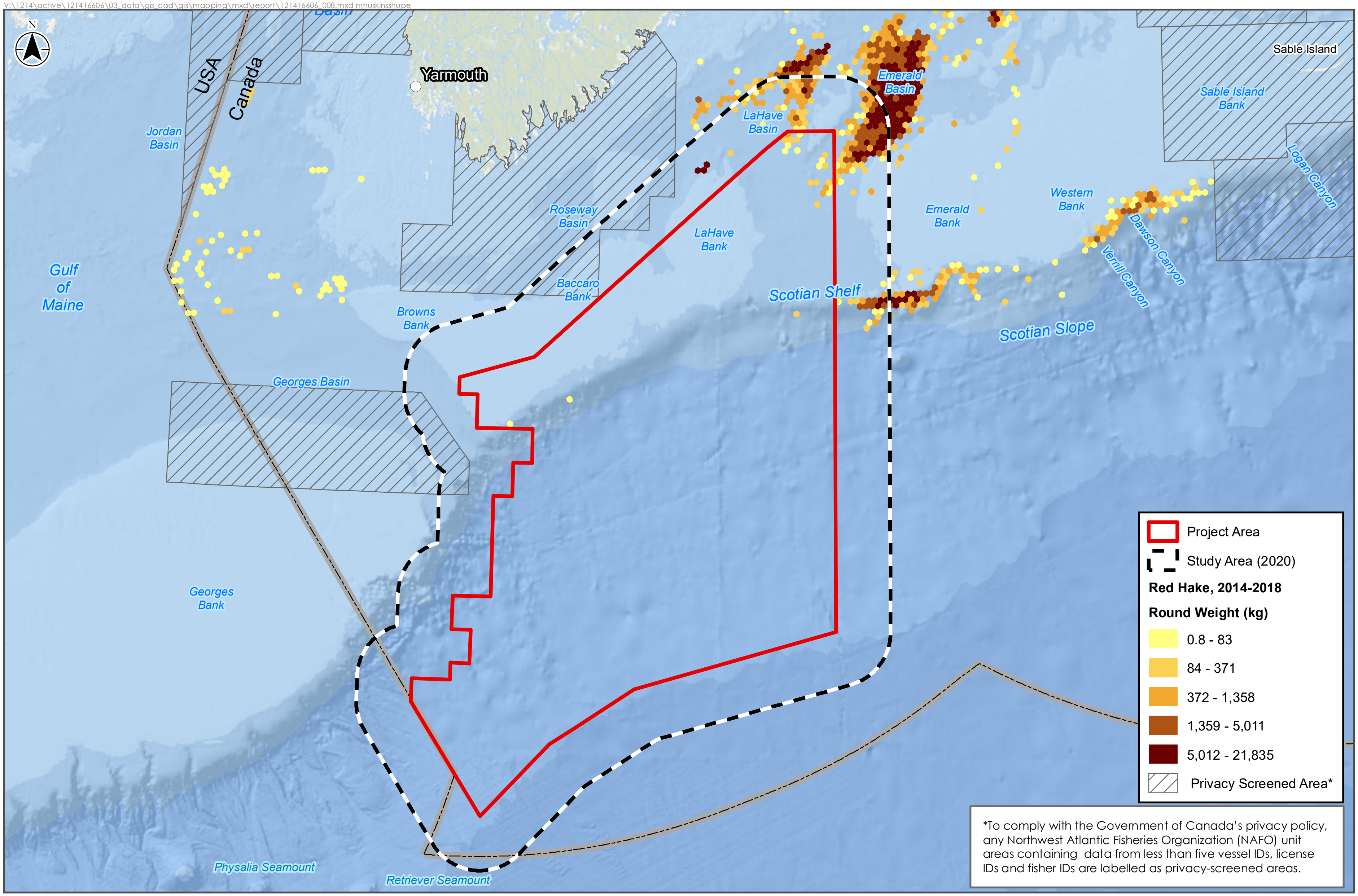
Figure C.15

121416606_008

V:\1214\active\121416606\03_data\gis_cad\gis\mapping\mxd\report\121416606_008.mxd mhuskinsshupe



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

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0 25 50 75
Kilometres

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121416606_008

Red Hake Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.16

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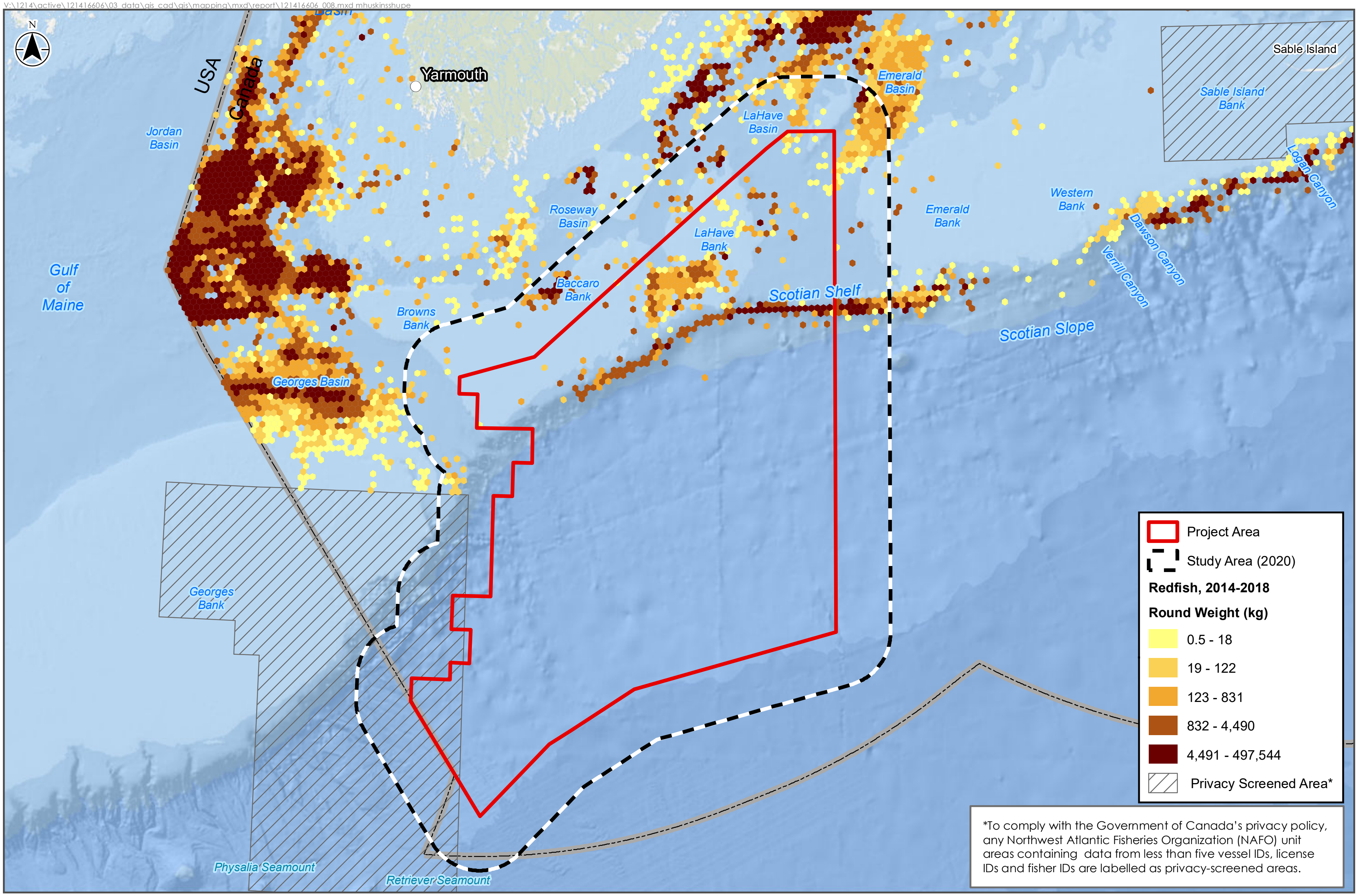

