STRATEGIC ENVIRONMENTAL ASSESSMENT
SYDNEY BASIN AND ORPHEUS GRABEN
OFFSHORE CAPE BRETON
NOVA SCOTIA

Submitted to:

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EXECUTIVE SUMMARY

This document describes the nature, purpose and results of a Strategic Environmental Assessment (SEA) that has been completed by the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB, or the Board) in relation to potential offshore petroleum exploration licencing decisions and activities in the Sydney Basin and Orpheus Graben Areas off eastern Nova Scotia.

SEAs are undertaken early in the planning and decision-making process of resource exploration and development activities and focus on providing a general description of the existing environmental setting, and on identifying and addressing overall environmental issues and key potential interactions. The SEA provides an evaluation of potential environmental issues in relatively broad terms to allow consideration early and proactively in planning, well before project-specific activities are defined and proposed. SEA's provide a structured review process through which the environmental and socioeconomic risks and benefits of proposed resource development activities can be evaluated.

SEA Study Area

The Study Area covers a large expanse of the north and northeastern Scotian Shelf, extending approximately 350 km north to south and 250 km west to east. The Study Area is bounded by the Laurentian channel to the north and Cape Breton Island to the south and west. The area consists of the Orpheus Graben to the east and the Sydney Basin to the north of Cape Breton.

Spatial and temporal boundaries

The spatial boundaries of the SEA and associated analysis reflect the nature and scale of any offshore oil and gas (particularly exploration) activities that may occur in relation to future Exploration Licences issued in the region, as well as the environmental zones of influence and potential associated disturbances. Therefore, although the SEA has a primary focus on the Sydney Basin and Orpheus Graben Areas themselves (approximately 37,280 km^2), the analysis has not been confined to the SEA Study Area. The assessment also considers the overall areas within which the valued environmental components (VECs) that could potentially be affected by oil and gas related activities (including accidental events) are located.

In terms of temporal boundaries, the SEA focuses on an overall time horizon of approximately 10 years, which would generally correspond to the temporal duration of any Exploration Licences issued in the area upon completion of the SEA. In conducting the assessment, particular consideration has been given to the overall timing and seasonality of the presence of marine biota and relevant marine activities within the Study Area, including any particularly important or sensitive time periods.

As has been the CNSOPB's practice in completing SEAs, it is intended that this assessment will be reviewed within a five year period to determine whether an update is required.

O&G Activities

Various types of oil and gas exploration activities may occur following the issuance of exploration licences and other authorizations and approvals by the CNSOPB. Typically, offshore exploration involves

6 key activities: (i) seismic surveys, (ii) seabed surveys, (iii) exploratory drilling and well abandonment (offshore), (iv) vertical seismic profiling, (v) vessel and helicopter traffic, and (vi) exploratory drilling and well abandonment.

VECs
Identification and analysis of potential environmental issues and interactions, mitigation measures and planning considerations related to possible future offshore oil and gas activities in the Study Area is focused on the four VECs that have been identified through the scoping process, namely:

1) Species of Special Status;
2) Special Areas;
3) Fisheries; and
4) Other Marine Components, Activities and Ocean Users

Species of Special Status
Species of special status were divided into 4 categories: (i) fish, (ii) marine birds, (iii) sea turtles and (iv) marine mammals.

Within the Study Area, a total of 25 species of marine or anadromous fish species are listed by federal (SARA/COSEWIC) or provincial (NSESA) governments as being of conservation concern. Of these, only four are considered to be *Species at Risk*, i.e. are legally protected species. The four marine fish species that have formal designation and protection under SARA include three species of wolffish (family Anarhichadidae) and the white shark.

Fifteen bird *Species at Risk* and *Species of Conservation Concern* occur in the province and in the waters offshore. Some of these species have the potential for negative interactions with projects within the Study Area for at least some part of the year; species that do not inhabit the offshore environment, or those that only migrate over the ocean in the daytime are considered unlikely to be affected by offshore oil and gas exploration or development activities and so were not assessed.

A single listed sea turtle *Species at Risk* (Leatherback-Atlantic population) is known to occur in the Study Area. One additional species that may occur in the Study Area, the loggerhead sea turtle (Atlantic Ocean population), is listed by COSEWIC but not under SARA.

A total of five federally listed marine mammal *Species at Risk* (blue whale-Atlantic population, North Atlantic right whale, northern bottlenose whale-Scotian Shelf population, fin whale-Atlantic population and harbour porpoise-Northwest Atlantic population) are known to occur in the Study Area. Additional species that may occur in the Study Area include the killer whale (Northwest Atlantic and Eastern Arctic populations) and Sowerby's Beaked whale (Atlantic Ocean), both species are listed by COSEWIC but not under SARA.

Special Areas
A number of marine and coastal areas within and adjacent to the Study Area have been designated as special areas, some of which are formally protected or designated under provincial, federal and/or other legislation and processes due to their ecological, historical and/or socio-cultural characteristics and importance. Others have been identified as being sensitive or otherwise special for biophysical and/or

socio-cultural reasons, but do not have formal protection. These areas have been grouped into 5 types: (i) Coastal Ecologically and Biologically Significant Areas (EBSAs), (ii) Offshore Ecologically and Biologically Significant Areas (EBSA), (iii) Marine Protected Area - Areas of Interest, (iv) Provincial Parks and Protected Areas, and (v) International Bird Areas (IBA).

Fisheries

Fisheries are an important and integral component of the socioeconomic environment in the Study Area, providing the foundation for local culture and a significant source of income and livelihood in the various communities that extend along the coast of the Study Area.

Commercial harvesting of a number of invertebrate, benthic, and pelagic resources is conducted throughout the year within the Study Area. Important species include snow crab, lobster, shrimp, halibut, turbot, cod, haddock, Pollock, hake, plaice, redfish, tuna, mackerel and herring. A variety of technologies are used to harvest commercial species; some use fixed gear (traps and longline) while others employ mobile gear (trawler and seiners). Much of the local catch is processed in the more than 15 fish plants operating within the coastal communities in the Study Area. Shellfish (mussels and oysters) and salmon aquaculture is an emerging component of the local fishery providing alternative employment and income in some communities in the Study Area.

There are also important recreational fisheries, Aboriginal communal commercial fisheries, and Food, Social and Ceremonial fisheries that take place in the Study Area.

Other Ocean Users

A number of other human activities and components also occur within or near the marine environment, and therefore have the potential to interact with, and be affected by, any future offshore oil and gas activities in the Study Area. These include general vessel traffic to, from and through the area, as well as whale and sea bird tours, research vessels, military activities and other commercial and recreational marine pursuits.

Mitigation

Based on the overview of the existing environmental setting of Sydney Basin and Orpheus Graben Areas and the potential environmental interactions and issues, mitigation measures have been identified, through key environmental considerations, to help guide future planning and decision-making.
A summary of typical mitigation measures implemented during offshore oil and gas exploration activities in the Nova Scotia offshore area to avoid or reduce potential environmental effects are listed below.

VEC	Mitigation Measures
Species of Special Status	Avoidance of known species at risk and/or sensitive species and areas and/or times where possible in the planning and conduct of oil and gas activities
	Reduction of airgun source levels in the design and implementation of offshore seismic programs to the minimum level practical for the survey, including the amount and frequency of energy used and its likely horizontal propagation
	The use of a gradual "ramp-up" procedure over a minimum 20 minute period to allow mobile marine animals to move away from the area if they are disturbed by the underwater sound levels associated with a seismic survey

	Establishment of a safety zone around the seismic air source array (with a radius of at least 500 m), which is monitored by a qualified Marine Mammal Observer (or through Passive Acoustic Monitoring in low visibility conditions) and specific protocols regarding observation requirements and times and shut-down as required
	Shut-down of seismic sound source(s) during line changes and maintenance activities with associated monitoring and ramp-up provisions
	Minimizing the amount of associated vessel and aircraft traffic, and the use of existing and common travel routes where possible and the avoidance of low-level aircraft operations wherever possible
	Minimizing environmental discharges and emissions from planned operations and activities, including compliance with relevant regulations and standards
	Possible pre-drilling surveys of the sea bed to assess the potential presence of sensitive benthic micro-habitats (such as corals)
	The installation and use of oil water separators to treat contained deck drainage, with collected oil stored and disposed of properly
	Selection of non-toxic drilling fluids, including the use of WBMs wherever possible and technically feasible
	Treatment of operational discharges (such as sewage, deck drainage, bilge/cooling water, wash fluids other waste) prior to release in compliance with the *Offshore Waste Treatment Guidelines* and other applicable regulations and standards
	Minimizing the use of artificial lighting on offshore vessels and installation, where possible with due regard to safety and associated operational requirements
	Programs and protocols for the collection and release of marine birds that become stranded on offshore installations, including associated regulatory guidance and permit requirements
	Inspections of ship hulls, drilling rigs and equipment for invasive species and associated follow-up maintenance Maximizing use of local vessels, drill rigs and equipment to reduce the spread of invasive species
	All foreign vessels operating in Canadian jurisdiction to comply with the *Ballast Water Control and Management Regulations* of the *Canada Shipping Act* (2001) during ballasting and de-ballasting activities.
	Avoiding or minimizing flaring, and the use of high efficiency burners
	Appropriate handling, storage, transportation and on-shore disposal of solid and hazardous wastes
	Water contaminated with hydrocarbons generated during flow testing (within certain tolerances), can be atomized in the flare (using high efficiency burners) or shipped on-shore for disposal
	Selection and screening of chemicals under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands*
	Use of turtle guards to minimize potential for turtle entanglement
	The use of mechanical procedures during well completion and abandonment activities where possible, including the proactive design of well structures to facilitate this
	Should blasting be required (such as in well abandonment), appropriate scheduling of these activities to avoid sensitive times, as well as setting of charges below the sediment surface, minimizing the amount of explosives utilized, the use of high velocity explosives and staggering of individual blasts.

	Spill prevention plans and procedures, with associated and effective spill preparedness and response plans in place
Special Areas	Environmental assessment to identify protected areas and local sensitivities and schedule operations during least sensitive periods
	Select the least sensitive location within the confines of the bottom target / drilling envelope
	Consider directional drilling to access targets beneath sensitive areas
	Consider cluster drilling to limit the extents of drilling sites
	In coastal areas, select equipment (e.g. vessel instead of helicopter) based on particular sensitivities of wildlife populations or habitats
Fisheries	Planning of oil and gas activities to avoid key fishing areas / harvesting times where possible
	On-going information gathering and analysis regarding fishing areas and times and continued monitoring of fishing activity
	Establishment and communication of safety zones
	Sequential approach to drilling multiple wells in an area
	Open, active and continuous communications and coordination procedures
	Hiring Fisheries Liaison Officers (FLOs) and using Single Points of Contact
	Early issuance of Notices to Mariners and other notifications / direct industry communications
	Avoidance of fisheries science survey activities (areas / times)
Other Marine Components and Ocean Users	Consult local authorities and other stakeholders regarding the survey program, permitting and notifications to user groups
	Make adequate allowance for deviation of towed equipment when turning and remain on planned survey track to avoid inadvertent interactions
	Make all towed equipment highly visible and labelled, attach active location devices to auxiliary equipment to aid location and recovery and prepare a contingency plan for lost equipment
	All equipment should be stored and handled according to operator's procedures and local regulations
	Report all unplanned interactions with other resource users to appropriate authorities
	In coastal areas, select sites and equipment to minimize disturbance, noise, light and visual intrusion
	Maintain communications with local authorities regarding notifications to other resource users and to meet the requirements established in the project planning process including operations of supply vessels
	When decommissioning an exploratory well, depending on the depth of the well location, it may be recommended that operators remove all debris from the seabed, and decommission support facilities to meet planning requirements

Planning

In Nova Scotia, the environmental planning process, which includes environmental assessment, project specific environmental management plans, regulatory permitting and compliance programs can be used to develop detailed guidance on measures to prevent or minimize adverse effects and enhance possible beneficial effects. Consultation, inspections and audits, and communications programs establish compliance and monitoring regimes to ensure regulatory requirements are met. Through planning, consultation, issues management, negotiation and accommodation, most adverse aspects of oil and gas exploration activities can be avoided, mitigated or influenced for the good of the environment and other resource users as well as oil and gas exploration projects.

In conclusion, there is opportunity to introduce new resource activity into the regional environment and economy of Nova Scotia. However, as is the case in all regions, full consideration must be given to minimizing the potential effects and optimizing the benefits of oil and gas exploration activities to Nova Scotia. As a result, attention must be given to an array of mitigation activities and measures, many of which are well established and proven effective offshore Nova Scotia and in other jurisdictions. In light of the longstanding involvement of local industries in the marine environment and the recognized ecological significance of some of the marine and coastal environments in the Study Area, consideration should be given to enhanced mitigation measures. These could include buffer zones around designated Special Areas and important fishing areas, and the introduction of seasonality into exploration activities to minimize spatial conflicts. It is understood that local engagement will be required to facilitate mitigation, and to ensure mutual benefits of any new project are accrued.

1 INTRODUCTION

This document describes the nature, purpose and results of a Strategic Environmental Assessment (SEA) that has been completed by the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB, or the Board) in relation to potential offshore petroleum exploration licencing decisions and activities in the Sydney Basin and Orpheus Graben Areas off eastern Nova Scotia.

The CNSOPB is an independent joint agency of the Governments of Canada and Nova Scotia that is responsible for the regulation of petroleum activities in the Nova Scotia Offshore Area. The Board was established in 1990 pursuant to the *Canada-Nova Scotia Offshore Petroleum Accord Implementation Acts* (*Accord Acts*), and has a mandate to apply the provisions of this legislation in regulating offshore oil and gas activities in the region, including with respect to:

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

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

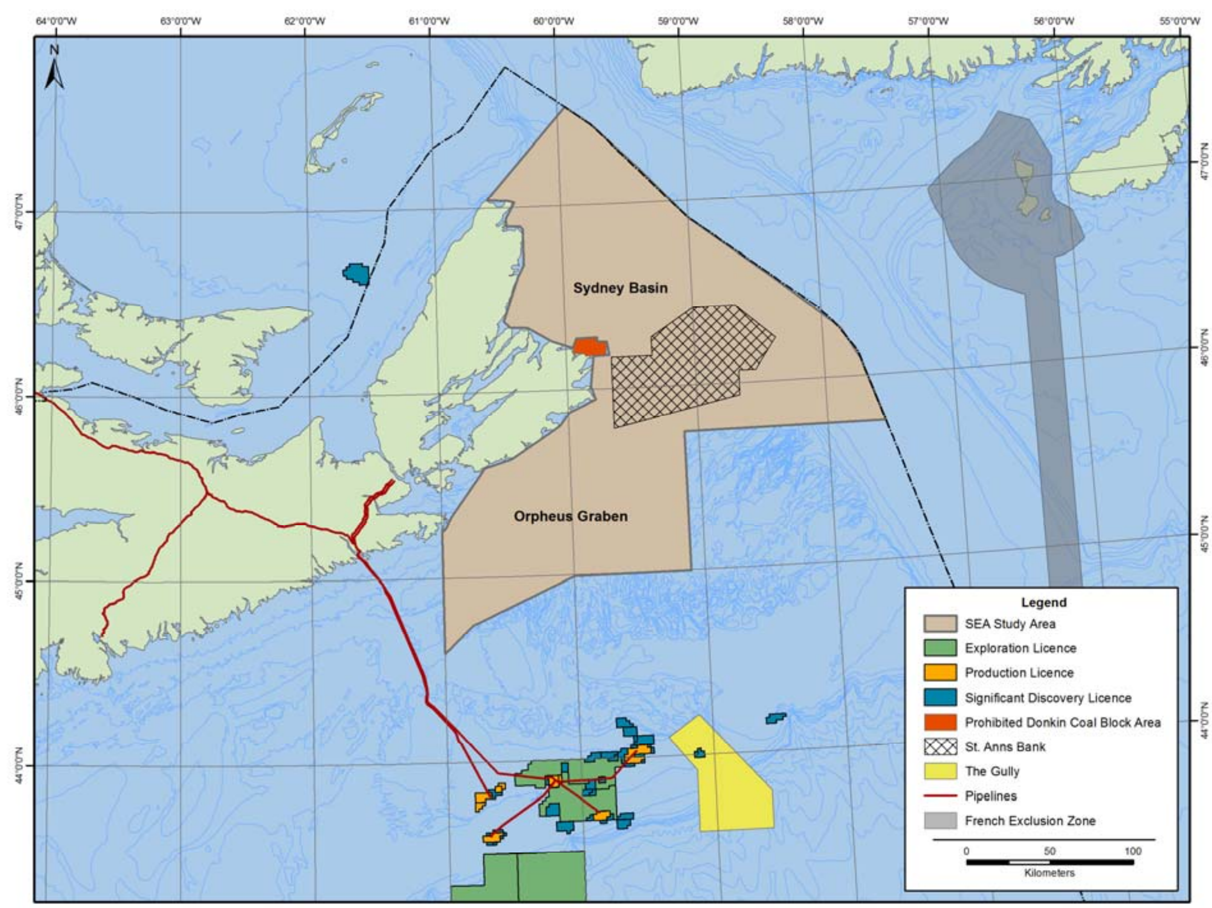
The CNSOPB's regulatory responsibilities under the *Accord Acts* include the issuance and administration of petroleum exploration and development rights in the Nova Scotia Offshore Area through a structured and transparent rights issuance process. As part of that process, an Exploration Licence may be issued for Crown Lands through an established Call for Bids, which provides the license holder(s) with defined rights regarding the exploration for, and possible future production of, petroleum resources in that area. Activities associated with such Exploration Licences may include the conduct of seismic or other geophysical surveys, geotechnical surveys, and the drilling and eventual abandonment of wells (either exploration or delineation).

As part of these regulatory processes, the Board has a responsibility, pursuant to the *Accord Acts*, to ensure that offshore petroleum exploration and development activities proceed in an environmentally responsible manner. In doing so, the CNSOPB conducts SEAs in portions of the Nova Scotia Offshore Area that may have the potential for offshore oil and gas exploration but have not been the subject of a recent SEA. The Board has conducted a number of SEAs for various portions of the Nova Scotia Offshore Area since 2003, which provide information on the regional environmental setting and associated environmental considerations, and which then help to inform subsequent regulatory decisions regarding future offshore oil and gas activities in the area in question. In particular, the information and findings of these SEAs help inform the Board's associated planning and decision-making processes regarding the potential issuance of future Exploration Licenses within that particular portion of the Nova Scotia Offshore Area.

This SEA for the Sydney Basin and Orpheus Graben Areas covers an approximately 37,280 km^2 area (Figure 1-1, also referred to interchangeably herein as the SEA Study Area) which is located off the eastern and southern parts of Cape Breton, Nova Scotia.

This Study Area has been established based on consideration of the geographic boundaries of the CNSOPB's jurisdiction (as defined by the northeastern edge of the Nova Scotia Offshore Area), as well as the limits of the study areas for previous SEAs undertaken by the CNSOPB and others for various parts of the Eastern Scotian Shelf and Slope (NS Offshore Area) and the Laurentian Subbasin (NL Offshore Area). The SEA Study Area includes lands that could be included in any potential future Call for Bids or resulting Exploration Licences in this area.

Figure 1-1 Sydney Basin and Orpheus Graben Areas - SEA Study Area



1.1 Nature, Purpose and Context of the SEA

SEA is a broad-based and regional approach to environmental assessment (EA) that proactively identifies and considers the potential environmental issues that may be associated with a plan, program or policy proposal. Because SEAs are undertaken early in the planning and decision-making process, they focus on providing a general description of the existing environmental setting, and on identifying and addressing overall environmental issues and key potential interactions. Thus providing an evaluation of potential environmental issues in relatively broad terms to allow consideration early and proactively in planning, well before project-specific activities are defined and proposed.

The preparation of the SEA for the Sydney Basin and Orpheus Graben Areas includes the identification, review and presentation of relevant information on the existing environmental setting of the Study Area, as well as an analysis of any key environmental issues that may be associated with future oil and gas exploration activities in the region, should licences be issued. It also identifies any relevant knowledge and data gaps and makes recommendations for future mitigation and planning. An important and integral component of the planning and conduct of the SEA has also been an associated program of public and stakeholder consultation.

Information from the SEA will assist the CNSOPB in determining whether further exploration rights should be offered in whole or in part for the Sydney Basin and Orpheus Graben Areas, as well as identifying any general restrictive or other mitigative measures that may be considered for application to any future projects and activities in order to avoid or reduce any adverse environmental effects.

It should be noted that SEA is not intended as a replacement for project-specific EA review processes and associated project planning and regulatory decisions. The objective of SEA is, rather, to provide the type and level of information necessary to aid and inform decision-making at the very earliest stages of the planning process, before project-specific activities are defined and proposed. Any future offshore oil and gas activities that may be proposed in the SEA Study Area pursuant to new exploration licences (if issued) may require review and approval under, and/or compliance with, a range of other applicable environmental legislation and regulations. These may include the federal *Fisheries Act*, *Species at Risk Act*, *Canadian Environmental Protection Act*, *Oceans Act* and others, as well as being subject to individual, project-specific EA reviews in accordance with the *Canadian Environmental Assessment Act* (2012) or the *Accord Acts*. The SEA will, however, provide relevant information on the region's existing environmental setting, as well as define key environmental issues, interactions and mitigation measures which may require consideration in the early planning phases of individual projects and/or in their subsequent regulatory approval processes.

1.2 Document Organization

This SEA Report is organized as follows:

Chapter 1 provides an introduction to the SEA, outlines the purpose and context of the assessment, and describes the overall organization of the document.

Chapter 2 provides an overview of the CNSOPB and the various planning and regulatory processes that apply to offshore oil and gas projects and activities in the NS Offshore Area. This is followed by a generic description of offshore oil and gas exploration and development (equipment and activities) and a discussion of any previous activities that have occurred within the Sydney Basin and Orpheus Graben Areas. The Chapter concludes with an overview of some of the main environmental effects and interactions which may be associated with these activities and various approaches and measures for their management.

Chapter 3 provides a description of the existing environmental setting of the SEA Study Area, including relevant components of its physical, biological and socioeconomic environments. This regional scale overview has been based upon existing and available environmental baseline information and datasets from a variety of sources.

Chapter 4 defines and describes the scope of the SEA and its associated environmental effects analysis. This includes a summary and reiteration of its spatial and temporal boundaries, the particular "strategic decision" that the SEA is intended to inform and influence, and the various public and stakeholder consultation initiatives that have been undertaken as part of the SEA and their key findings. It then identifies the Valued Environmental Components (VECs) upon which the SEA is focused and the rationale for their selection, as well as giving an overview of the approach and methods used to conduct the SEA.

Chapter 5 provides the environmental issues, mitigation and planning analysis for each of the VECs under consideration. Each VEC is addressed in a separate section, which includes a discussion of:

- Potential environmental interactions and effects;
- Standard mitigation measures which are often applied to offshore oil and gas activities to avoid or reduce these environmental effects; and
- Key environmental planning considerations and any additional activity, site or time-specific mitigation measures which may be required or appropriate for future exploration activities in the Study Area.

Chapter 6 provides a discussion of the manner and degree to which environmental features and processes may influence the planning and conduct of offshore oil and gas activities in the Study Area, with particular reference to relevant aspects of the physical environment.

Chapter 7 provides an analysis of potential cumulative environmental effects that may result from future offshore oil and gas activities in the region in combination with each other and with other past, present and reasonably foreseeable projects and activities, and associated planning considerations and implications.

Chapter 8 evaluates the availability and adequacy of existing environmental information for the SEA Study Area, and any relevant data gaps, requirements and opportunities to address them.

Chapter 9 presents a summary of the key findings and conclusions of the SEA.

Chapter 10 provides the references used in the SEA, including the literature cited and any personal communications.

Supporting information is provided as Appendices.

2 POTENTIAL OFFSHORE OIL AND GAS EXPLORATION ACTIVITIES

The following sections provide an overview of the CNSOPB and the various planning and regulatory processes that apply to offshore oil and gas activities in the Nova Scotia Offshore Area (summarized from CNSOPB 2015).

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

2.1 Canada - Nova Scotia Offshore Petroleum Board

The CNSOPB was established in 1990 and is responsible, on behalf of the Governments of Canada and Nova Scotia, for the regulation of petroleum activities in the Nova Scotia Offshore Area (see Chapter 1), reporting to both the federal Minister of Natural Resources Canada and the provincial Minister of Energy. The *Canada-Nova Scotia Offshore Petroleum Accord Implementation Acts* (*Accord Acts*), administered by the CNSOPB, implement the 1986 Canada-Nova Scotia Offshore Petroleum Resources Accord and govern all petroleum operations in the NS Offshore Area.

The CNSOPB’s overall mandate is summarized below:

> To apply the provisions of federal-provincial *Accord Act* legislation governing offshore oil and gas activities, including:
>
> - Health and safety of workers;
> - Protection of the environment;
> - Management and conservation of petroleum resources;
> - Canada-Nova Scotia employment and industrial benefits;
> - Issuance of licenses for exploration and development; and;
> - Resource evaluation, data collection, curation and distribution.

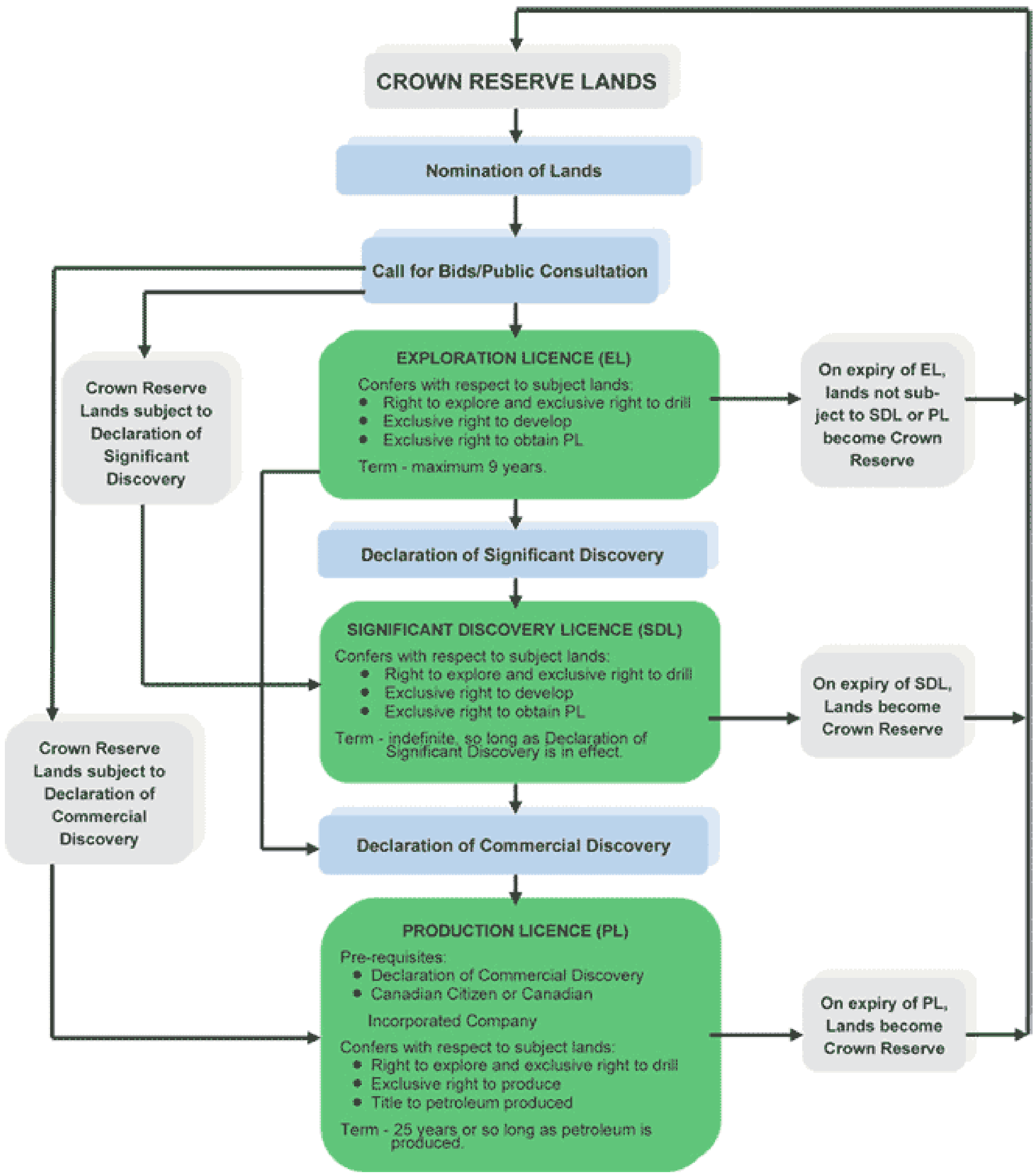
The Board's management and regulatory activities include issuing and administering offshore licenses and petroleum rights through an established and well defined process that is open and transparent, an overview of which is provided in the following sections.

2.1.1 Crown Reserve Lands / Nomination of Lands

A Call for Nominations is a preliminary step that provides interested parties with the opportunity to identify and suggest lands of interest for potential inclusion in a subsequent Call for Bids. Crown lands can be nominated by any person or company, or may be identified and put forward by the Board itself.

Nominations can be made at any time, and the Board issues an official Call for Nominations in April of each year which have a closing date of December 1st. In its review and evaluation of any nominations made, the CNSOPB places considerable emphasis on identifying and considering any known environmentally sensitive areas and fisheries concerns, as well as a number of other factors including water depth, proximity to infrastructure, prospectivity of the lands, data availability and others. The Board also consults with relevant federal and provincial government agencies as part of that process.

Figure 2-1 General Overview of CNSOPB Land Management Process



http://www.cnsopb.ns.ca/lands-management/licensing

2.1.2 Calls for Bids

A Call for Bids is a formal announcement by the Board that a license is available to be awarded for a particular offshore area through a competitive bidding process, as nominated by industry or identified by the Board itself. A Call for Bids specifies the type of interest (licence) to be issued and the associated terms and conditions of same, as well as the form and manner in which the bid is to be submitted, the closing date and the criteria to be used in evaluating bids. Call for Bids are typically issued in mid-April and remain open for a minimum of 120 days, closing in early November. Any individual or company may bid on a parcel of land and any person or group can provide written comments on the specific parcels included in the bid for consideration by the Board before any such license is issued. Bids for Exploration Licenses are evaluated on the basis of total work expenditures or, in other words, the amount of money proposed for exploration on the land parcel during period one of the license (see below). Work expenditure bids are refundable based on the amount of money that a company spends on exploration.

The issuance of a Call for Bids and the eventual issuance of an Exploration License are "fundamental decisions" within the legislation, and as such are subject to review and approval by the federal Minister of Natural Resources and the provincial Minister of Energy.

2.1.3 Exploration License

Based on the outcomes of a Call for Bids and their subsequent review by the CNSOPB and Ministerial approvals, an Exploration License may be granted to the successful bidder. Exploration Licenses are typically issued on January 15 each year, and provide the license owner(s) with the right to explore, and the exclusive right to drill and test for petroleum and to potentially obtain a Production License. Exploration Licenses have a maximum nine year term, and the interest owner is required to drill or spud and diligently pursue one exploratory well on or before the expiry date of Period I (five years) as a condition of obtaining tenure to Period II. Failure to do so results in reversion to Crown Reserve of the license, and forfeiture of the security deposit or any balance thereof. If the license requirement is fulfilled, the interest owner is entitled to obtain tenure to Period II.

It is important to note that the issuance of an Exploration License for a particular portion of the NS Offshore Area does not, in and of itself, authorize the license holder to carry out physical exploration activities (fieldwork) within that license block. The drilling of an exploration well, for example, requires various project-specific regulatory approvals and authorizations, through which the operator must present detailed information on its planned exploration activities, and in doing so, demonstrate that they can undertake such work in a manner that is in keeping with applicable requirements and standards for safety and environmental protection.

Further information on the CNSOPB's lands management and licensing processes, as well as any active calls for nominations and bids and existing licenses in the NS Offshore Area can be found on the Board's website at *http://www.cnsopb.ns.ca/lands-management.*

2.1.4 Authorizations and Approvals

The CNSOPB's regulatory role also includes the issuing of specific authorizations and approvals pertaining to offshore oil and gas exploration (geophysical and drilling programs) and development projects and activities in the NS Offshore Area. Operators are required to meet certain requirements before the Board can approve offshore petroleum related activities, the regulatory framework for which is comprised of the relevant provisions of the *Accord Acts* and its Regulations as well as applicable Board guidelines and policies.

Prior to issuing any such authorizations, the Board requires that adequate and appropriate supporting information be provided on the operator’s plans and capabilities, which depending on the specific nature of the proposal, may include one or more of the following:

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

2.1.5 Environmental Assessment

Environmental Assessment is a regulatory review process that is often applied to proposed development projects. Its purpose is to identify and evaluate the potential environmental effects of proposed projects, in order to help ensure that these issues can be considered and incorporated into project planning and decision making. EA involves predicting a project's potential effects and identifying and proposing measures to avoid or reduce adverse outcomes and to enhance any benefits, and often includes considerable public and stakeholder consultation at various stages of the process.

Proposed projects and activities in Nova Scotia may be subject to provincial and/or federal EA legislation and processes.

The *Canadian Environmental Assessment Act* (*CEAA*) is the legislative basis for federal EA in Canada. The federal EA process and its associated legislation has been in place for several decades, and traditionally applied to projects that involve the federal government - as proponent or as a source of funding, land and/or certain permits. On July 6, 2012 a new CEAA (2012) came into force, which revised and updated the nature and focus of the federal EA process in Canada, including the projects that it applies to and its various procedural elements. The current federal EA legislation and its procedures focus on potential adverse environmental effects that are within federal jurisdiction, including effects on: fish and fish habitat; other aquatic species; migratory birds; federal lands; effects that cross provincial or international boundaries; those that affect Aboriginal peoples, such as their use of lands and resources for traditional purposes; and changes to the environment that are directly linked to or necessarily incidental to any federal decisions about a project.

The current *CEAA* also has an associated set of *Regulations Designating Physical Activities*, which identify the particular projects that may require a federal EA. These specify a variety of types and scales of oil and gas related projects and activities that are subject to federal EA requirements, including:

> The drilling, testing and abandonment of offshore exploratory wells in the first drilling program in an area set out in one or more exploration licenses issued in accordance with the *Canada–Newfoundland and Labrador Atlantic Accord Implementation Act* or the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*.

The Minister of the Environment may also designate a project that is not currently listed in the Regulations if there is the potential for environmental effects in areas of federal jurisdiction or public concerns about such effects. If the federal EA process does apply to a proposed project, it commences with the proponent's submission of a Project Description document to the Government of Canada for review. Upon receipt of an adequate Project Description from a proponent, the Canadian Environmental Assessment Agency has 45 days, including a 20-day public comment period, to determine whether to require a federal EA. During this "screening" step, government will examine whether the project may cause adverse environmental effects on areas of federal jurisdiction or as a result of an associated federal decision. If further EA review is deemed to be required, this may take one of two forms: 1) Standard EAs, or 2) Review Panels (with legislated timelines being defined for each). Designated projects that are regulated by the Canadian Nuclear Safety Commission or the National Energy Board automatically require an EA by those regulators. There is a legislated 365 day timeline for a Standard EA, and assessments by Review Panels must be completed within 24 months (with these timelines applying to government activities and not to the periods required by the proponent to prepare the EA itself). The federal EA process eventually culminates in a decision as to whether or not the project can proceed, and if so, under what conditions.

In addition to the described federal EA process and requirements, the CNSOPB, as part of its responsibility for environmental protection, requires that EAs be conducted under the *Accord Act* for any exploration projects and any other offshore petroleum projects for which an EA is not required pursuant to *CEAA* (2012).

At the time of writing, two CEAA (2012) EAs were in progress related to proposed oil and gas exploration drilling programs in the NS Offshore Area: (i) Shell Canada Ltd. and (ii) BP Exploration (Canada) Ltd. (CNSOPB 2015).