Sources: Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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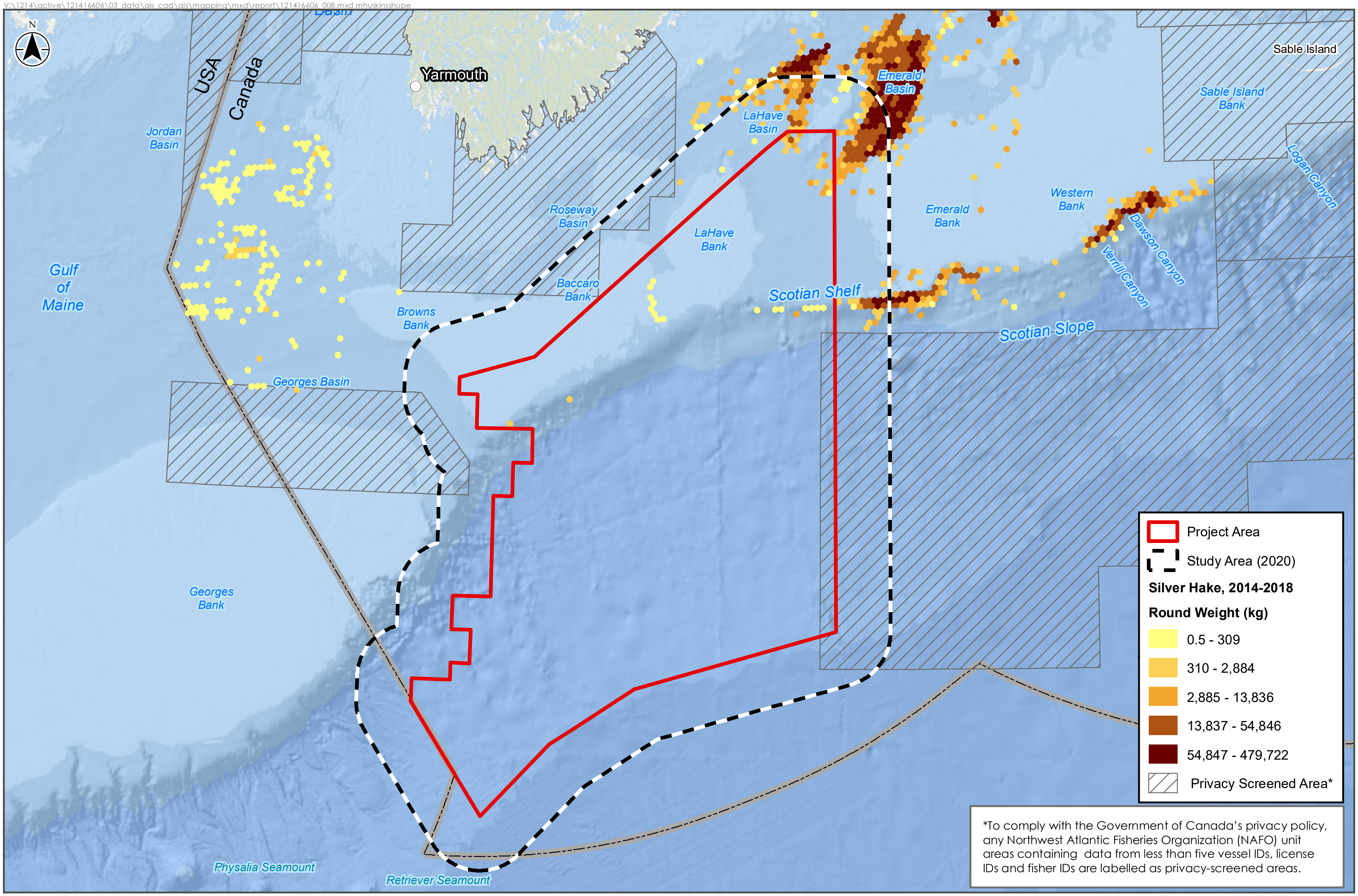
121416606_008

Redfish Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.17



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

NAD 1983 UTM Zone 20N

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Sliver Hake Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.18