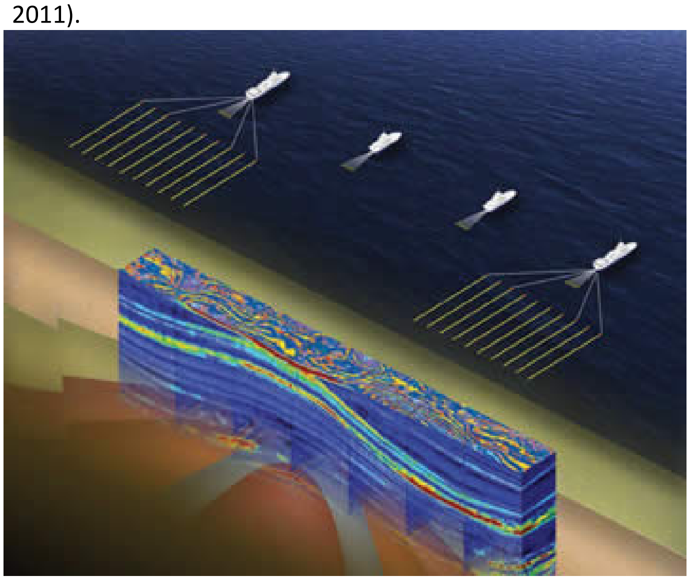
2.2 Generic Description of Offshore Oil and Gas Exploration Activities

Various types of oil and gas exploration activities may occur following the issuance of exploration licences and other authorizations and approvals by the CNSOPB. Typically, offshore exploration involves 6 key activities: (i) seismic surveys, (ii) seabed surveys, (iii) exploratory drilling and well abandonment (offshore), (iv) vertical seismic profiling, (v) vessel and helicopter traffic, and (vi) onshore-to-offshore exploratory drilling and well abandonment (onshore). Tables Table 2-1 to Table 2-6 provide a description of the purpose, methodology and equipment, spatial and temporal boundaries, emissions and key environmental concerns of each typical exploration activity.

The following sections provide a general and relatively high-level description of offshore geophysical (seismic) surveys and drilling programs as they are typically proposed and carried out in the NS Offshore Area. More detailed and specific descriptions of these activities are typically included in project-specific regulatory approval documentation. It is noted that the land-based effects of onshore drilling are considered in general terms, and will not be described or assessed further in the SEA.

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

SEISMIC SURVEYS
Purpose
• Prior to drilling, geophysical (seismic) investigations are often conducted in order to get an understanding of what is below the surface. Reflection seismology estimates the properties of the subsurface from reflected seismic waves. • Surveying methods generally fit into two categories: 1) those that use the natural fields of the Earth (i.e. gravity, magnetic, electromagnetic); and 2) those that require an input of artificially generated energy (i.e. air guns).
Methodology and Equipment (Natural Source Methods)
• Gravity Surveying: In gravity surveying, variations in the Earth's gravitational field due to density differences between diverse subsurface rock types are measured and recorded. A geological body, whose density differs greatly from its surroundings, will cause a change in the Earth's gravitational field, which is known as a gravity anomaly. These anomalies allow the interpreter to gain ideas about the size, depth and rock type of various features. Gravity data can be collected quite easily from an aircraft or a marine vessel using a gravimeter. Due to the relative ease of collecting the data from a ship, gravity data is often recorded in conjunction with a marine seismic acquisition program. • Magnetic Surveying: Magnetic surveys investigate subsurface geology by mapping anomalies in the Earth's magnetic field that result from varying magnetic properties in the underlying rocks. Most of the minerals that compose rocks are essentially non-magnetic; however, some iron rich minerals can produce significant magnetic anomalies. While the nature of magnetism makes it a more suitable survey type for mining prospects, it can provide large scale information about regional geologic structure. Magnetic surveys are performed on land, at sea and in the air using a magnetometer and are likewise often completed in conjunction with other surveys. • Electromagnetic Surveying: Electromagnetic surveying measures the ground's response to propagating electromagnetic fields. Electromagnetic fields are comprised of alternating electrical and magnetic fields, as the changing of one field generates the other. As such, any conductive body beneath the surface will result in the production of strong secondary electromagnetic fields, thus making this a useful tool in remote sensing for ore bodies. Electromagnetic principal can also be utilized for hydrocarbon exploration. Controlled Source Electromagnetics (CSEM), for example, is a marine geophysical technique used to map potential hydrocarbon accumulations below the seafloor. A dipole source that transmits an electromagnetic field is towed by the ship just above the seafloor. The field is altered by the underlying lithology, subsequently detected and recorded by a receiver array positioned on the seafloor. Interpretation of the data can help identify layers that are conductive or resistive. Typically, for hydrocarbon exploration, one looks for the more resistive features, as hydrocarbon bearing formations are relatively more resistive than the surrounding layers.
Methodology and Equipment (Artificial Source Methods)
• In an offshore seismic survey, high-energy sound sources (airguns) are towed behind a survey vessel while it travels along a track line in a prescribed grid crossing known or suspected hydrocarbon accumulations.

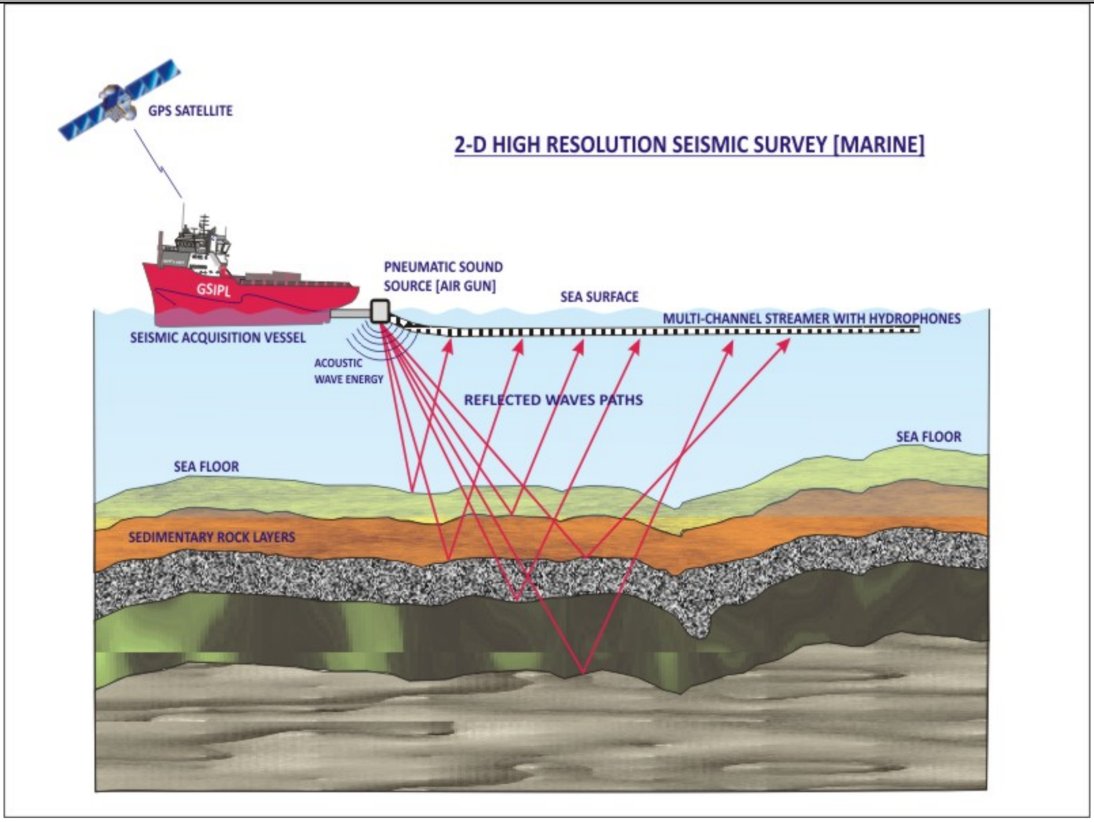
SEISMIC SURVEYS
During the survey, the sound source is fired at regular intervals and directs high energy (low frequency) sound bursts toward the seafloor which can penetrate below the surface. The reflected sound energy is then recorded by sensitive hydrophones (streamers, up to several kilometres in length) which are towed behind the vessel. Computer-based data processing systems then convert the reflected sound (acoustic signals) into seismic data that can be used to map possible hydrocarbon accumulations within the survey area. • There are several methods of data acquisition that may be used depending upon the level of information that is desired: • *Two-Dimensional (2D) Seismic Surveys:* The 2D survey is typically used for exploring a large area in order to identify sites or zones which may warrant further study, and typically uses a single source array and streamer, spaced at 1 km or greater. • *Three-dimensional (3D) Seismic Surveys*: These enable a greater resolution of potential and known oil and gas fields, and provide a more detailed picture of the area under investigation. These surveys may concentrate activity over a relatively small geographical area. 3D surveys typically 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 typical spacing of several hundred metres. • *Wide Azimuth Seismic Survey: A* wide azimuth survey attempts to capture wider offset data than a conventional seismic survey. Wide Azimuth Seismic Surveys typically involve several vessels (towing air guns) making successive passes over the target area, increasing the offset between the streamers and the source vessels by the width of the streamer spread each time (O&G Producers, 2011).  *https://www2.aapg.org/explorer/2008/03mar/resolution.cfm*
Typical Duration (temporal boundaries)
The following timelines provide a relative estimate only, as actual time frames are dependent on the size of the area being surveyed: • 2D Seismic Surveys cover a large area in a short period of time, a survey is therefore of short-term duration at a given location (weeks). • 3D Surveys tend to be of longer duration (up to several weeks) • Wide Azimuth Surveys are typically completed over several months.
Geographical Area (spatial boundaries)
• 2D Seismic Surveys cover relatively large geographical area (up to thousands of kilometers). Survey lines tend to be over 1 km apart.

SEISMIC SURVEYS
• 3D Surveys tend to concentrate activity over a relatively small geographical area with survey lines typically spaced several hundred meters apart. • Wide Azimuth Surveys are more focused and in the spatial range of 3D surveys but cover a large area due to the multi-vessel configuration. • Attenuation of sound from seismic surveys through the marine environment increases the spatial boundary. Sound propagation is influenced by a number of activity and site specific factors.
Emissions
• Potential emissions and discharges that may be associated with marine-based seismic surveys include vessel discharges (such as deck drainage, sanitary waste), atmospheric emissions (exhaust) and the noise and general presence of vessels and lights associated with offshore survey activity. • Sound from air guns can propagate to distances up to 75 km and over 100 km in deeper water.
Key Environmental Issues
• Potential effects on birds. Noise impact from seismic surveys on surface-feeding and diving seabirds near the source arrays. Possible indirect effects in alteration of prey concentration and displacement from foraging areas. Attraction of birds to vessel lighting and to vessels through the discharge of organic waste. • Effects of seismic noise on marine wildlife including potential sublethal effects such as PTS, TTS, short term displacement from preferred feeding, spawning, nursery grounds or migratory routes. • Interaction of seismic vessel activity and fixed fishing gear (e.g. gill nets and longlines) that may be set out over long distances in water and have no fishing vessel nearby. • Potential interference with traditional ocean users such as commercial shipping, recreational marine traffic and commercial fishing activity. • Accidental spills and discharges of hydrocarbons can expose birds to oil by breathing contaminated air, through skin contact, through eating contaminated prey, or by ingesting contaminants while preening contaminated plumage.

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

SEABED SURVEYS
Purpose
• A seabed survey is often conducted in advance of drilling a well in order to identify seabed features (obstructions, aggregations of habitat forming corals or sponges, wrecks/cables, unstable substrate) and subsurface conditions (presence of shallow natural gas) that may interfere with drilling operations.
Methodology and Equipment
• 2D High Resolution surveys are conducted using 2D high resolution (2DHR) digital seismic. The technique is similar to a standard 2D marine seismic program except the source is a small volume compressed air source or a device that generates an acoustic pulse from an electrical discharge. The streamer used is also much shorter and is towed (along with the source) at shallower depths than conventional 2D seismic programs, which allows for higher frequency content from the source and therefore higher resolution data. • Side-scan sonar, sub-bottom profiling, multi-beam echo-sounder and seafloor imagery data may also be gathered, which can further aid in studying marine life and in determining seafloor surface integrity for drilling equipment. • Geotechnical data may also be collected during the survey to verify the integrity of the seabed for drilling equipment, this can include core sampling, vibrocores and cone penetrator technology (CPT). • Environmental sampling may be undertaken to characterize benthic habitat.

SEABED SURVEYS



http://geostar-surveys.com/methodology%20-%20High%20Resolution%20Seismic%20surveys.html

Typical Durations (temporal boundaries)

- Depending on data acquisition type (geophysical, geotechnical, environmental), a seabed survey can range from days up to a month.

Geographical Area (spatial boundaries)

- Seabed surveys are focused on the target drilling location and do not generally extend more than 1 km from the proposed well site.

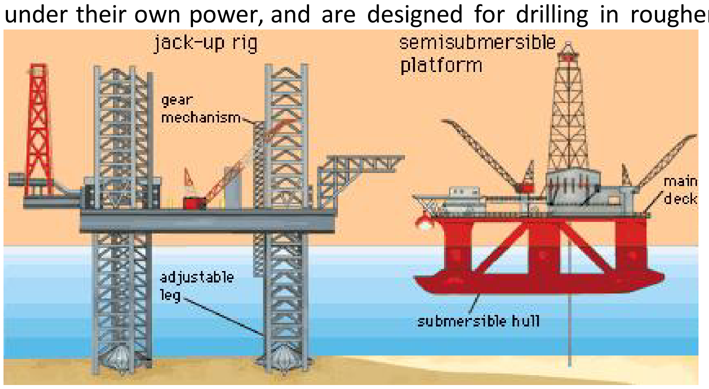
Emissions

- Potential emissions and discharges that may be associated with survey vessels include vessel discharges (such as deck drainage, sanitary waste), atmospheric emissions (exhaust) and the noise and general presence of vessels and lights associated with offshore survey activity.
- Limited sound from geophysical and geotechnical sampling.

Key Environmental Issues

- Effects of underwater noise on marine wildlife
- Interaction of vessels and gear with marine wildlife
- Potential interference with traditional ocean users (fishing industry)
- Spills and discharges

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

OFFSHORE EXPLORATORY DRILLING and WELL ABANDONMENT
Purpose
• Exploration wells are advanced to determine the presence of petroleum resources at particular locations. Based on the results, delineation wells may then be drilled to define the extent and characteristics of the hydrocarbon field. • Once drilling and any associated well testing is completed, offshore wells are typically abandoned.
Methodology and Equipment
There are several types of offshore drilling rigs typically used in Atlantic Canada. The type of rig chosen is based primarily on the characteristics of the physical environment at the proposed drill site, particularly water depth, planned drilling depth, anticipated weather conditions and associated mobility requirements. • *Jack-up rigs* are typically used in shallow water depths of between 10 and 100 m. These units are towed to a drill site, the rig's retractable legs are lowered to the sea floor, and the platform is then elevated until it reaches the desired height above the sea surface. • *Semi-submersible Drilling Units* are typically used in relatively deep waters (70-1,000 m on anchor or at greater depths using dynamic positions systems) or in areas where increased mobility is required due to ice or other factors and operational risks. These units can either be towed to the drill site or move under their own power, and are designed for drilling in rougher seas.  *http://www.britannica.com/technology/jack-up-rig* • *Drill Ships* are the most mobile type of drilling installation, and are used in areas of relatively deep water. These ships contain complete drilling systems, and are almost entirely self-contained and can therefore operate at remote sites with limited support. Drill ships can be anchored to the bottom in water depths of approximately 200-1,000 m, with dynamic positioning systems allowing some drill ships to operate in waters depths of over 1,000 m. • The main drilling components on an offshore drilling rig include: - The derrick to hoist and lower the drill pipe and casing section; - Drill string, drill bit and pipe handling equipment; - Rotation Equipment (electric or hydraulic motors for turning the drill string and drill bit); and - Drilling Fluids System that handles fluids (drilling mud) that lubricate and cool the drill bit and hole, circulate cuttings and carry them back to the surface, and maintain pressure in the well. • Drilling muds are used to lubricate the drill bit and flush drilled rock cuttings from the bit, carrying them up to the surface. There are three basic types of drilling muds: water-based muds (WBM), synthetic-based muds (SBM), and oil-based mud (OBM). • Drilling muds are transported with the cuttings up the riser to the drilling rig for recovery and reuse. At surface, the cuttings are removed from the drilling mud by specialized separation equipment. Treated cuttings that meet regulatory criteria may be discharged at the drill site, or returned to shore for disposal. (NOTE – Discharge of OBM is not permitted offshore Nova Scotia.)

OFFSHORE EXPLORATORY DRILLING and WELL ABANDONMENT

• Offshore drilling installations also contain support infrastructure and facilities such as transportation facilities (for helicopters and support vessels), work areas, safety equipment and crew accommodations.
• Drilling typically occurs in a number of stages:
  • *Conductor hole*: Initially a large diameter (approximately 1 m wide) hole is drilled at the beginning of the well, which is used to install and set the equipment required for drilling the well to depth. Water-based drilling mud (WBM) is used to drill this portion of the well, and as there is no equipment in place to return them to the drilling unit at this early stage (before the riser is installed), these drilling muds and rock cuttings are released onto the seabed.
  • *Casing installation*: Once the conductor hole is completed, the drill string is removed, followed by the running and cementing of steel pipe and the installation of the blow-out preventer and drilling riser. The casing helps to strengthen and stabilize the wall of the conductor hole and to prevent seepage of muds and other fluids during drilling. The blowout preventer is a system of high pressure valves that prevent water or hydrocarbons from escaping into the environment in the event of an emergency or equipment failure during drilling. The drilling riser connects the casing set at the seafloor up to the drilling unit, and therefore allows muds and cuttings to travel back to the rig for processing, reuse and/or disposal.
  • *Well drilling*: With the casing and associated equipment in place, the drill bit and riser are lowered into the conductor hole from the derrick. Drill pipe sections are added as drilling progresses. As sections are completed, the drill string is pulled out of the well and the sections of the casing are joined together, lowered into the well, and cemented into place.
  • *Well evaluation and testing*: If significant hydrocarbons are found during an exploration drilling program, formation fluids (which may contain hydrocarbons and/or water) are collected and tested.
  • *Well abandonment*: Cement mixtures or mechanical devices are used to plug the well, the casing is cut and removed just below the surface of the seafloor and all equipment is removed. Wellheads are removed from the seafloor, often using a mechanical cutting device. In the event that this device fails, a chemical/directed explosive method to detach the wellhead may be employed. A remotely operated vehicle (ROV) or other equipment is then used to inspect the seabed to ensure that no equipment or obstructions remain in place.