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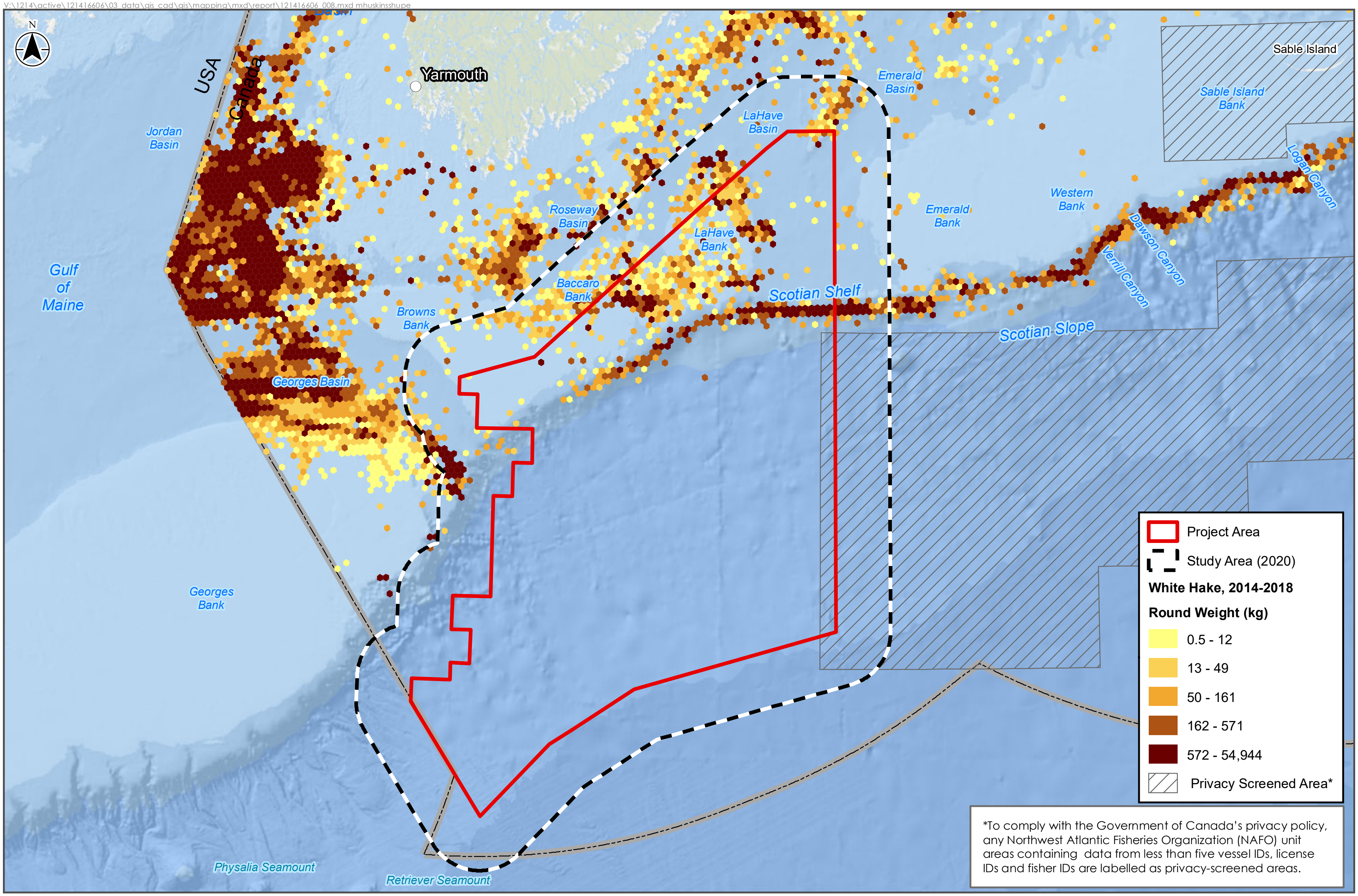
121416606_008

V:\1214\active\121416606\03_data\gis_cad\gis\mapping\mxd\report\121416606_008.mxd mhuskinsshupe



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

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

White Hake Landings
Composite Landings (kg) per 10 km² hexagon

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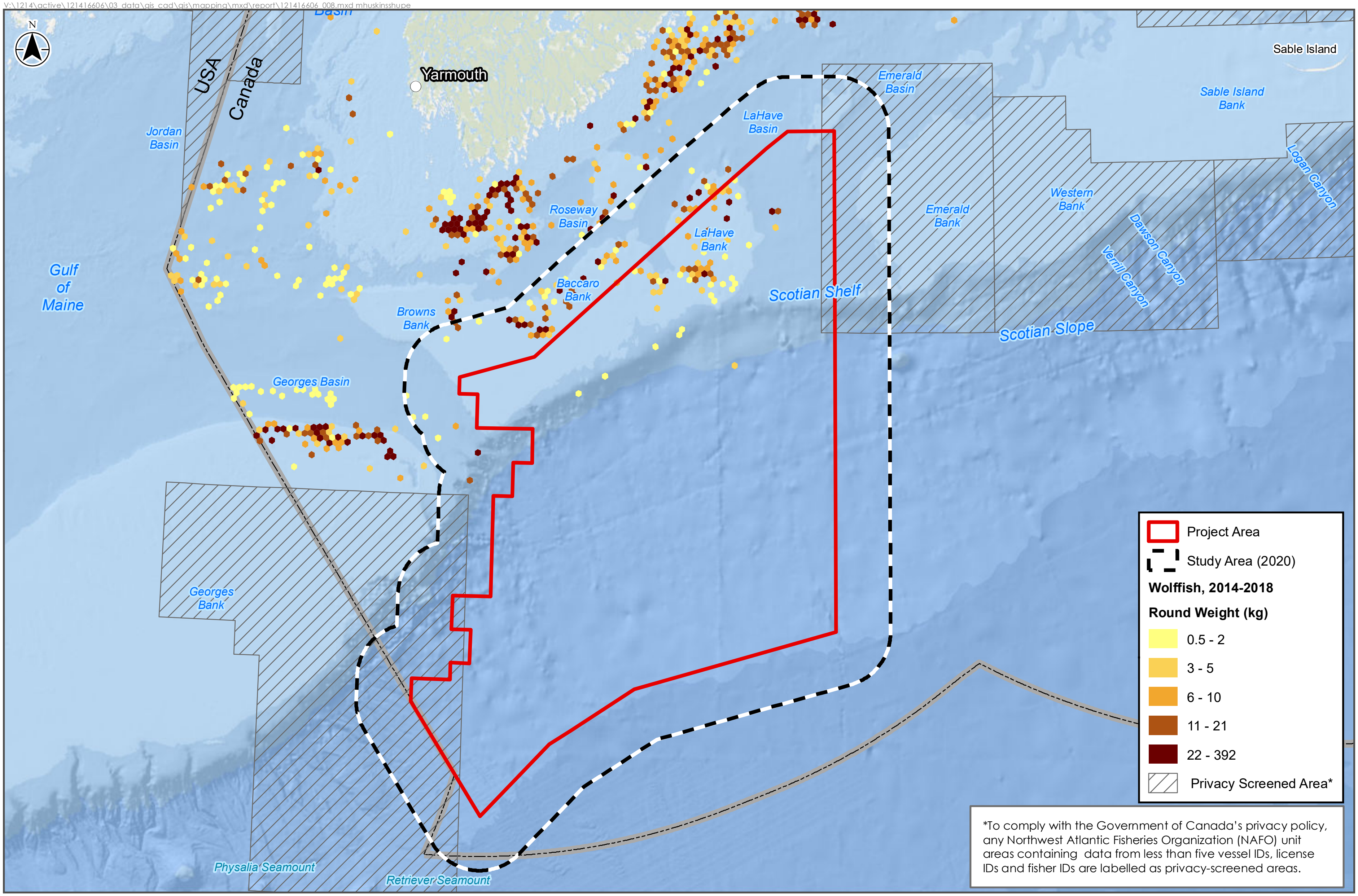
Figure C.19