Typical Durations (temporal boundaries)
• 30 to 90 days (including well testing and completion) depending on well complexity.
Geographical Area (spatial boundaries)
• To encompass the drilling platform and a safety zone that is usually the greater of either the area within a 500 m radius of the drill unit or, if the unit is anchored, a zone 50 m from the anchor pattern as per the requirements of the Collision Regulations under the Canada Shipping Act.
Emissions
• Atmospheric emissions from engine exhaust, and flare emissions (during testing). • Heat and light emissions from navigation, deck and underwater lights. • Drilling waste including drilling muds and associated rock cuttings. • Potentially oily water associated with deck drainage, bilge water, and ballast water. • Water based mud and cement returns to the seafloor during conductor drilling and cementing. • Noise from standby / supply vessels, helicopter operations, drilling, rig machinery, dynamic positioning thrusters and Vertical Seismic Profiling (VSP). • Miscellaneous solid waste (i.e. paper, domestic waste, scrap metal, empty drums, pallets and strapping) is transported to shore for sorting, recycling and disposal according to the *Nova Scotia Solid Waste-Resource Management Regulations* and municipal requirements as applicable. • Sewage and food wastes.
Key Environmental Issues

OFFSHORE EXPLORATORY DRILLING and WELL ABANDONMENT
• Smothering of benthic habitat and fauna in the immediate vicinity of the well. • Effects of drilling noise on marine wildlife. • Spills and unauthorized discharges. • Potential interference with traditional ocean users (fishing industry). • Interaction of vessels and gear with marine wildlife

Table 2-4 Description of Offshore Exploration Activities – Vertical Seismic Profiling (VSP)

VERTICAL SEISMIC PROFILING (VSP)
Purpose
• To make seismic borehole measurements near the end of drilling to correlate with/confirm surface seismic data. • Also referred to as a check-shot survey, a VSP is undertaken following completion of drilling to confirm well depth.
Methodology and Equipment
• The VSP is undertaken by placing a string of receiver (geophones) in the well which record reflected seismic energy originating from a seismic source at the surface. • Check-shots are recorded at multiple intervals down the well. The acoustic source is triggered approximately 5 times to create a sonic wave that is recorded by the geophones, which is digitized and transmitted to the surface recording equipment.
Typical Durations (temporal boundaries)
• Hours to days when carried out within the time frame of a typical drilling program (30 – 90 days).
Geographical Area (spatial boundaries)
• Attenuation of sound may increase beyond the dimensions of the drilling rig. Sound propagation is influenced by a number of activity and site specific factors (sound from air guns can propagate to distances up to 75 km and over 100 km in deeper water)
Key Environmental Issues
• Effects of underwater noise on marine wildlife.

Table 2-5 Description of Offshore Exploration Activities – Vessel and Helicopter Traffic

VESSEL AND HELICOPTER TRAFFIC
Purpose
• Supply vessels and helicopters are used to transport personnel, equipment and materials to and from a drilling rig during an offshore drilling program. Supply vessels typically make several round trips per week to the drilling unit throughout a drilling program, and a dedicated stand-by vessel also usually attends the rig throughout the drilling program. Personnel and limited materials are transported to and from the drilling rig by helicopter. • Other vessels are used for various purposes during seismic survey operations.
Methodology and Equipment
• Supply vessels to carry equipment and bulk supplies (cement, potable water, fuel and mud product), vessels typically range in size from 20m to 100m. • Dedicated stand-by vessel attending the rig at all times when on location. • Helicopters used for supply, crew changes, and/or medical emergencies during seismic surveys and drilling operations. • One or two small vessels used to monitor for fishing activity in the area and to prevent gear loss and

VESSEL AND HELICOPTER TRAFFIC
entanglement.
Typical Durations (temporal boundaries)
• Vessels and helicopters would be required for the duration of the drilling program (30 – 90 days or longer for deep water drilling). • Two to three supply vessel trips per week. • Three or four helicopter flights per week to transport personnel to and from the rig.
Geographical Area (spatial boundaries)
• The transit route(s) between the onshore supply base and heliport and the offshore drilling site. • Confined to the dimensions of the rig. • Standby/support vessels typically remain within a defined area surrounding the drill unit as a safety precaution. The safety zone is usually the greater of either the area within a 500 m radius of the drill unit or, if the unit is anchored, a zone 50 m from the anchor pattern as per the requirements of the *Collision Regulations* under the *Canada Shipping Act*.
Emissions
• Atmospheric emissions such as exhaust emissions and light emissions. • Oily water associated with deck drainage, bilge water, and ballast water. • Sewage and food waste. • Noise • Miscellaneous solid waste (i.e. paper, domestic waste) is transferred to shore for sorting, recycling and disposal according to the *Nova Scotia Solid Waste-Resource Management Regulations* and municipal requirements as applicable.
Key Environmental Issues
• Vessel collisions with marine wildlife. • Attraction of wildlife to vessel lights and discharges. • Noise effects on marine wildlife. • Spills and unauthorized discharges. • Helicopter noise over onshore flightpath.

Onshore to offshore drilling, which uses horizontal/directional drilling techniques, may be used when oil and gas prospects are located close to shore. The process is similar to subsea drilling, but the environmental issues also include land-based effects. It is noted that land-based effects are beyond the scope of this SEA, they are addressed in general terms in Table 2-6, but will not be considered further in the effects assessment of Valued Environmental Components (VECs).

Table 2-6 Description of Offshore Exploration Activities – Onshore to Offshore Drilling

ONSHORE TO OFFSHORE DRILLING
Purpose
• Directional drilling techniques are often employed when offshore prospects are (i) close enough to land (under 10 km), and/or (ii) vertical access is difficult or too costly. • Can be used to mitigate the impact of marine activities associated with well drilling on environmentally sensitive offshore areas
Methodology and Equipment
Onshore to offshore drilling entails drilling a well from an onshore location using horizontal directional drilling to access and investigate potential hydrocarbon resources that are located offshore. Typical land based drilling equipment is used for well construction and the wells are constructed in a manner similar to a typical onshore

ONSHORE TO OFFSHORE DRILLING
well except for the fact that the horizontal section extends offshore to a point below the seabed. Components and activities associated with onshore to offshore drilling may include the following: • Access routes to drilling location (development or upgrading of transportation infrastructure as required; • Construction of a drill pad of appropriate size (typically several hectares) at the drill site; • Mobilization and set-up of an appropriately sized drill rig (often in modules which are later assembled at the well location), drill mud handling and cuttings cleaning systems, blowout prevention and pressure control equipment, crew facilities, and other components; • Mobilization and set-up of associated support equipment and ancillary infrastructure (e.g., generators, water sources, crew accommodation or other on-site facilities, fuel and chemicals storage, waste disposal systems, containment ponds, emergency response equipment); • Regular movements of other equipment, materials and personnel to and from the drill site as required. Completion and cessation of drilling operations, followed by well abandonment procedures, equipment removal, site decommissioning and rehabilitation procedures, in accordance with applicable regulatory standards and approvals
Typical Durations (temporal boundaries)
• Drilling operations usually run 24 hours per day for the duration of the drilling program. • Directional drilling is typically a slower process due to the need to stop regularly and survey, and slower progress in drilling itself (lower rate of penetration). • Weeks or months, depending on the planned distance.
Geographical Area (Spatial Boundaries)
• Confined to the dimensions of the drill site and associated access routes
Emissions
• Light, noise and air emissions associated with on-site equipment use, drilling activities, any flaring required as part of well testing; • Solid and liquid waste generation and disposal, including drilling fluids and cuttings (treatment, storage and disposal), grey/black water, cooling water, garbage; • Potential spills of fuel, drill fluids, chemicals or other materials during their use, transportation, storage and eventual disposal; and associated potential interactions with water, vegetation, wildlife and other resources.
Key Environmental Issues
• Possible effects on historic and heritage resources, vegetation, wetlands and other habitats due to site clearing activities; • Increased access to previously remote areas (through the development or new or upgraded roads) and associated environmental issues; • Disturbances to adjacent communities, resources, wildlife, and land and resource use activities (recreational, commercial), due to site access restrictions and/or indirectly through project-related noise, traffic, visual intrusions or other changes to the nature, distribution, quality and/or enjoyment of such areas, resources and activities by local residents and/or visitors; • Waste management and disposal of rig generated waste (e.g. waste water, domestic waste, construction debris, cuttings, drilling fluids, chemical packaging, etc.); • Attraction of wildlife to rig lights, flaring and discharges; • Increased heavy vehicle effects on local highway infrastructure (bridges, culverts, roads); • Vehicle collisions with wildlife; and • Spills and unauthorized discharges.

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

In accordance with their mandate, the CNSOPB requires an Operator to prepare an Environmental Protection Plan (EPP) for drilling activities to manage routine discharges, emissions and solid waste (Note: an EPP is not required for seismic programs). The EPP identifies types, quantities, and mitigation measures to minimize any environmental impacts of these discharges/emissions. Typical emissions, discharges and solid waste types include air emissions, heat/light emissions, noise, bilge and ballast water, deck drainage, drilling muds (oil, synthetic and enhanced mineral oil based), solid waste and municipal-type waste (organics, plastics, construction materials etc). Mitigation measures for each source are discussed in Chapter 5. At a minimum, the following regulations and guidelines apply:

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

The primary guidelines for managing routine emissions and discharges associated with offshore exploration activities are the *Offshore Waste Treatment Guidelines* (OWTG) (NEB *et al.* 2010) and the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands* (NEB et al. 2009). Further information on these guidelines can be found on the Board's website at *http://www.cnsopb.ns.ca/reference.*

2.2.2 Environmental Protection Systems for Accidental Events and Malfunctions

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

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

3 EXISTING ENVIRONMENTAL SETTING

3.1 Physical Environment

The Study Area covers a large expanse of the north and northeast Scotian Shelf, extending approximately 350 km north to south and 250 km west to east. The Study Area is bounded by the Laurentian Channel to the north and Cape Breton Island to the south and west. The area consists of the Orpheus Graben to the east and the Sydney Basin to the north of Cape Breton, and St. Anns Banks to the northeast. The boundary furthest to the east is about 120 km east of Louisbourg, Cape Breton, while the northern boundary is about 50 km north of Cape Breton Highlands National Park (Figure 1-1).

3.1.1 Bathymetry

The depth at the Study Area ranges from about 50 m near coast to about 150 m on the off-shore perimeter. The depths at the Orpheus Graben are generally deeper to an average of about 125 m than the depths at the Sydney Basin, with about 90 m on the average.

3.1.2 Climatology

The following sections provide an overview of the key climatological conditions and characteristics of the SEA for the Sydney Basin, St. Anns Bank, and Orpheus Graben Study Areas, including wind, air temperature, precipitation, and fog and visibility.

There are numerous hindcast data nodes located within the Study Area. Recognizing this, and the large marine area covered by the Study Area, three MSC50 grid point locations were selected to be generally representative of the region. The locations are noted below:

- 6007926 (45°N, 60°W) for the Orpheus Graben;
- 6011517 (47°N, 60°W) for the Sydney Basin; and
- 6009614 (46°N, 59°W) for the St. Anns Bank

This is in keeping with the approach for, and the type and level of information that has been included in, other SEAs in the NS offshore area. It is noted that the intent is to provide a regional overview for general illustration, rather than detailed and site-specific climatological information for design and operational purposes.

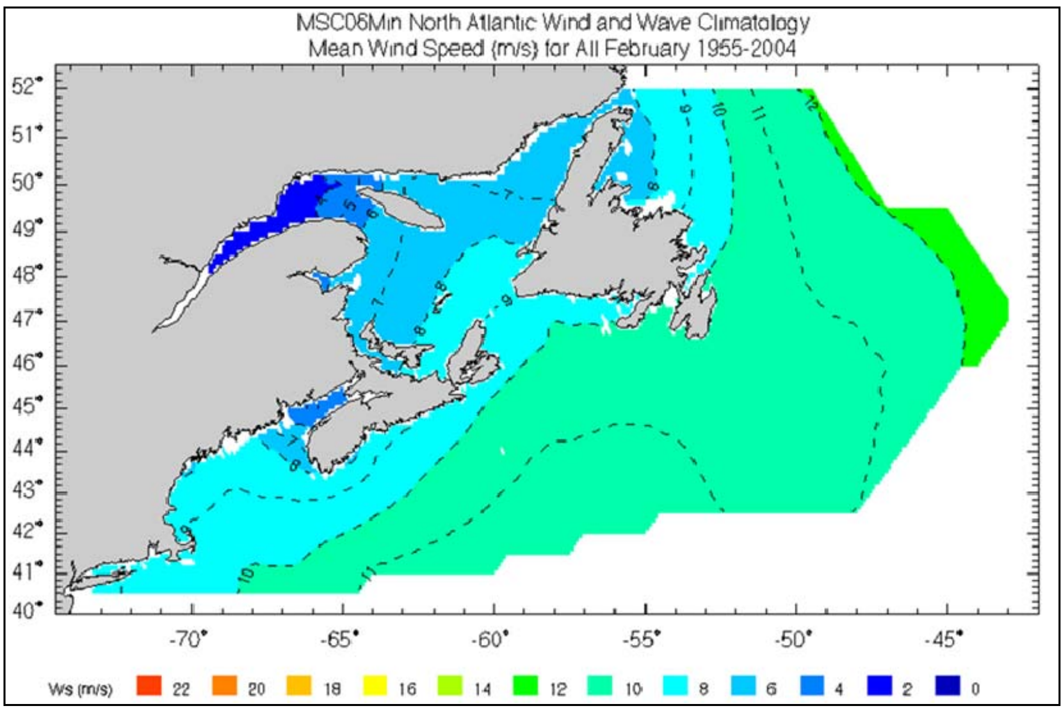
3.1.2.1 Wind Conditions

It is recognized that there are limitations in using a single point to be representative of a large area. For the wind and wave climatology, the Study Area has been characterized using three points. A review of regional wind conditions as reported in the MSC50 hindcast climatology (Oceanweather 2011) does not indicate a large variation in the climate, and the three points as selected above are considered to provide reasonable coverage. A similar review of regional wave conditions is presented in Section 3.1.3.1.

Maps of the mean and 99th percentile wind speeds for February, as an indication of winter time when conditions are generally least favourable, are presented in Figure 3-1. These particular analyses cover the period 1955 to 2004.

Mean wind speeds in February range from about 8 m/s in the area of the Study Area (Figure 3-1). Inspection of the corresponding August map, as an indication of summer time conditions, shows corresponding mean wind speeds of 4 to 6 m/s across the entire Study Area.

Figure 3-1 MSC50 Wind and Wave Climatology, Regional Mean Wind Speed, February



Source: Oceanweather (2011)

3.1.2.2 Air Temperatures

The atmospheric properties over the ocean surface broadly spanning the Study Area have been characterized using the International Comprehensive Ocean-Atmosphere Data Set (ICOADS), as it represents the most extensive available database of observations of atmospheric and sea conditions. The dataset consists of global marine observations recorded from 1662 to the present, compiled by the United States National Centre for Atmospheric Research (NCAR 2012). The period from January 1962 to December 2013, inclusive was selected for the analysis.

The monthly air temperature statistics exhibit strong seasonal variations, with mean temperatures ranging from -4.2°C in February to 18.5°C in August. Throughout the year the mean daily minimum and maximum temperatures generally stay within about 3°C of the mean temperature.

3.1.2.3 Precipitation

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

Lightning strikes are also a possibility during thunderstorm activity, and lightning climatology based on the Canadian Lightning Detection Network data (Burrows and Kochtubajda 2010) is available for parts of the SEA Study Area. A summary for each sub-region in the Study Area is provided below:

a. Sydney Basin

Most of the observed precipitation events are in the form of rain or snow, while other precipitation types, such as mixed rain and snow, freezing rain, and hail, occur far less frequently. The monthly frequency of rain events is lowest in January and February, when the snow occurrence frequency is at its peak. The situation is somewhat reversed between April and November, with maximum rain frequency in October, and minimum snow frequency from June to September.

Freezing rain and drizzle are relatively infrequent, occurring about one percent of the time during any given month, and do not occur at all between June and October. Thunderstorms are the main generating mechanism of hail, and therefore the observation of hail is expected during thunderstorms. Hail and thunderstorms indeed occur with similarly low frequencies. There is a year-round potential for thunderstorms and hail, with the highest frequency of occurrence occurring in from mid-winter to mid-spring.

b. St. Anns Bank

Most of the observed precipitation events are in the form of rain or, in the winter, snow, while other precipitation types, such as mixed rain and snow, freezing rain, and hail, occur far less frequently. The monthly frequency of rain events is lowest in July. The snow occurrence frequency is at its peak in January and February. Maximum rain frequency occurs in November and December, and minimum snow frequency from June to October. Freezing rain and drizzle are relatively infrequent, occurring less than one percent of the time during any given month, and do not occur at all between July and October. There is a year-round potential for thunderstorms and hail, with the highest frequency of occurrence occurring in the month of April.

c. Orpheus Graben

Most of the observed precipitation events are in the form of rain or snow, while other precipitation types, such as mixed rain and snow, freezing rain, and hail, occur far less frequently. The monthly frequency of rain events is lowest in June to September. The snow occurrence frequency is at its peak during January and February. Maximum rain frequency occurs in October and November, and minimum snow frequency from June to September. Freezing rain and drizzle are relatively infrequent, occurring less than one percent of the time during any given month, and do not occur at all between June and October. There is a year-round potential for thunderstorms and hail, with the highest frequency of occurrence occurring in late fall to winter.

3.1.2.4 Fog and Visibility

The Study Area has some of the highest occurrence rates of marine fog in North America. Fog for the marine Study Area is often of the advection type. Advection fog is formed when warm moist air flows over a cold surface such as the cold Northwest Atlantic Ocean, and can persist for days or weeks. Advection fog is most prevalent in spring and summer. Visibility is affected by the presence of fog, the number of daylight hours, as well as frequency and type of precipitation. For this characterization, visibility from the ICOADS dataset has been classified as very poor (<0.5 km), poor (0.5 to 2 km), fair (2 to 10 km) or good (> 10 km). The monthly and annual frequencies of occurrence of each state are shown in the Figures and Tables which follow.

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

a. Sydney Basin

Visibility within this sub-region varies considerably throughout the year. Good or fair visibility combined occur 89 percent of the time annually. Good visibility (greater than 10 km) is most frequent during September and October, and least frequent in January and February. Visibility is poorest from May to July.

b. St. Anns Bank

Good or fair visibility combined occur 86.5 percent of the time annually. Good visibility (greater than 10 km) is most frequent during September and October, and least frequent in April, May and July. Visibility is poorest in the spring and summer.

c. Orpheus Graben

Good or fair visibility combined occur 90 percent of the time annually. Good visibility (greater than 10 km) is most frequent during September and October (>65 percent of the time both months), and least frequent in January (41.5 percent). Visibility is poorest in the spring and summer. Annually, visibility is very poor or poor 10.1 percent of the time.

3.1.3 Oceanography

The following sections provide an overview of the select oceanographic conditions and characteristics of the Study Area, including waves and ocean currents.