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

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Wolffish Landings
Composite Landings (kg) per 10 km² hexagon

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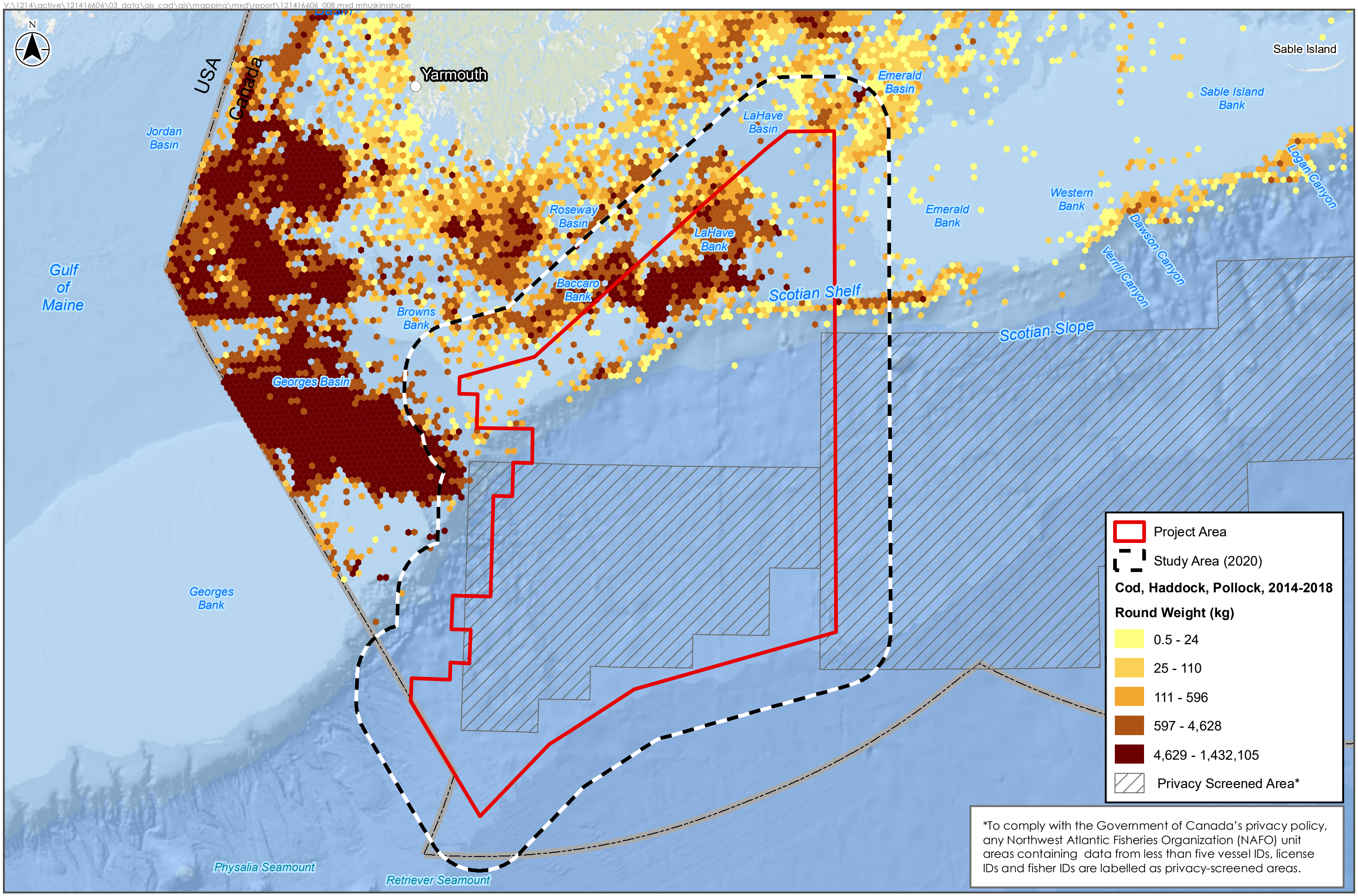
Figure C.20



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

NAD 1983 UTM Zone 20N

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

Cod, Haddock, and Pollock Landings
Composite Landings (kg) per 10 km² hexagon

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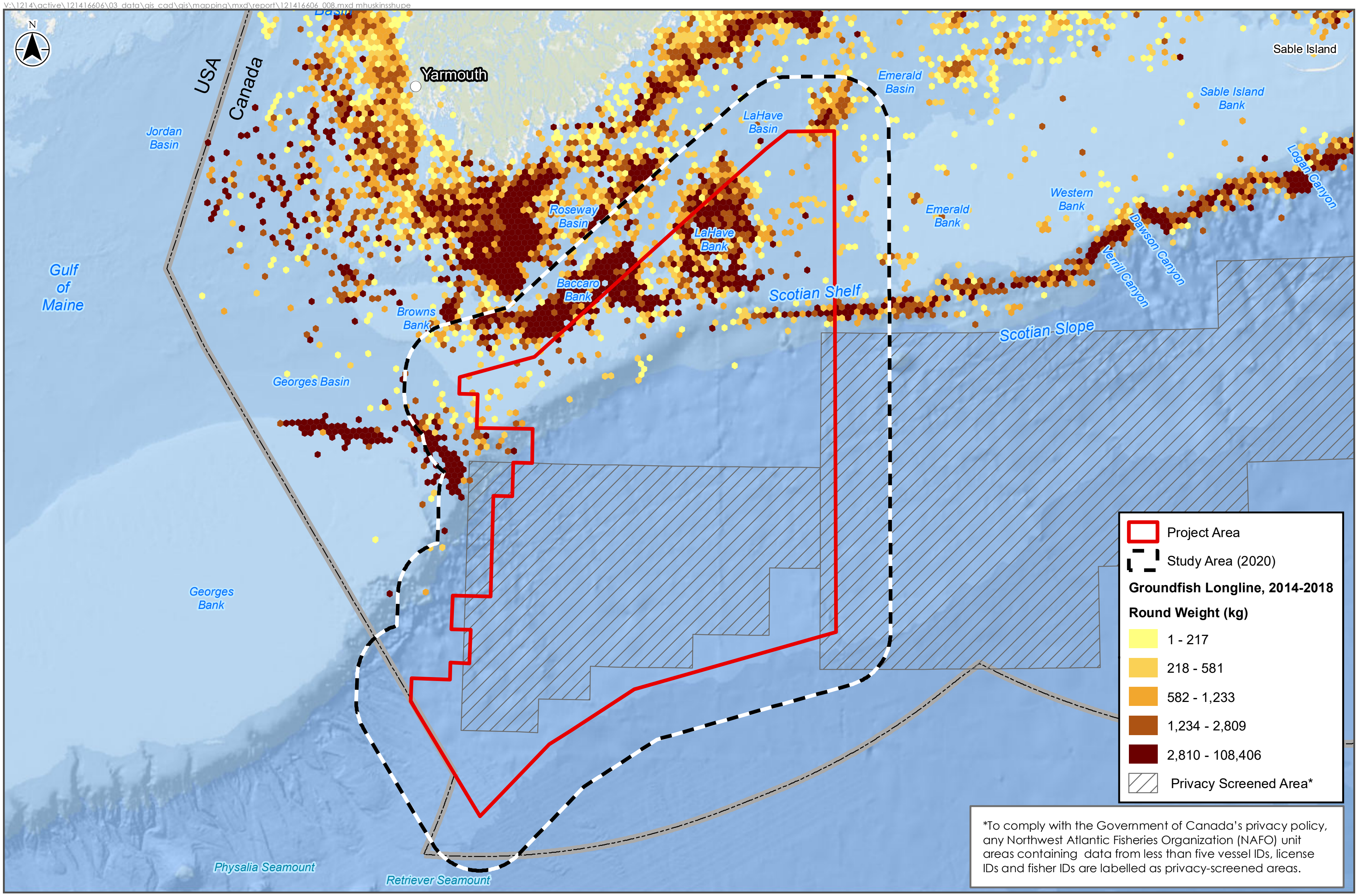
STRATEGIC ENVIRONMENTAL ASSESSMENT