3.1.3.1 Waves

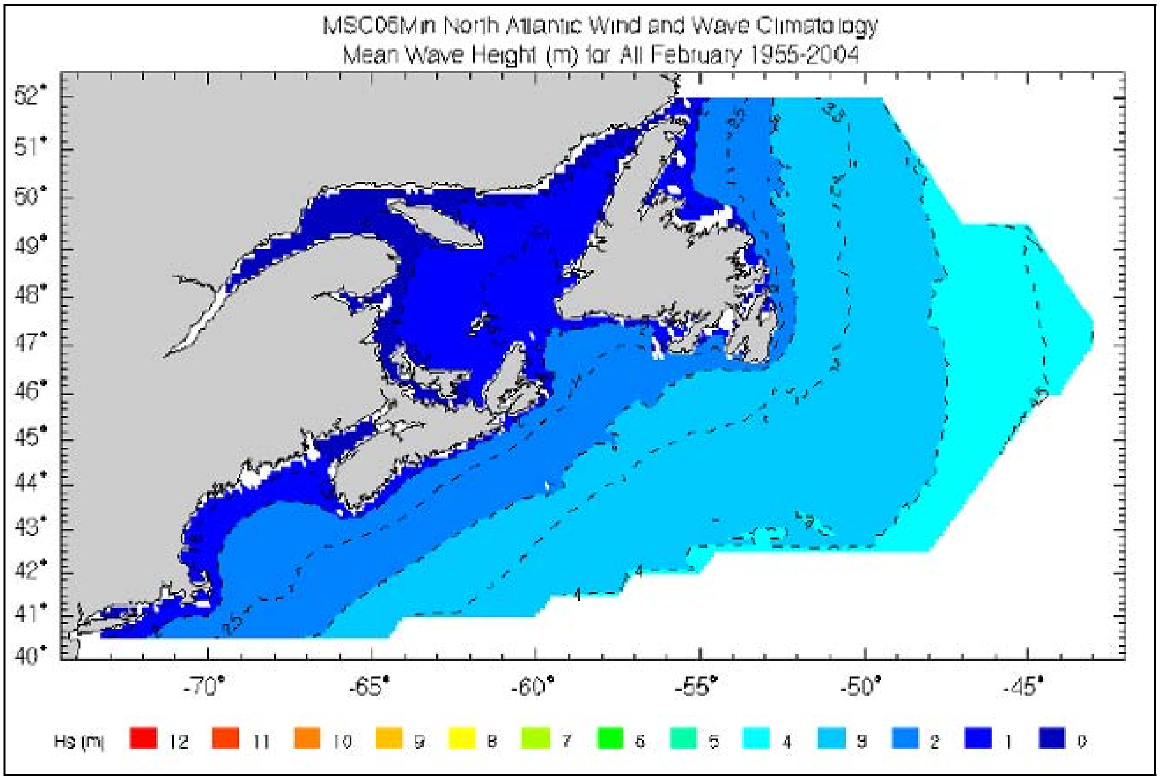
Due to the spatial and interannual variability in ice cover and other conditions throughout the SEA Study Area, the wave climate is expected to vary among different locations, particularly during the winter period, with ice presence as a modifying variable for wave climate statistics at specific locations. The descriptive statistics for wave height, peak period, and direction are from four select MSC50 nodes spanning the Study Area:

- 6007926 (45°N, 60°W) for the Orpheus Graben;
- 6010317 (46.4°N, 60.3°W) for the Near Coast in Sydney Basin
- 6011517 (47°N, 60°W) for the Sydney Basin; and
- 6009614 (46°N, 59°W) for the St. Anns Bank

Inspection of the regional wave climate as reported in the MSC50 hindcast climatology (Oceanweather 2015) does not indicate a large variation in the climate, and the four points as selected above are therefore considered to provide a reasonable and illustrative coverage. Maps of the mean and 99th percentile wave height for February, as an indication of winter time when conditions are generally least favourable, are presented in **Figure 3-2**.

Mean wave heights in February range from about 1 to 2 m for the Sydney Basin and St. Anns Bank mostly 2 m for the in the Orpheus Graben area (Figure 3-2). Inspection of the corresponding August map (not shown) suggests that corresponding mean wave heights of about 1 m is uniform across the entire Study Area and close to zero in the near coast region in Sydney Basin.

Figure 3-2 MSC50 Wind and Wave Climatology, Regional Mean Wave Height, February



Source: Oceanweather (2015)

3.1.3.2 Ocean Currents

The Gulf of St. Lawrence is central to the current flow in the Cabot Strait. The Gulf of St. Lawrence receives the freshwater discharge from the St. Lawrence River system. Together with the flow contribution from the straight of Belle Isle, current flows through the Cabot Strait out to the Scotian Shelf.

The currents in the Study Area (Sydney Basin, St. Anns Bank and Orpheus Graben) vary per site, with the strongest currents expected at the Sydney Basin at 0.2 m/s and the weakest in the St. Anns Bank region at 0.05 m/s for the upper 50 m. Current statistics for all current meter data from the Bedford Institute of Oceanography (BIO) have been queried from the Ocean Data Inventory (ODI) database (Gregory 2004, DFO 2013). Overall, these provide a good representation of the regional current regime for the Study Area with each region being represented at several sites and at several collection dates (see Table 3-1 for the number of data collection at each study area). The database consists of all current meter records that have a record length of at least five days within a given month.

Table 3-1 Number of current records per depth range in the study area

Region	Depth			
	0 to 50 m	50 to 100 m	100 to 200 m	greater than 200 m
Sydney Basin	134	235	310	80
St. Anns Bank	348	447	489	0
Orpheus Graben	322	418	435	16

Source: Ocean Data Inventory, June 2015, for region 44 °N to 48 °N, 61 °W to 58°W (DFO 2013)

3.1.4 Ice Conditions

The seasonal occurrence of sea ice and icebergs off the north coast of Nova Scotia has been extensively observed and documented throughout the last several decades. The most comprehensive sea ice dataset and associated weekly climatic statistics for Eastern Canada have been compiled and published in the Sea Ice Climatic Atlas the Canadian Ice Service (CIS, 2011). The latest version of the atlas covers the climatology for the most recent 30 year period (1981 – 2010), incorporating observations from a variety of sources: RADARSAT-1, RADARSAT-2, Envisat, NOAA AVHRR and Modis imagery. The satellite data has been verified against available aircraft and ship observations, as well as datasets made available by the International Ice Patrol (IIP), under the jurisdiction of United States Coast Guard. The following two subsections summarize the sea ice climatology, as well as iceberg occurrence in the Study Area based on IIP iceberg sightings.

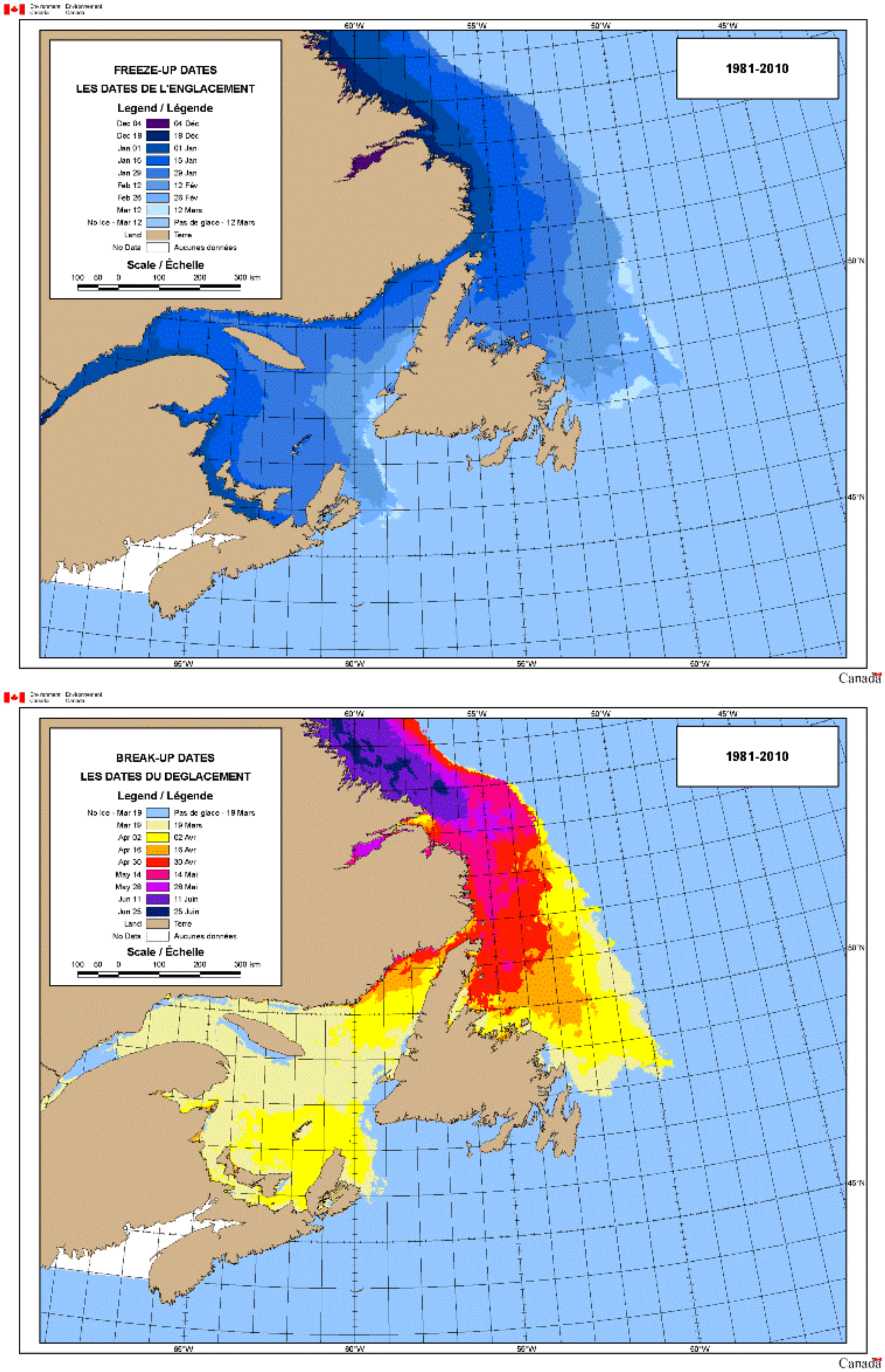
3.1.4.1 Sea Ice

Sea ice in the Study Area mostly occur in the Sydney Basin and St. Anns Bank, and only on the coastal region in the Orpheus Graben Area. The water on the Gulf of St. Lawrence freezes initially in the early winter, freezing progressively in the offshore direction. The portion of Sydney Basin closest to the Gulf of St. Lawrence starts to freeze in late January – early February then expands to coastal portion of Orpheus graben region, reaching maximum median ice concentration of 30 percent, by the first week of March. The maximum sea ice thickness typically forming in the Study Area is in the range of 10-120 cm, consistent with the classification of first-year ice.

After mid-March the ice cover begins to retreat, with the southern half of the Study Area typically being ice-free by April 2, while ice break-up in the northern half of the Study Area is expected to occur by mid-April (

Figure **3-3**, bottom panel). The Study area is expected to be free of ice by the week of April 16, however there remains a low probability (1-15%) of sea ice occurrence in the northernmost parts until late-April.

Figure 3-3 (Top) Freeze-up dates, and (bottom) ice break-up dates over the period 1981-2010 (CIS 2011).

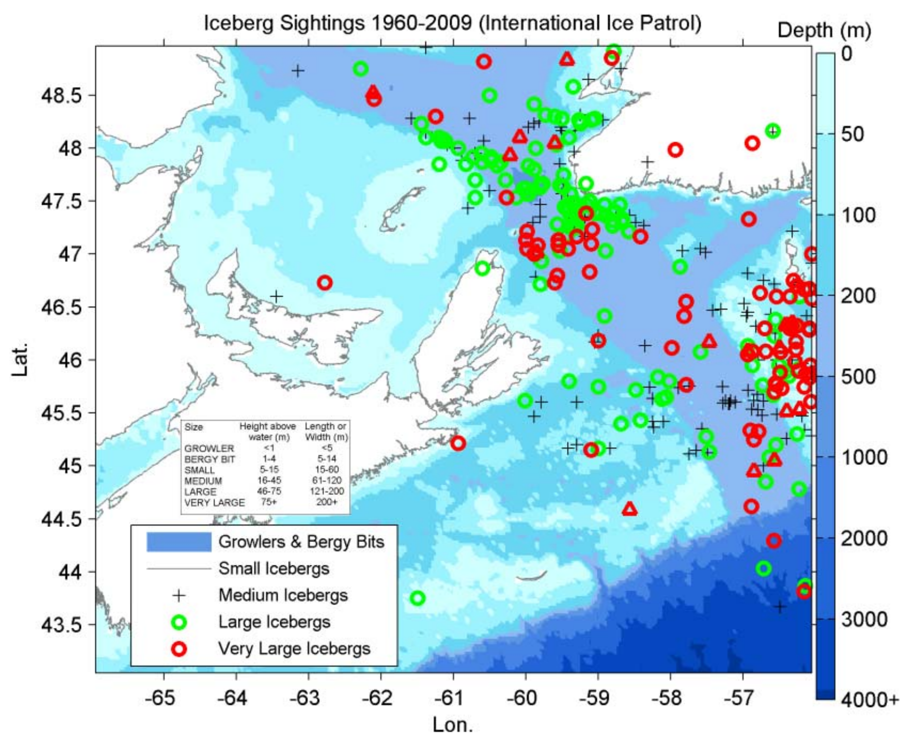


3.1.4.2 Icebergs

The most comprehensive dataset of iceberg sightings in the Study Area over the past half century has been recorded by the International Ice Patrol (IIP), managed and operated by the United States Coast Guard since 1912. The IIP and the CIS collaboratively issue daily iceberg analyses under the North American Ice Service (NAIS), which aims to unify North American ice information and improve service to mariners.

The iceberg sightings for the period 1960 to 2009 have been plotted in
Figure **3-4**. The icebergs have been classified into several size categories, from growlers and bergy bits (5 – 14 m horizontal scale), through small icebergs (15-60 m), medium icebergs (61-120m), large icebergs (121-200m) and very large icebergs (>200m). There have been no recorded sightings of very large icebergs in or near the Study Area. Many of the observed icebergs are originated from the Gulf of St. Lawrence drifting towards the Atlantic Ocean, passing in the north of the Study Area. Some of the icebergs occasionally do get transported into the study area, including mostly small and medium icebergs in the northern parts, and growlers, bergy bits, small icebergs and large icebergs in the central and southern parts of the Study Area. While the historic occurrences of icebergs are useful to consider for strategic planning purposes, marine operations and navigation in the Study Area are always guided by analyses and charts of actual ice conditions issued by the CIS.

Figure 3-4 Iceberg sightings in and adjacent to the Study Area, classified by iceberg size (IIP 2012).



3.1.5 Planning Implications of Oceanography, Climatology and Ice Conditions

3.1.5.1 Oceanography and Climatology

The bathymetric configuration, atmospheric forcing conditions, and the resulting ocean circulation patterns are of critical importance for operational planning, navigation, as well as emergency response or oil spill response operations. The climatological trends are important to consider for strategic, long-term planning, however extensive real-time observations and forecasts of ocean currents, wind and wave conditions should be taken into account for operational purposes. Climatological records have identified a large amount of interannual variability in air temperatures over the entire Gulf of St. Lawrence, which have been shown to be correlated with trends in sea ice formation in the Gulf and the surrounding waters (Galbraith et al., 2011). The record high temperatures and record low maximum ice volumes in the 2009/10 season seem to indicate a trend of warming, however there is no conclusive indication as to whether these observations amount to a consistent upward trend, or simply increased interannual variability.

The Study Area represents an area rich with physical oceanographic features, with highly variable spatial distributions of air and sea temperatures, salinity, currents and waves that change on a seasonal, as well as interannual basis. Therefore it is important that site-specific EAs investigate and incorporate a more detailed representation of the environmental conditions that may differ from those representative of the broader Study Area.

3.1.5.2 Ice Conditions

The occurrence of sea ice and icebergs in the Study Area have been well documented through the efforts of the IIP and CIS, and seasonal charts and advisories are available for operational purposes. The climatological records show that the majority of the Study Area is expected to experience substantial coverage with first-year ice between mid-January and mid-March, however the freeze-up and break-up dates can vary widely from year to year. Icebergs are rarely expected to occur in the Study Area, with annual probabilities of less than 10% restricted to small sections in the northern part of the domain. Sea ice and icebergs have significant implications for the safety of crews, and efficiency of marine operations, and need to be considered as part of comprehensive ice management plans.

The potential for icing of superstructures in the Study Area is significant, with a combination of near-freezing surface water temperatures in the winter and seasonal wind conditions favourable to icing. Icing can pose a significant hazard to crews and vessels operating offshore and mitigative measures should be considered during operational planning.

3.2 Biological Environment

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

3.2.1 Approach and Key Information Sources

All of the species groups discussed in this section (invertebrates, fish, birds, marine mammals, turtles, species at risk and species of conservation concern) interact to some degree, and many play key trophic roles in the ecosystem of the Study Area, influencing or influenced by other taxa through ecological interactions such as predation and competition. While a species may be considered insignificant from a commercial or cultural perspective, it may play a significant ecological role in the food web or larger ecosystem (*e.g.,* act as a key prey item for another species). Marine species abundances and distributions have often been looked at independently and not as part of a complete ecosystem. This approach of identifying and considering some key species individually is still valuable, but must be supplemented by a more multi-species approach in science and fisheries management. For example, multi-species approaches have helped researchers understand how the trophic structure or food webs of the eastern Scotian Shelf ecosystem has been changing as a result of anthropogenic (such as fishing) and natural (climate change) disturbances. Recent work has, for example, hypothesized that the ecosystem structure of the Eastern Scotian Shelf has changed via a "regime shift", with a decrease of demersal long-lived piscivorous species such as cod or redfish and an associated increase in planktivorous (plankton-eating) pelagic fish and invertebrates (Bundy 2005, Choi *et al.* 2005, Frank *et al.* 2005). Although there is still considerable discourse within the scientific community on the extent that overfishing (Frank *et al.* 2006) or climate change (Rothschild 2007) have caused these transitions in the ecosystem in the Study Area and the northwest Atlantic in general, it is generally agreed that both have had a significant influence in the observed regime shift.