121416606_008

Figure C.21



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

NAD 1983 UTM Zone 20N

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

Groundfish - Longline Landings
Composite Landings (kg) per 10 km² hexagon

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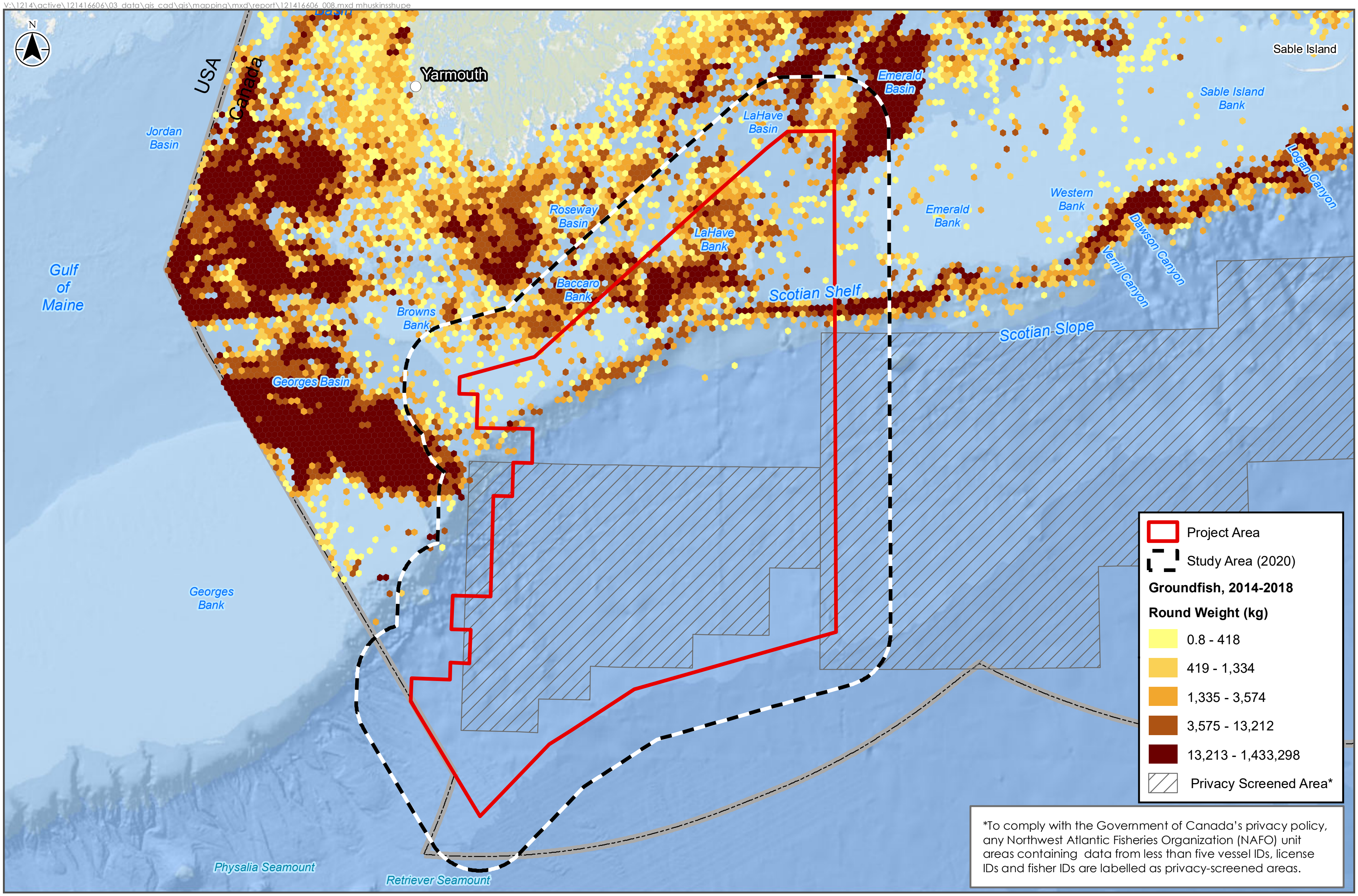
121416606_008

Figure C.22

V:\1214\active\121416606\03_data\gis_cad\gis\mapping\mxd\report\121416606_008.mxd mhuskinsshupe