Data from Canadian DFO Research Vessel (RV) surveys (2004 to 2014) were used in the description and analysis presented in this document. These data are based on random, stratified sampling from research vessels and are the most up-to-date information available for the Study Area. These data are used as to define important species and to describe current species distributions. However, as the portion of the Laurentian Channel Slope within the Study Area is outside of the main area regularly surveyed by DFO, it is acknowledged that the Laurentian Channel Slope portion is poorly sampled. Some older DFO survey data (1997-2002) is available for the Laurentian Channel, however, and is discussed in this document. In addition, certain taxa (particularly small, pelagic, and infaunal species) within the area surveyed are poorly represented in this survey methodology. However, this approach still provides useful information for a considerable portion of the Study Area on many ecologically and commercially important species. The data from the surveys were also screened to identify key species that occurred in high abundance within the Study Area. The ecology of these species are described in greater detail and maps of their distribution relative to the Study Area are provided in the sections that follow.

Visualizations of select species distributions were derived using the GIS Spatial Analysis System (SPANS) potential mapping surface methods utilized in previous research (Han and Kulka 2007, Kulka 2009) and EAs (*e.g.,* AMEC 2014, AMEC 2015, GXT 2014). The technique makes use of the geo-referenced survey catch rate data to define spatial differences in fish density and biomass. These maps are displayed and described for focal invertebrate and finfish species. Where possible and reasonable, inferences have been made for areas poorly covered by DFO RV surveys based on distribution within the overall study area and available information on the biology and ecology of species.

3.2.2 Ecosystem Overview

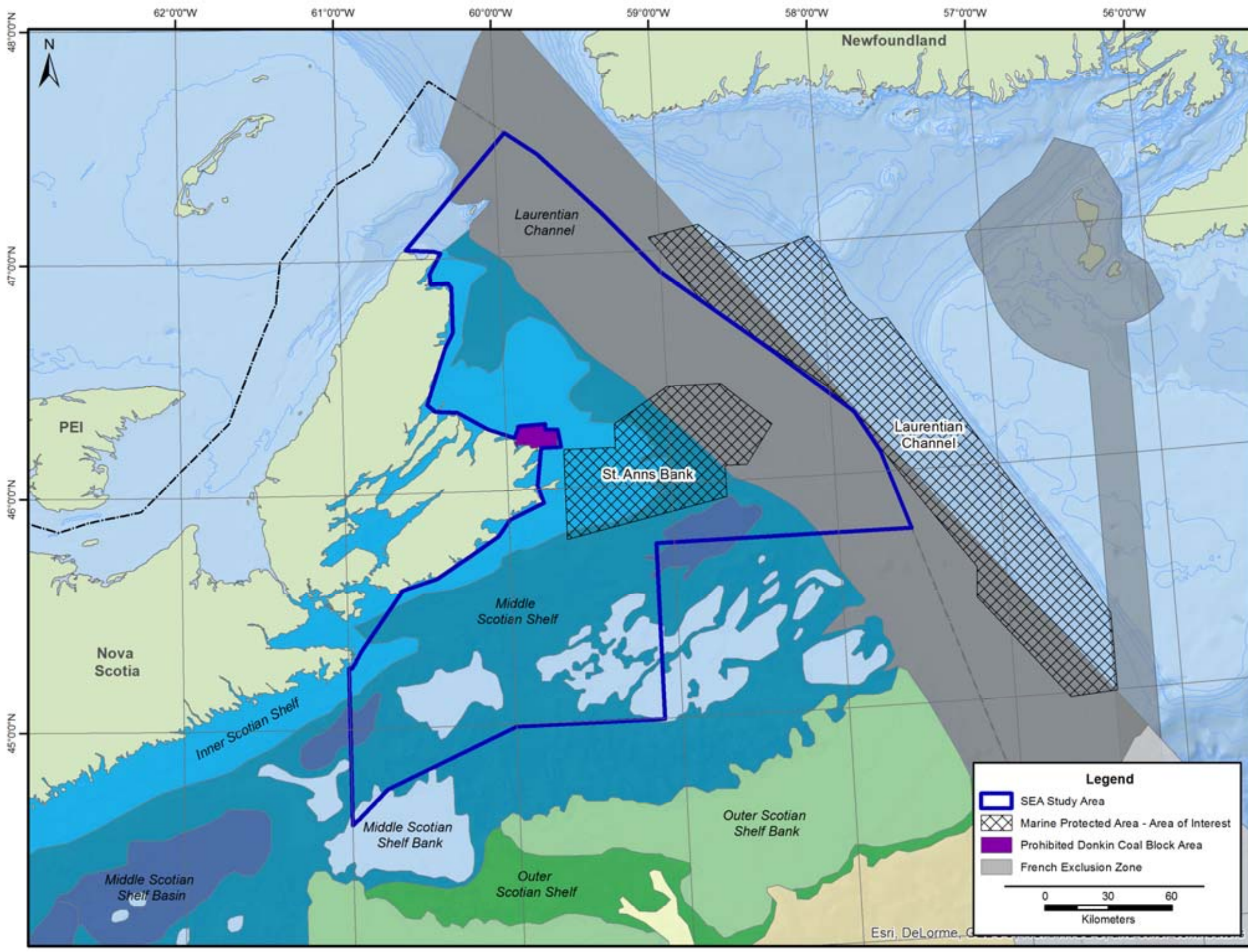
The offshore marine ecosystem is made up of species and habitats that are linked together through ecological relationships and processes (*e.g.* Gomes *et al.* 1992, Templeman 2010, Zwanenburg *et al.* 2006). In the Study Area, primary production is predominantly derived through phytoplankton. These tiny photosynthetic organisms form the base of the food chain, feeding energy to higher trophic levels (fish, marine mammals, and birds), through zooplankton, planktivorous fish and invertebrates. Species which feed on dead organic material, (detritivores) then break down this material and permit nutrients from dead organisms to be recycled through the food web. Due to the interdependence of species and habitats, perturbations (such as overfishing, changing climatic conditions) can affect many elements of the ecosystem (Rose 2004, Choi *et al.* 2005, Koen-Alonso *et al.* 2010, Devine and Haedrich 2011, Perez-Rodriguez *et al.* 2012) through direct (direct mortality) and indirect (competition or changes in predation rates) means.

In the early 1990s, many of the east coast groundfish fisheries, including that of the eastern Scotian Shelf, collapsed. This coincided with a shift to colder ocean waters beginning in the early 1980s (Zwanenburg *et al.* 2002). These changes caused a drastic ecosystem response that included increases in primary production and invertebrates (including shrimp and crab) and greatly reduced numbers of many long-lived groundfish species (Bundy 2005, Choi *et al.* 2005, Frank *et al.* 2005). It also was also associated with an increased abundance in cold-water fish species such as capelin and Greenland halibut (Zwanenburg *et al.* 2002). The collapse of groundfish stocks released some species such as shrimp from predation, further augmenting their abundance (Worm and Myers 2003). Benthic invertebrates such as shrimp and lobster are now key fisheries species. This ecosystem shift has had significant ecological, economic and social repercussions. While many researchers have documented recent ecosystem shifts, observations of such phenomena predate modern fisheries science in the western North Atlantic (Rose 2004).

3.2.2.1 Main Seabed Regions

In 2009, WWF Canada and DFO prepared a map of seafloor regions according to seabed features off Nova Scotia and New Brunswick (WWF Canada 2009). Main seabed features within the Study Area are depicted in Figure 3-5. A brief overview of each of these seabed features is provided below. Descriptions of some common coastal habitat types are also provided.

Figure 3-5 Main Seabed Features within the Study Area



3.2.2.1.1 Inner Scotian Shelf

The Inner Scotian Shelf extends an average of 25 km from shore. It then slopes to the basins of the Middle Scotian Shelf in water depths of 70 – 100m (WWF Canada 2009). It can be considered a submarine extension of Nova Scotian coastal areas, with characteristic roughly eroded bedrock. Within this region, conditions vary considerably over short distances and the distribution of bedrock, sand, and gravel is patchy, creating high surface relief and a variety of habitats. Exposed bedrock areas support extensive beds of macroalage such as kelp, knotted wrack and rockweed (WWF Canada 2009). Subtidally, kelp forests provide habitat for many invertebrate species and refugia for small fish. In shallower areas, encrusting coralline algae cover rock surfaces, while eelgrass beds and tidal marshes are found in sheltered bays. Abundant benthic invertebrate species in the region include horse mussels, sea cucumbers, seastars, amphipods, barnacles, crabs, scallops, urchins, and significant populations of lobsters (WWF Canada 2009).

The Inner Scotian Shelf encompasses both intertidal and subtidal regions. The intertidal zone is the area of shore between the highest and lowest extent of the tides. Portions of this zone may be flooded and exposed by tides twice a day, while the upper and lower portions may only be exposed during the monthly extremes in tides (spring tides). Species assemblages in such environments are determined by physical and biological factors such as substrate type, level of exposure, currents, tidal regime, water and air temperatures, and, in colder areas, the degree of winter ice scour. Biological factors such as competition and predation also exert control over the species assemblages. Characteristic intertidal invertebrate species of rocky shores include mussels, periwinkles, and barnacles. Sandy shores are home to various clam species, and moon snails. In addition to the factors listed previously, algal species are also affected by nutrient availability and grazing by herbivores. Common species in the SEA Study Area include rockweeds and knotted wrack, as well as encrusting coralline algae.

The subtidal zone is the area permanently inundated by the ocean. The subtidal community consists of shallow subtidal (< 30 m depth) and deep subtidal (30 to 200 m depth) communities (WWF Canada 2009). Much of the deep subtidal is composed of a series of banks separated by glacially deepened troughs. Subtidal benthic communities vary spatially throughout the Study Area, influenced by factors such as depth, sediment type, current regime, oxygen levels, and temperature. Characteristic benthic deep subtidal invertebrate species in the more oceanic areas include lobster, snow crab, toad crab, rock crab, Iceland scallops, sea scallops, northern shrimps, Stimpson's surf clams , propeller clams, ocean quahogs and sea urchins (WWF Canada 2009).

Rocky shore

Much of the exposed shoreline in the Inner Scotian Shelf consists of bedrock such as granite or quartzite that is rather resistant to erosion and has a steep gradient. Areas with softer bedrock types tend to have more gently sloping coastlines (Bundy *et al.* 2014). Rocky shores can support extensive macroaglae beds and provide habitat for a wide variety of fish and invertebrates species.

Beaches

Beaches occurring within the SEA Study Area are comprised of sand, pebble and/or cobble. Beaches result mainly from the erosion of glacial till and are more prominent near drumlins. Erosion of drumlins separates the glacial till components (the sand, mud, gravel and cobbles and boulders) and redistributes them according to wave and current energy. Sand is generally transported to relatively sheltered beaches and nearby deeper waters. Due to their mobility in rough sea conditions, neither pebble nor cobble beaches can support seaweed in exposed areas. In more sheltered areas, however, they can provide suitable substrate for encrusting algae, macrophytes and sessile invertebrates. Sand beaches are extremely unstable and cannot support algae growth other than filamentous algae (Bundy *et al.* 2014).

Estuaries

The inner Scotian Shelf also contains some areas of estuarine habitat. Estuaries are coastal habitats that have marine waters diluted by riverine freshwater inputs. These habitats can vary in nature and size. Estuaries are noted for extremely high levels of productivity and serve as nursery areas for a variety of biota (Correll 1978). High levels of productivity are achieved when limiting resources of nitrogen and phosphorus are brought to marine waters from freshwater sources. These nutrients and plankton are pushed out to sea in fresh surface waters but much sinks into denser marine water below and is retained in the system (Correll 1978).

In addition to overall high productivity, estuaries contain important habitats for aquatic plants (*e.g.* eelgrass), invertebrates, fish and waterbirds. Fish species such as Atlantic cod use estuarine eelgrass habitats as nurseries (Gregory *et al.* 2006), whereas other finfish use estuaries for feeding (*e.g.* Atlantic salmon, McCormick *et al.* 1998; American eel, Velez-Espino and Koops 2010) or as staging areas for migration (*e.g.* Atlantic salmon, American eel, Dutil *et al.* 1989). For anadromous species that exhibit population structuring at small scales (Bradbury *et al.* 2009; COSEWIC 2011), local disturbance could have conservation implications for entire populations.

Mud Bottom

In sheltered areas, current speeds are low enough that fine grained sediments are able to settle from the water column and form mudflats. Such mudflats usually occur near estuaries, where sediments are supplied from riverine sources. Mud bottoms commonly occur in the most sheltered harbours, but can also occur in deeper basins where it has been accumulating for thousands of years. In general, mudflats are generally more stable than sandy bottoms and may support diatoms and blue green algae. Green seaweeds such as species of *Ulva* and *Enteromorpha* may also occur. In very sheltered areas, mud can be anaerobic, which affects the species assemblages present, but in areas with higher currents, the mud can be well aerated and well drained (Bundy *et al.* 2014).

Tidal or Salt Marshes

Tidal marshes are a type of marsh which are submerged on a daily basis by the tides. They generally occur in sheltered areas, where mud and silt can accumulate. Organic material in tidal sediments accumulate to the point that sediments become anaerobic. This limits the types of plants that can survive in this habitat. The plant species present also vary by elevation relative to sea level and degree of submergence. Plants in the lower marsh are also strongly affected winter ice damage (Bundy *et al.* 2014). Salt marshes are very productive, and play important roles in the life cycles of many species, including commercially important fish (Mann 2000).

3.2.2.1.2 Middle Scotian Shelf

The Middle Scotian Shelf is a region which extends the whole length of the Shelf. In the west, it is simply a narrow strip of bedrock, while the in the east, in the vicinity of the SEA Study Area, this region is a wide complex network of ridges, valleys and small gravel-covered banks (WWF Canada 2009). This complex topography results in a large number of habitat types and substrates. This variable topography includes the deep holes of Canso and an area known as “the Noodles”. This region of channel networks is associated with high diversity of fish and is also important habitat for sponges, shrimps and snow crab (WWF Canada 2009).

Middle Scotian Shelf Banks

The Middle Scotian Shelf region also includes a number of offshore banks. These banks tend to vary in shape and surface material. Banks within the SEA Study Area, such as Middle, Canso and Misaine Banks, tend to have gradually sloping margins. Misaine Bank, is noted for the extensive networks of channels caused by the melting sheet after the last period of glaciation (WWF Canada 2009). Fauna communities on the large sandy banks include sand dollars, amphipods, and important forage fish such as sand lance. Other areas support large bivalves such as quahogs, surf clams and scallops, while lobsters, horse mussels, brittle stars and crabs are found in gravelly areas (WWF Canada 2009).

Middle Scotian Shelf Basins

In the middle of the Scotian Shelf, several large open basins run parallel to the coast. Glacier activity and sediment deposition have smoothed out these basins and filled them with clay. In some areas, boulder-covered ridges of glacial till protrude, while small depressions known as pockmarks occur where natural gas has escaped through the sediments (WWF Canada 2009). Phytoplankton in these basins is periodically fertilized by influxes of warmer slope water forced into the basins by storm activity. This supports dense populations of krill and other zooplankton, which are preyed upon by witch flounder, red and silver hake (WWF Canada 2009). Mud-loving species such as heart urchins and mud stars live in the clay sediments. On the eastern Scotian Shelf, such basins provide excellent habitat for commercially important snow crab and shrimps (WWF Canada 2009).

3.2.2.1.3 Laurentian Channel

A small part of the SEA Study Area encompasses a portion of the Laurentian Channel. This Channel is a deep submarine valley, over 1200 km long; the remains of a former river valley which was eroded by glacial ice. Nutrient-rich water from the Atlantic Ocean travels into the Gulf of St Lawrence via this channel. The seafloor substrate consists mostly of sandy mud, while gravel occurs on the channel slopes. Marine life is abundant on the seafloor of the Laurentian Channel. The water column supports dense concentrations of krill (euphasids), while anemones and corals such as sea pens and cup corals can be abundant in areas near the middle of the channel. Common fish species include witch flounder, redfishes, and black dogfish.

3.2.3 Microbes

The term 'Marine microbes' encompasses all microscopic organisms found in saltwater. Marine microbial communities consist of viruses, prokaryotes (bacteria), and protists. Microbes utilize a variety of energy sources. Some, known as photoautotrophs, rely on sunlight as their primary energy source or as an auxiliary source (photoheterotrophs), while the majority, the heterotrophs, rely on organic material as their energy source (DFO 2011a). Note that photosynthetic microbes such as cyanobacteria are discussed in Section 3.2.5.1 Phytoplankton). Bacteria known to occur off eastern Cape Breton include the dominant SAR11 phylotype cluster, and other abundant phylotypes such as SAR86-like cluster, SAR116-like cluster, *Roseobacter*, Rhodospirillaceae, Acidomicrobidae, Flavobacteriales, *Cytophaga*, and unclassified Alphaproteobacteria and Gammaproteobacteria clusters. Heterotrophic, eukaryotic protists include Dinophyceae, Alveolata, Apicomplexa, amoeboid organisms, Labrynthulida, and heterotrophic marine stramenopiles. Ciliates include *Strombidium*, *Lohmaniella*, *Tontonia*, *Strobilidium*, *Strombidinopsis*, and the mixotrophs *Laboea strobila* and *Myrionecta rubrum*. Most viruses are cyanophages and bacteriophages, including podoviruses; additionally, there is some evidence of Mimivirus and Chlorovirus (Ford and Serdynstra 2013).

Though they are tiny, microbes in the marine environment are extremely abundant and play many critical roles in marine ecosystems. They play key roles in global carbon and nitrogen cycling. Their role in microbial decomposition, an important part of nutrient cycling, is essential. Heterotrophic bacteria break down organic molecules, such as those in biological detritus, and make those nutrients available for uptake and use by other organisms, such as plants.

Most heterotrophic marine bacteria rely on material derived from phytoplankton, including waste exuded from plankton cells, as well as waste released from grazers which feed on phytoplankton (DFO 2011a). Microbes are also an important food supply for larger organisms.

Some species of heterotrophic bacteria are also capable of utilizing the energy contained within hydrocarbon compounds. Crude oil, which is originally of biological origin, is known to seep naturally into the marine environment (Kvenvolden and Cooper 2003). The majority of hydrocarbons that enter the marine environment are biodegraded by indigenous microbial communities (Atlas 1991, Leahy and Colwell 1990, Prince 2010). These hydrocarbon-degrading microorganisms are common in the marine environment (Head *et al.* 2006, Yakimov *et al.* 2007), and more than 200 bacterial, algal, and fungal genera, encompassing over 500 species, are recognized as being capable of hydrocarbon degradation (see reviews by Head *et al.* 2006 and Yakimov *et al.* 2007).