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

NAD 1983 UTM Zone 20N

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

Groundfish Landings
Composite Landings (kg) per 10 km² hexagon

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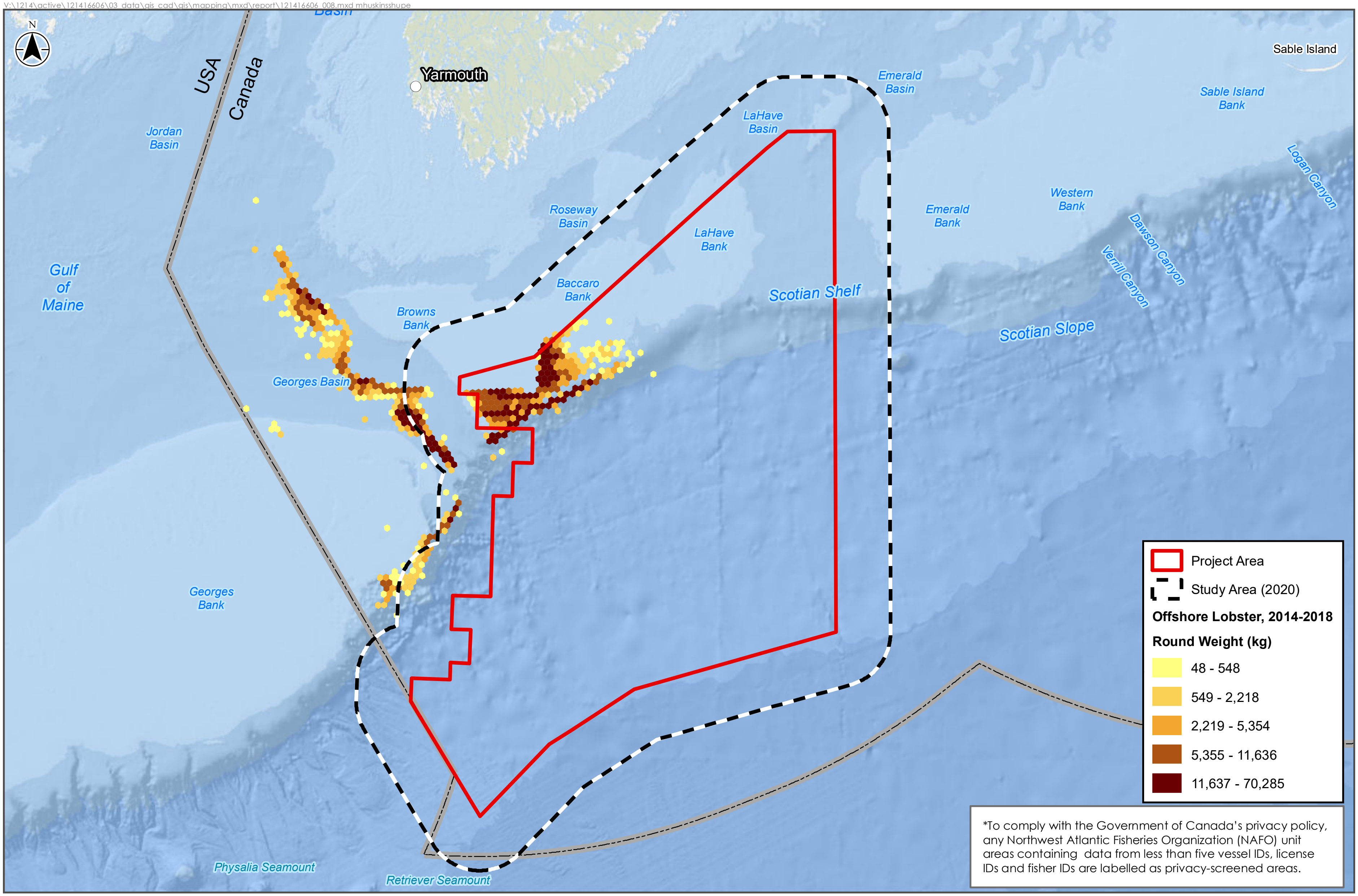
121416606_008

Figure C.23



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

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Offshore Lobster Landings
Composite Landings (kg) per 10 km² hexagon

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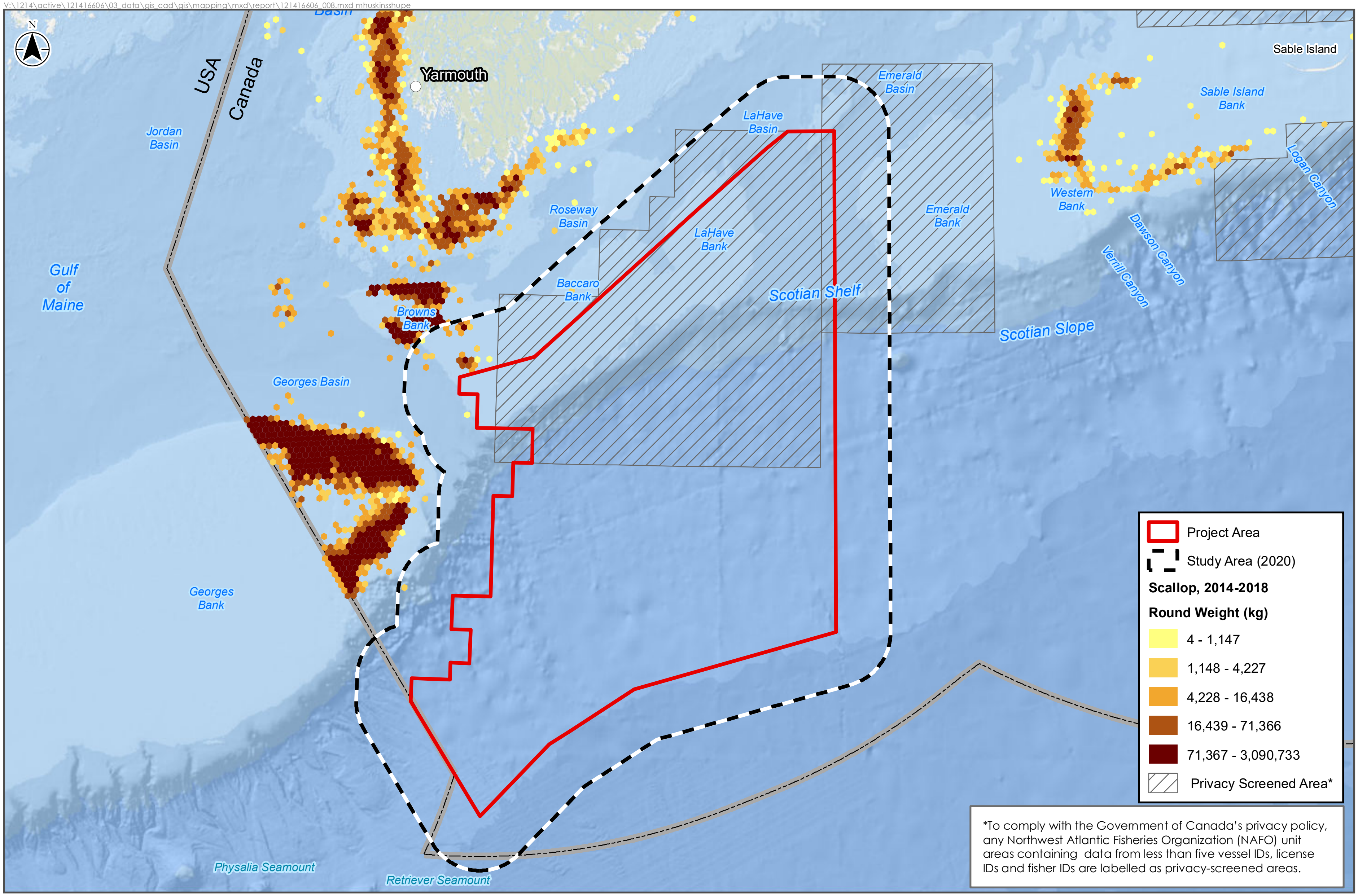
121416606_008