However, there is little information available on native indigenous microbial communities that aid in oil degradation under *in situ* conditions at spill sites (Alonso-Gutierrez *et al.* 2009.). There is also little knowledge available on the effects of varying environmental parameters on the activities of indigenous hydrocarbon-degrading microorganisms. It has been suggested that the oil degradation capacity of microbial populations in marine sediments may be limited by low oxygen and nutrient levels, as well as the poorly understood ecological interactions between bacterial populations (Head *et al.* 2006). Overall, our ability to understand and predict the *in situ* bacterial community response to environmental stimuli, such as the presence of oil contamination, is primitive (Head *et al.* 2006, Prosser *et al.* 2007).

3.2.4 Macroalgae and Plants

The algae and marine plants occurring with the Study Area play a vital role in the ecosystem. Using just sunlight and nutrients, they produce organic matter which provides the basis of the marine food webs and provide structure, creating important habitat where they occur. Macroalage and vascular plants are discussed in the following subsections.

3.2.4.1 Macroalgae

Macroalgae are abundant on the coasts of the SEA Study Area, where they provide a vital food source to a number of species, as well provide structure and increase habitat complexity of coastal environments. They contribute significantly to inshore productivity, and intertidal and subtidal algal beds are important parts of the nutrient and carbon cycle in the nearshore (Mann 1972). They are the most important primary producers in coastal embayments or estuaries and contribute significant amounts of detritus. One coastal study estimated that that macroalgae production was 10 times greater than phytoplankton production per unit area (Moore and Miller 1983). However in offshore ecosystems where the water is too deep to allow macroalgae to attach and grow, phytoplankton are responsible for the majority of primary production (Prouse *et al.* 1984).

The two major factors affecting the abundance of intertidal macroalgal species are tidal range and ice coverage. A larger tidal range results in a larger intertidal zone, creating more habitat for intertidal species. Winter ice can scour macroalgae from its substrate, leading to less-developed intertidal macroalgal communities in areas subjected to winter ice, particularly pack ice, as occurs in the northern portions of the SEA Study Area.

Another factor now influencing the abundance of macroalgae off Nova Scotia is the occurrence of an invasive species of green algae, *Codium fragile* or Dead Man's fingers. This species can colonize inshore areas to the point that it dominates areas previously dominated by kelp beds (Harris and Tyrrell 2001, Chapman *et al.* 2002, Mathieson *et al.* 2003), leading to decreased habitat quality for species relying on kelp. The establishment of *Codium* has been aided (Scheibling *et al.* 1999), by another invasive species, the lacy crust bryozoan (*Membranipora membranipora*) which grows on kelp fronds, making them brittle and more prone to breakage, resulting in gaps in kelp beds where *Codium* can establish. Invasive species are discussed in more detail in section 3.2.6.5 (Invasive Marine Species).

Seaweeds along the rocky shores of Nova Scotia can be classified into three main groups. These are the Rhodophyta or red algae, the Phaeophyta or brown algae, and the Chlorophyta or green algae. Of the three types of macroalgae, the green algae have the highest light requirements and grow in the shallowest environments, particularly the intertidal zone. Red algae such as Irish moss (*Chondrus crispus*) and Dulse (*Palmaria palmata*) do not require as much light and grow from the intertidal to the shallow subtidal zones. Large species typically grow attached to a hard substrate, or they occur as epiphytes on other algae.

Most brown algae species occur on hard-bottom, coastal substrates, especially in cooler waters. Examples are the rockweeds (*Fucus* and *Ascophyllum* species), and the kelps (*Laminaria* and *Saccharina* species). Rockweeds usually dominate the intertidal zone in rocky areas, while kelps can form dense stands in subtidal areas. In both the intertidal and subtidal zones, algae species provide important shelter and a source of food for many marine invertebrates and fish. Table 3-2 lists some common algal macrophyte species on the Atlantic coast.

Table 3-2. Common algal macrophyte species on the Atlantic coast of Canada (from Bundy *et al.* 2014)

Species	Common Name
Ascophyllum nodosum	Rockweed or Knotted Wrack
Chondrus crispus	Irish moss
Palmaria palmata	Dulse
Phyllophora spp.	Dead Moss or False Moss
Ulva lactuca	Sea Lettuce
Fucus vesiculosus	Bladder Wrack
Fucus serratus	Toothed Wrack
Fucus distichus	Bladder Wrack
*Saccharina (*previously *Laminaria) longicruris*	Lasagna Kelp
Laminaria digitata	Horsetail Kelp
Agarum cribrosum	Colander or Holey Kelp
Codium fragile[1]	Dead man's fingers

[1] Invasive Species

3.2.4.2 Vascular Plants

Few true vascular plants can live in the marine environment. However, the one species that does occur in the Study Area, eelgrass (*Zostera marina*), can form extensive beds and provides a vital food source as well as structural complexity to coastal environments. Eelgrass beds are acknowledged to be highly productive areas within coastal waters (DFO 2009c, Waycott *et al.*, 2009, Parker and Worcester 2010). Eelgrass also plays an important role in stabilizing sediments and buffering the shore line and offers shelter for many species (DFO 2009c). These beds also provide fish and invertebrates with shelter from predation (Gorman *et al.* 2009).

Eelgrass beds occur frequently in shallow subtidal waters within the SEA Study Area. In some areas of Nova Scotia, eelgrass beds are threatened by the invasive green crab (*Carcinus maenas*), which interfere with the stability of the beds by digging into the sediment (Garbary and Miller 2006, Garbary *et al.* 2014).

3.2.5 Plankton

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

3.2.5.1 Phytoplankton (Microalgae)

Phytoplankton or microalgae consist of microscopic free-floating algae and cyanobacateria species. They are primary producers of oceanic ecosystems, using sunlight to produce energy (sugar) from carbon dioxide and water via photosynthesis. This energy production forms the base of marine food webs. Phytoplankton are thought to be responsible for up to half of all global photosynthesis (Barsanti and Gualtieri 2006).

Types of phytoplankton occurring on the eastern Scotian Shelf include diatoms, cyanobacteria, dinoflagellates and coccolithophores, euglenids and other single celled and colonial algae (Li *et al.* 1998, Graham and Wilcox 2000). Phytoplankton communities on the Eastern Scotian Shelf are generally dominated by diatoms and dinoflagellates. Other species present include members of the Bacillariophyceae, Dinophyceae, Prymnesiophyceae, Prasinophyceae, Trebouxiophyceae, Cryptophyceae, Dictyochophyceae, Chrysophyceae, Eustigmatophyceae, Pelagophyceae, Synurophyceae, and Xanthophyceae classes, as well as numerous genera of prokaryotic cyanobacteria. The abundance of the various taxa varies seasonally. Also, due to the complex mixture of water masses on the Scotian Shelf, Arctic, temperate and subtropical forms occur on the Shelf at various times (Head and Harris 2004).

The distribution and abundance of phytoplankton in surface waters is largely controlled by nutrient concentrations in the water column, sunlight availability, and herbivory. Nutrient concentrations in surface waters are largely controlled by the seasonal mixing patterns of marine waters, with upwelling events bringing nutrient-rich water from near the seafloor to the surface. This upwelling of the water column in spring, combined with increased sunlight availability, causes a peak in phytoplankton production, known as the spring bloom. This creates an increased food supply for other species, particularly herbivourous zooplankton (Rivkin *et al.* 1996.) Many fish and invertebrate species attempt to synchronize their annual reproductive cycles to take advantage of the increased biomass of phytoplankton (Platt *et al.* 1973, Cushing 1990). The spring bloom can persist for a few weeks until the key nutrients (nitrate, phosphate) are depleted in the surface waters. Secondary producers (zooplankton) prey heavily on the phytoplankton, resulting in a mid-summer low in phytoplankton abundance. The development of thermally stratified water layers as (thermocline) as summer progresses minimizes mixing of the water column, further reducing the nutrient supply to surface waters. After the bloom, large phytoplankton are reduced in abundance and the dominant zooplankton tend to be omnivores which prey on flagellates and ciliates (Rivkin *et al.* 1996). A smaller fall bloom often occurs with the advent of fall upwelling, though flagellates and dinoflagellates tend to dominate this later bloom.

The strength of the phytoplankton bloom can vary across years. Song *et al.* (2011) modeled interannual variability in phytoplankton blooms and plankton productivity on the Scotian Shelf and concluded that annual productivity on the Shelf was controlled by a combination of light and nutrient limitation, which offset one another and are of nearly equal importance. Since 1992, spring blooms on the Scotian Shelf start earlier in the year, are more intense, and last longer (Zwanenburg *et al.* 2006, Head and Pepin 2009).

Aside from seasonal trends in abundance, phtyoplankton abundance also varies spatially. Areas of constant or frequent upwelling tend to have higher nutrient levels and support higher phytoplankton areas throughout the year. These upwelling zones are created by both topography and currents and can be found where the Shelf meets deeper water and within the thermal gradients between the shelf and slope waters (Anderson and

Gardner 1986; Templeman 2007). Plankton also tend to be concentrated at convergence zones, where major currents meet. The Sydney Bight area has been noted as an important area of high phytoplankton productivity year-round (Breeze *et al.* 2002).

Phytoplankton abundance is often measured via the concentration of chlorophyll compounds in the water column, which can be done remotely. Figure 3-6 depicts the average chlorophyll concentrations during spring blooms from 1997–2007 on the Scotian Shelf and surrounding ocean.

Figure 3-6 Average chlorophyll concentration during spring blooms from 1997–2007 on the Scotian Shelf and surrounding ocean (From Ford and Serdynska 2013, white polygon is proposed St. Anns Bank AOI)

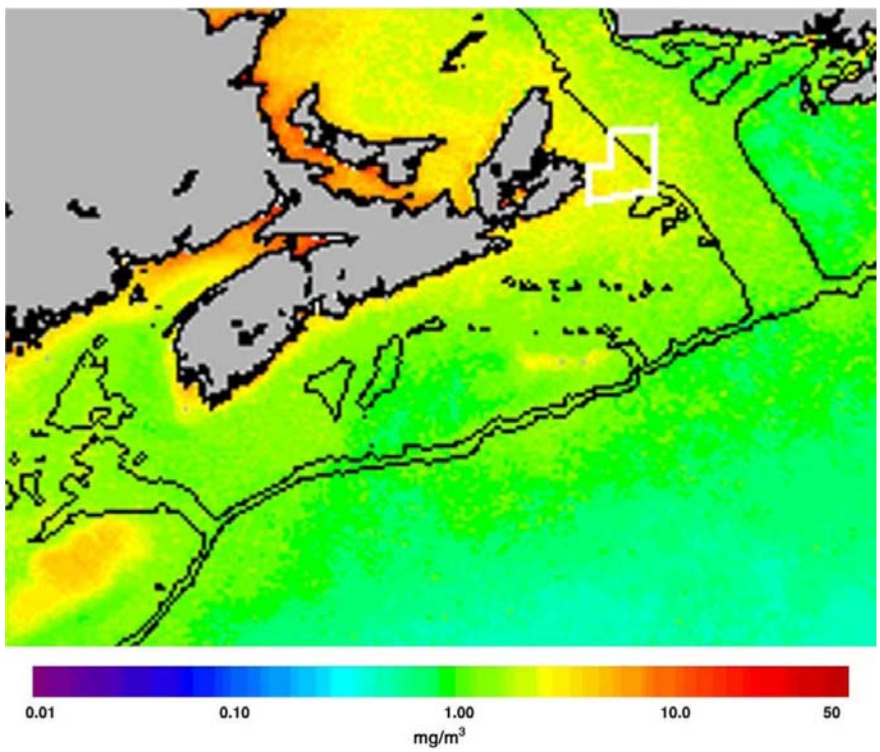
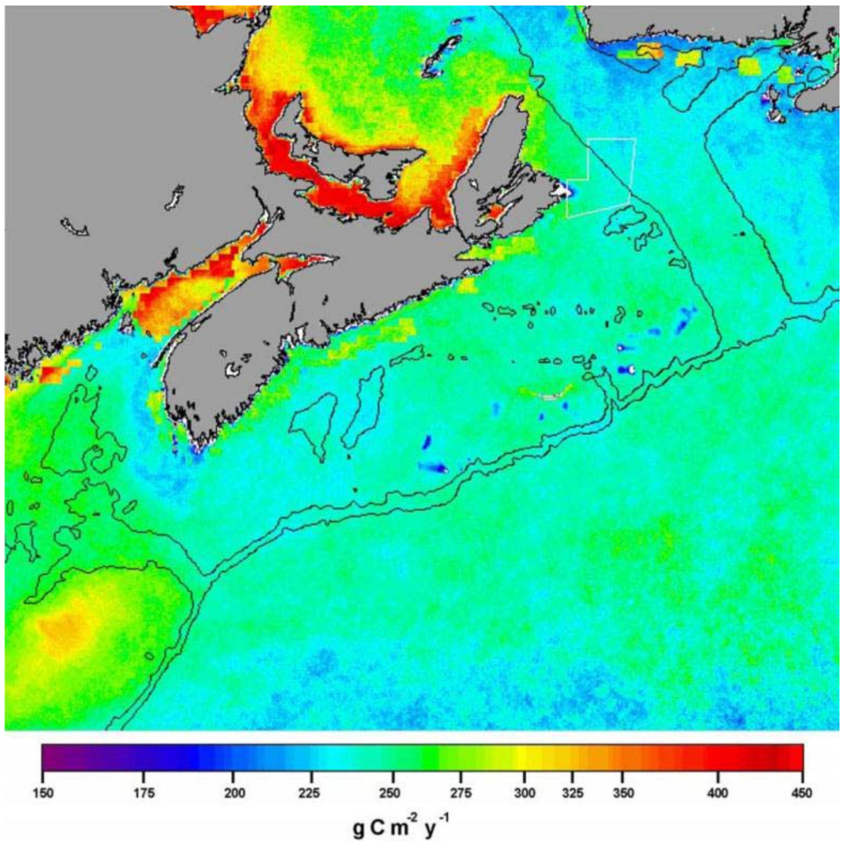


Figure 3-7 Average annual primary productivity on the Scotian Shelf over the period 1998–2004 (From Ford and Serdynska 2013, white polygon is proposed St. Anns Bank AOI).



The organic matter and detritus produced by primary production plays a key role in transporting nutrients and biogenic carbon from the surface waters to the sea floor (Rivkin *et al.* 1996, Tian *et al.* 2001).

Figure 3-7 shows the average annual primary productivity on the Scotian Shelf from 1998 to 2004.

Plankton communities can also vary across longer time scales. Analyses of data from Continuous Plankton Recorder sampling (a long-term plankton sampling project focussing on the North Atlantic), covering the Scotian Shelf back to the 1960s, show that phytoplankton levels were higher in the 1990s and 2000s than in previous decades (Head and Pepin 2009). On the eastern Scotian Shelf, plankton abundance has been decreasing since a peak in the 1990s (Head and Sameoto 2007). These changes correspond to variations in the Northern Atlantic Oscillation (NAO), a measure of the intensification of northwestern atmospheric flows that result in increased mixing and sea ice extent, causing colder, fresher ocean conditions. Thus when the NAO intensifies, nutrient levels increase and benefit primary productivity.

3.2.5.2 Zooplankton

Zooplankton are small floating or swimming marine organisms that generally drift with the current. Within marine food webs, they are a key energy pathway between primary producers and species occupying higher trophic levels, such as fish, whales and seabirds (Maillet *et al.* 2004). Zooplankton communities includes holoplanktonic organisms which complete their life cycle within the plankton. Examples are amphipods, krill, ctenophores, larvaceans, copepods, and salps. These are in contrast to meroplanktonic organisms, which spend only part of their lives as plankton. Examples include most larval forms of sea urchins, sea stars, crustaceans, marine worms, some marine snails, most fish, and some cnidarians.

Zooplankton occur in a range of sizes. The microzooplankton (20-200 µm in length) includes ciliates and the eggs and larvae of larger taxa. Mesozooplankton are 0.2-2 mm in length and include copepods, Cladocerans; Ostracods; Chaetognaths, amphipods, larvaceans, pelagic molluscs, and larvae of benthic organisms such as echinoderms, molluscs, and crustaceans. The macrozooplankton are 2mm to 20 cm long and include organisms such as krill, salps, and ctenophores. Finally, megaplankton are > 20 cm long and include jellyfish, squid, and some salps.

Zooplankton population and community dynamics are influenced by both advection and by local environmental conditions, and vary across several temporal and spatial scales (Morales 1999, Dalley *et al.* 2001). Peaks in zooplankton production in the Northwest Atlantic vary from year to year (Dalley and Anderson 1998). On the Scotian Shelf, zooplankton levels have been lower in more recent years than in the 1960s and 70s (opposite the phytoplankton trend) and are beginning to recover from the lows observed in the 1990s (Harrison *et al.* 2007). In general, the temporal and spatial variation in zooplankton abundance follows that of phytoplankton, in that a peak occurs in spring and declines afterward as the phytoplankton food base is depleted and the zooplankton community is exposed to continual predation by other zooplankton, fish, birds, and marine mammals.

Within the zooplankton community, copepods make up over 80 percent of the species richness in the Northwest Atlantic (Dalley *et al.* 2001). Calanoid copepods are by far the dominant component of zooplankton communities on the Scotian Shelf (Head and Harris 2004). During late winter and spring, the Nova Scotia Current supplies Scotian Shelf waters with most *Calanus* species which originate from the Gulf of St Lawrence to the north (Herman *et al.* 1991). For example, more than 60% of the mesozooplankton biomass of the St Anns Bank region in spring is accounted for by large copepods of the genus *Calanus* (Head and Harris 2004). The three main species, *Calanus finmarchicus, C. hyperboreus,* and *C. glacialis* overwinter on the Scotian Shelf by descending into deeper water. Deep Scotian Shelf basins have been shown to harbor large populations of zooplankton during autumn and winter which consist mainly of late stages of *C. finmarchicus, C. hyperboreus,* and *C. glacialis* (Herman *et al.* 1991).

Zooplankton has been sampled along two survey lines throughout the SEA Study areas in spring and fall since 1999 (DFO 2011). These lines extend into the Cabot Strait and off of Louisbourg. The three Calonoid copeopods, together with smaller copepods in the genera *Pseudocalanus, Oithona,* and *Temora* account for > 80% of the total copepod abundance at stations CSL1–3 and LL1–3 in spring, > 90% in shelf and deep waters in summer, and > 80% at CSL1–3 and > 60% at LL1–3 in fall.