Figure C.24



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

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

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Scallop Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.25

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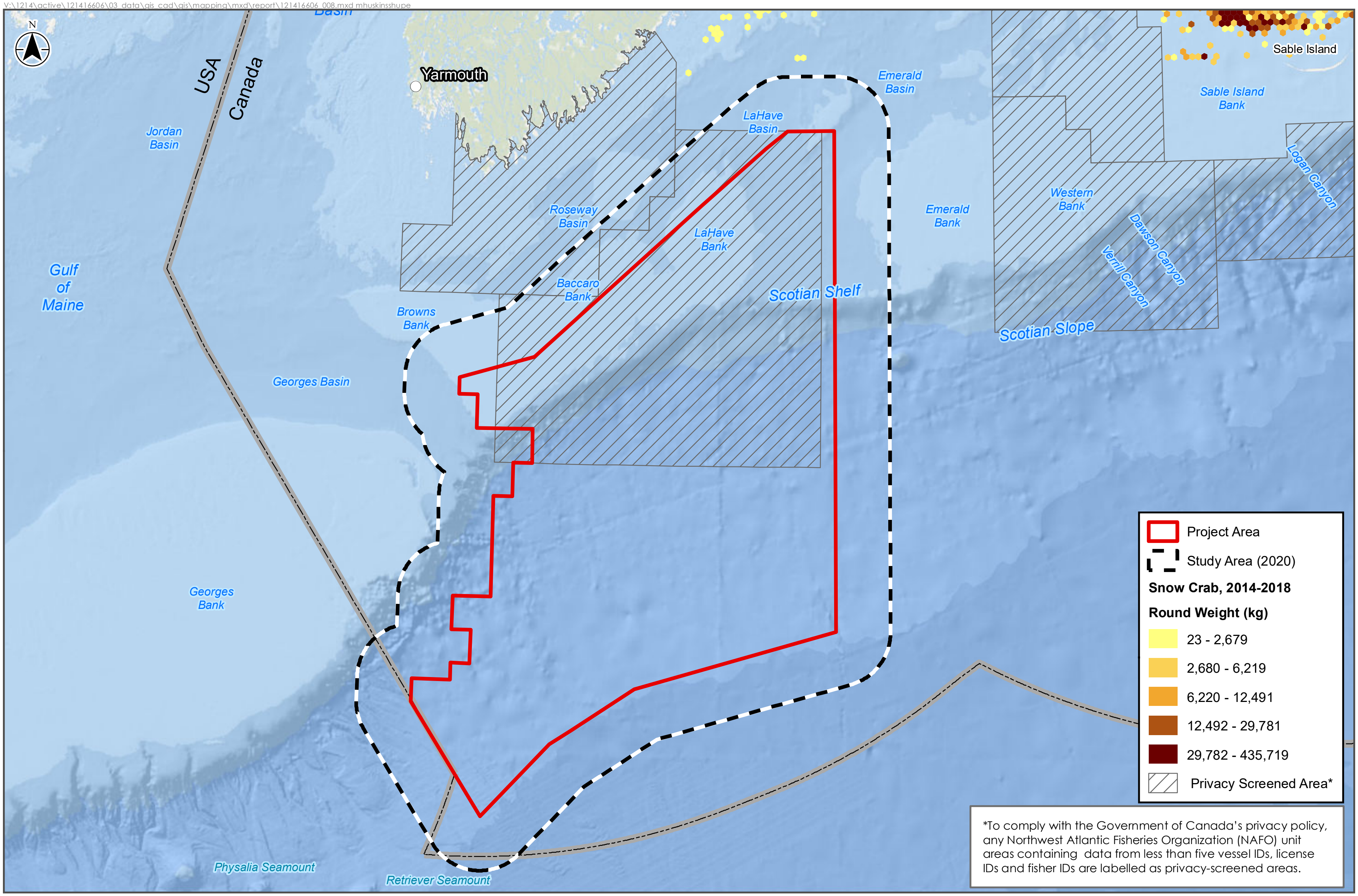

Sources: Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Snow Crab Landings
Composite Landings (kg) per 10 km² hexagon

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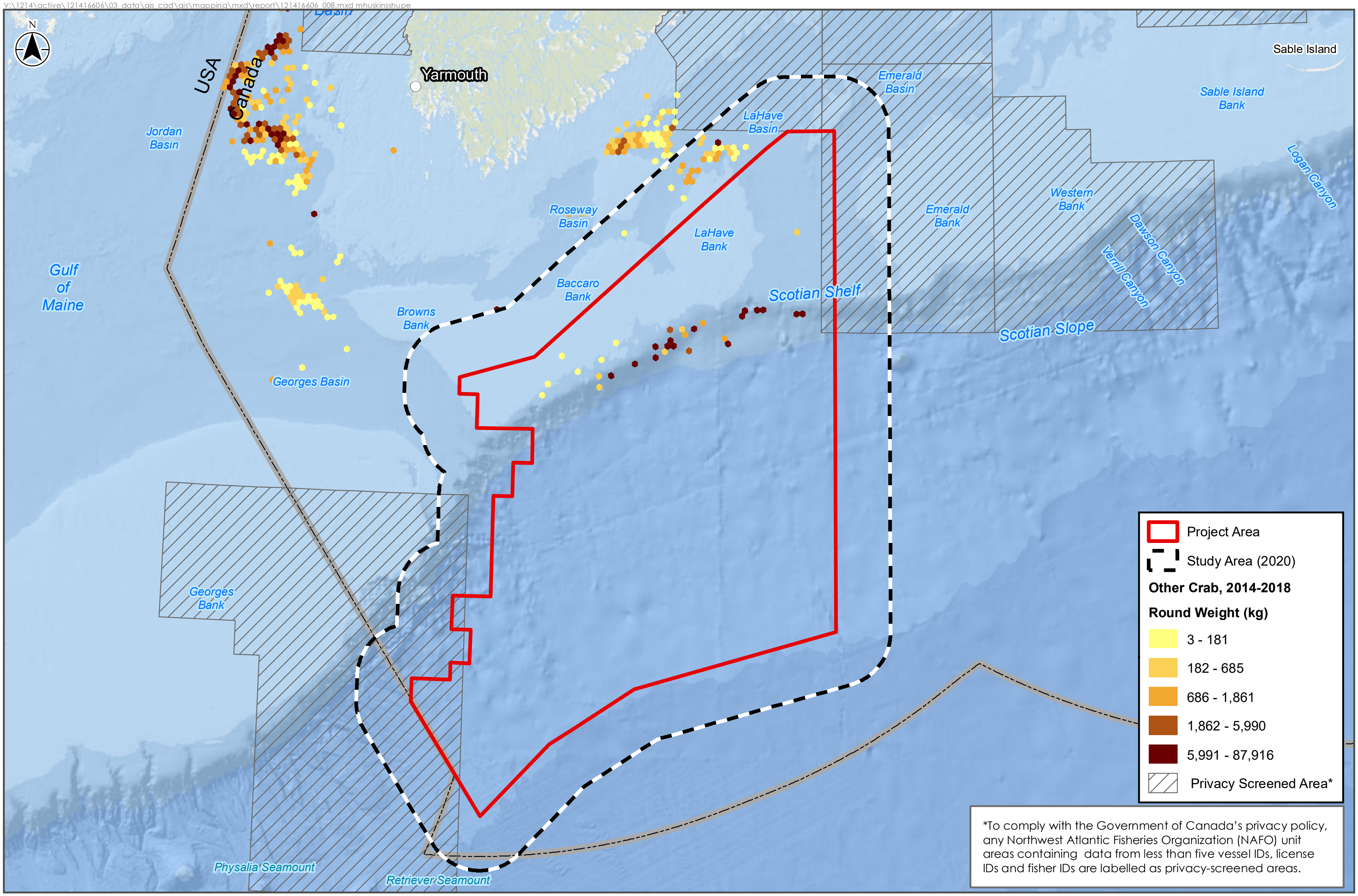
Figure C.26



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

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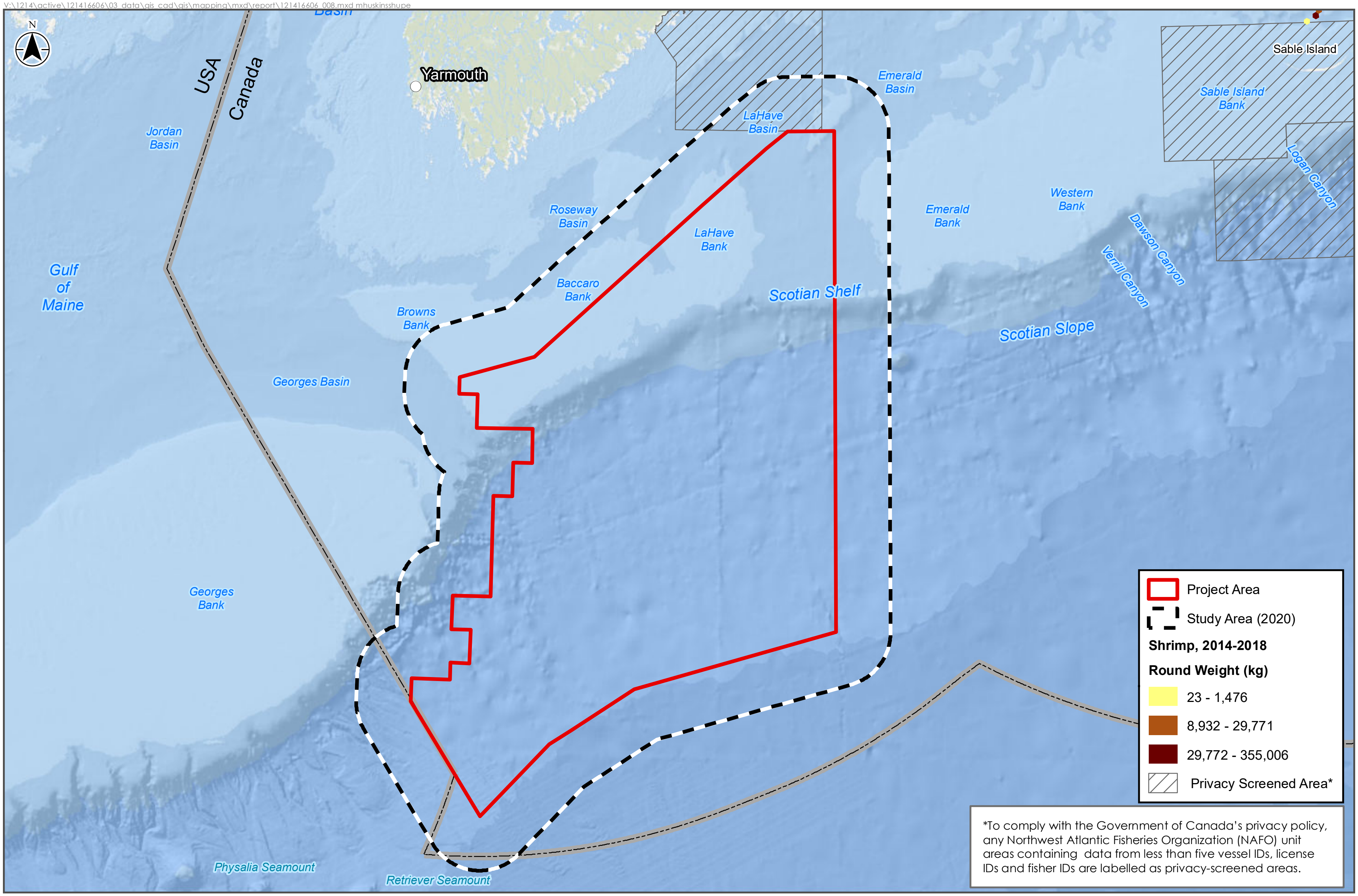
Other Crab Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.27



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

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Shrimp Landings
Composite Landings (kg) per 10 km² hexagon

Figure C.28