Euphausiids, commonly known as krill, are small shrimp-like crustaceans which belong to the crustacean order Euphausiacea. They are large zooplankton (up to 4 cm in length) that form a major link in the food web between plankton and large predators such as fish and other high trophic levels (Sameoto and Cochrane 1996). Modelling of krill abundance has indicated that a band of high abundance of vertically migrating krill occurs along the Laurentian Channel slope (Sourisseau *et al.* 2006).

Tremblay and Roff (1983) identified five "core" zooplankton species for the Scotian Shelf, which were widespread and abundant. These were the copepods *Calanus finmarchicus, Metridia lucens, Pseudocalanus minutus and Oithona similis*, and the pelagic predatory sea snail *Limacina retroversa.*

Many zooplankton species (*e.g. C. finmarchicus*) have been shown to migrate vertically on a daily basis, in order to minimize their predation risk. Individuals move to surface waters at night to feed on light-dependent phytoplankton and return to greater depths during the day (Dalley and Anderson 1998). Such migrations benefit biological production by replenishing organic carbon and nitrogen in surface layers (such as thermoclines) and are an important component of benthic-pelagic coupling (Morales 1999).

3.2.5.3 Ichthyoplankton (Pelagic Larval Fish and Eggs)

Many marine fish species utilize a reproductive strategy known as broadcast spawning, in which the fish release their eggs and sperm into the water column to be fertilized (Chambers 1997, Scott and Scott 1988). The eggs then passively disperse in the water column as they develop and hatch into larvae. The larvae then generally drift in the current as they develop into juvenile fish. These floating fish eggs and larvae are referred to as ichthyoplankton, and can have considerable importance to local fisheries, both as a source of new fish and as a food supply for larger organisms. On the Scotian Shelf, at least 147 species, representing 91 genera were reported in ichthyoplankton samples collected as part of the Scotian Shelf Ichthyoplankton Survey (SSIP) (Shackell and Frank 2000). The species within ichthyoplankton assemblages vary depending on season and location (Frank *et al.* 1992; Dalley and Anderson 1998; Bradbury *et al.* 2008), as well as hydrographic and physical oceanographic features (*e.g.,* Frank and Leggett 1983, Cowen *et al.* 1993; Moser and Smith 1993). Assemblages of ichthyoplankton often share spawning strategies (*e.g.,* Sherman *et al.* 1984, Doyle *et al.* 1993).

Abundance of fish eggs and larvae can differ from year to year by orders of magnitude (Dalley and Anderson 1998, Bradbury *et al.* 1999, Houde 2008). All fish larvae possess a yolk sac when then hatch, which sustains them until they are large enough to feed on their own. This is a critical stage, for if a fish larva does not find food soon after depleting its yolk reserves, it will starve. Mortality rates of larval stages can vary strongly across years, impacting the size of subsequent age-classes (Cushing 1990, Houde 2008).

The reasons for these fluctuations in mortality rate remain poorly understood for many species. Some fisheries scientists (Brander and Hurley 1992, Sherman *et al.* 1987) have suggested that some fish species may spawn according to the timing of plankton blooms, which is considered to be a main food source for larvae. Poor survival of larvae has been attributed to starvation caused by a mismatch in this timing. Other studies (Leggett and Deblois 1994, Mousseau *et al.* 1998) have reported only limited evidence to support the match– mismatch hypothesis. Mousseau *et al.* (1998) also suggested that, in general, larvae are not dependent on peak zooplankton blooms. They showed that larval fish production on Sable Island Bank can be partially supported by the microbial food web and may not be entirely dependent on spring and fall blooms. Both calanoid and cyclopoid copepods, which are important larval prey, are known to be able to prey on members of the microbial food web.

Fisheries scientists have also suggested that year-class failures are attributable to transport of larvae to habitats unsuitable for their survival (*e.g.,* Houde 2008). This could be caused by unusual environmental conditions affecting spawning or nursery habitats, or causing changes in spawning location or behaviour. It is known, for example, that some oceanographic features such as thermoclines (Frank *et al.* 1992), upwelling zones (Ings *et al.* 2008) and gyres (Bradbury *et al.* 2008) tend to retain ichthyoplankton. As these features are spatially restricted (Bradbury *et al.* 1999; Bradbury *et al.* 2008), changes in spawning locations could have large effects on the drift trajectory of larvae. In addition, the retentiveness of certain oceanic features can differ across seasons.

Shackell and Frank (2000), using data from the SSIP from 1978-82, described ichthyoplankton communities on the Scotian Shelf as dominated by Redfish, Hakes (Longfin, Silver, Red And White), Witch Flounder, Sand Lance, and Fourbeard Rockling. Other fish larvae that were regularly captured in tows included commercial species such as Atlantic Cod, American Plaice, Haddock, Atlantic Herring, Monkfish and Atlantic Mackeral. Species at Risk such as Northern, Striped, and Spotted Wolffish were also reported. Additional data on distribution of ichthyoplankton on the Scotian Shelf are available in Stewart *et al.* (2003).

Table 3-3 provides a summary of known ichthyoplankton abundance and distribution in the vicinity of the SEA Study Area.

Table 3-3 Summary of Known Distribution and Seasonality of Fish Eggs (E) and Larvae (L) for Select Marine Fish Species, with a focus on the Eastern Scotian Shelf.

Species	Month												Known Spawning Locations
	J	F	M	A	M	J	J	A	S	O	N	D	
Monkfish [1,2]					E	E L	E L	E L	E L				Scotian Shelf
American Plaice [3,4]				E L	E L								Scaterie Bank, Misaine Bank, Laurentian Channel, Sable Island Bank, Middle Bank, Canso Bank, St Anns Bank
Atlantic Cod (Northern)[5,6,7]	E	E	E L	E L	E L	E L	E L	E L	E L	E L	E L	E L	Sable Island Bank , Misaine Bank, Sable Anns Bank, Middle Bank, Sydney Bight (coastal), Scaterie Bank
Atlantic Argentine[1]		E	E	E	E								Scotian Shelf, Sable Island Bank
Atlantic Herring[8]										l	l		Sable Island Bank
Atlantic Mackeral [9,1, 10]				E	E	E L	E L	E L					Scotian Shelf, Sable Island Bank
Capelin[5]	L	L	L	L	L			L	L	L			St. Anns Bank St Anns Basin Misaine Bank Eastern Scotian Shelf (coastal)
Winter Flounder[2]						L	L	L	L				Scotian Shelf
Cunner[2]					E	E L	E L	E L	L	l			Scotian Shelf
Fourbeard Rockling[2]					E	E L	E L	E L	E L	E L	L		Scotian Shelf
Haddock [1112]			L	E	E L	E L							Sable Island Bank

Species	Month												Known Spawning Locations
	J	F	M	A	M	J	J	A	S	O	N	D	
Hake[2]					E	E	E	E	E	E			Scotian Shelf
Long-finned hake [1]	E	E								E	E	E	Scotian Shelf
Pollock [13]	E	E	L	L							E	E	Sable Island Bank
Silver Hake [214]				E	E	E	E	E L	E L	E			Scotian Shelf
Witch FLounder[151]							L	E L	E L	L			Sable Island Bank Scotian Shelf
Yellowtail Flounder[15]				E	E	E	E						Sable Island Bank
Atlantic Wolffish[2]		L	L	L	L								Scotian Shelf
White hake [16,17]					L	L		L	L				Scotian Shelf

[1.] Markle and Frost 1984, [2.]Stewart *et al.* 2003,[3.]Nevisnky and Serebrykov 1973, [4]Neilson *et al.* 1988,[5]Breeze *et al.* 2002, [6]Hanke *et al.* 2000, [7]Gage and O'Boyle 1984,[8]Harris and Stephenson 1999,[9]Stewart *et al.* 2003,[10]Fortier and Villeneuve 1996,[11]Hanke *et al.* 2001b, [12]O'Boyle *et al.* 1984,[1.]Hanke *et al.* 2001a,[14]Rikhter *et al.* 2001,[15]Neilson *et al.* 1998, [16]Davis *et al.* 1998, [17]Fahey and Able 1989

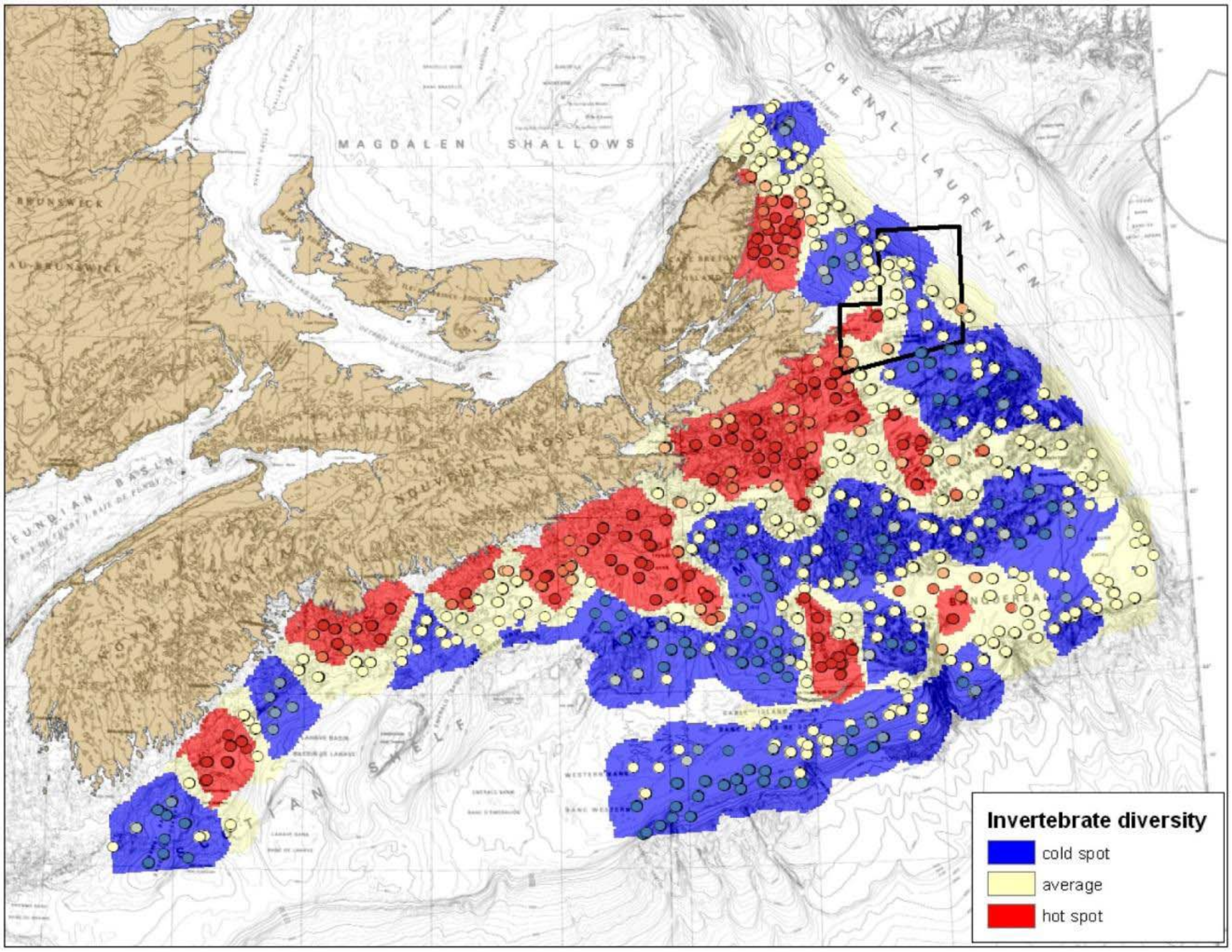
3.2.6 Benthic Marine Invertebrates

Marine invertebrates are comprised of a very diverse group of spineless organisms, which live in virtually all marine habitats. They live from the intertidal zone to the deepest parts of the ocean. Marine invertebrates may live on or near the sea floor (benthic species) or may be pelagic and occur throughout the water column. Benthic species include those which live within the sea floor (infauna, *e.g.* worms and clams) and epifauna, or species which live on the sea floor (*e.g.* lobsters and whelks). Pelagic species include small zooplankton species, as well as larger more mobile species such as squid.

DFO's RV survey has only recorded invertebrates in Nova Scotia consistently since 1999. These surveys do not sample organism less than 4 cm in length and generally do not sample organisms living within the seabed. Only select invertebrates (lobster, shrimp, crab, scallop, echinoderms) are recorded because they are caught regularly in the survey, are quantifiable, and may have commercial value (Tremblay *et al.* 2007). Others, such as corals and sponges are difficult to ID at sea and so are only identified at a high level (*e.g.* "sponge").

Figure 3-8 depicts 'hot spots' of invertebrate diversity as indicated by the annual DFO snow crab survey. These hot spots tend to be near shore, in areas of complex bathymetry.

Figure 3-8 Invertebrate biodiversity hot spots on the eastern Scotian Shelf (based on the DFO snow crab survey). (Source: Ford and Serdynska 2013).



3.2.6.1 Overview of Main Taxa

The main marine invertebrate taxonomic groups occurring in the SEA Study Area are described in this section. Descriptions include general ecology, behaviour, and ecological importance. Main marine invertebrate species and/or taxa of commercial or ecological importance are also outlined in Table 3-4. Zooplankton species, which are also invertebrates, were discussed in Section 3.2.5.

Crustaceans

The Crustaceans form a very large group of arthropods, which includes familiar species such as crabs, lobsters, krill, and barnacles. They have exoskeletons, which they must moult to grow. Crustaceans exhibit a wide range of forms, ranging from small sessile barnacles, which feed on suspended materials, to highly mobile lobster and crabs and free-floating organisms such as copepods. Each of the main groups of crustaceans occurring in the study area is discussed briefly below, with mention of species of particular ecological or socioeconomic importance.

Decapods includes many familiar marine groups, such as crabs, lobsters, prawns and shrimp. They have ten legs, with one pair of legs often having enlarged pincers. Most decapods are scavengers, though some are also predatory. Small decapods are often prey for large fish such as cod. DFO has reported at least 33 species of decapods from the Scotian Shelf surveys, unfortunately no data is available for the Laurentian Channel.

Table 3-4. Select Marine Invertebrate Taxa Occurring on the Scotian Shelf within the SEA Study Area.

Species or Taxon	Details[1]
	CRUSTACEANS
American lobster (*Homarus americanus*)	**Typical Habitat** Preferred Substrate: gravel, cobble, boulder Preferred Depth: 2-145 m **Biology and Ecology** • Distribution from Southern Labrador to North Carolina • Offshore populations occur from 110-145 m depth on the outer edge of the continental shelf • Feeds on benthic invertebrates (crabs, sea urchins, mussels, polychaetes, periwinkles and sea stars) and fish carcasses **Status and Use** • Commercial fishery
Northern shrimp (*Pandalus borealis*)	**Typical Habitat** Preferred Substrate: mud, silt Preferred Depth: 150 – 600 m **Biology and Ecology** • Distributed from west Greenland to Georges Bank • Feeds on polychaetes, small crustaceans, detritus, marine plants, copepods, and euphausiids • Important prey species for halibut, cod, redfish, and harp seals **Status and Use** • Commercial fishery • Ecologically important: forage species
Snow crab (*Chionoecetes opilio*)	**Typical Habitat** Preferred Substrate: mud, sand Preferred Depth: 60 – 400 m **Biology and Ecology** • Distributed in the Northwest Atlantic from Greenland to the Gulf of Maine • Feeds on polychaetes, bivalves, echinoderms, and fish carcasses • Commonly observed species in SEA Study Area • Prey species for various groundfish other snow crabs and seals **Status and Use** • Commercial fishery
Striped pink shrimp (*Pandalus montagui*)	**Typical Habitat** Preferred Substrate: sand (Warren and Sheldon 1967) Preferred Depth: 140 – 260 m (Hudon et al 1992)

Species or Taxon	Details[1]
	Biology and Ecology • Undertakes diurnal vertical feeding migrations (Hudon et al 1992) • Feeds mainly on copepods in pelagic waters and on polychaetes and foraminiferans at benthic depths (Hudon et al 1992) • Prey species for halibut, cod, redfish and seals **Status and Use** • Commercial fishery • Ecologically important as forage species
Green Crab (*Carcinus maenas*)	**Typical Habitat** Preferred Substrate: soft bottoms Preferred Depth: 0- 6 m **Biology and Ecology** • Native to Europe • Voracious appetite and aggressive competition with other species makes the green crab a threat to shellfish and a nuisance for the fishing industry • Eats clams, mussels, oysters, scallops and even small lobster • Reach sexual maturity at two or three years of age, and live up to seven years. • A true swimming crab, green crab can swim up off the sea floor and reach prey items native crab species cannot. • Reproductive schedule varies, but females typically release their eggs during the summer months. • Burrows into the seabed, damaging the roots of plants, such as eelgrass • Capable of surviving out of water for up to a week. • A widespread invasive species which has caused concern for bivalve aquaculture and shellfish fisheries. • Considered to be one of the 100 worst invasive species in the world **Status and Use** • Currently no commercial fishery in region • An invasive species
Rock Crab	**Typical Habitat** Preferred Substrate: prefers sandy bottom Preferred Depth: 0-20m **Biology and Ecology** • Found from Labrador to South Carolina • Prefers sand but can be found on all types of substrate • Poorly sampled by DFO groundfish surveys, likely due to their preference for shallower depths **Status and Use** • Commercial Species
Amphipods, various species (Amphipoda)	**Typical Habitat** Preferred Substrate: silt, sand, gravel (Houston and Haedrich 1984) Preferred Depth: 100 – 300 m (Konstantinov et al 1985) **Biology and Ecology** • Feeds on algae (Duffy and Hay 1991) • Prey for commercially important species including American plaice and yellowtail flounder (Pitt 1973) • One coastal species, the Japanese Skeleton Shrimp (*Caprella mutica*) is a pest of aquaculture **Status and Use** • Ecologically important; important food source for fishes

Species or Taxon	Details[1]
Hooded shrimp, various species	**Typical Habitat** Preferred Substrate: gravel, sand (Houston and Haedrich 1984) Preferred Depth: varies **Biology and Ecology** • Northwest Atlantic distribution from Newfoundland to Cape Cod (Gosner 1979) • Prey species for American plaice, yellowtail flounder, and cod (Bruno et al 2000, Pitt 1979) **Status and Use** • No conservation status or fishery in region
Copepods, various species ***Calanus finmarchicus*, *C. glacialis* and *C. hyperboreus*. *Pseudocalanus* spp. *Oithona* spp.**	**Typical Habitat** Preferred Substrate: pelagic Preferred Depth: varies with developmental phase and season **Biology and Ecology** • Calanoid copepods all spend part of the year, when surface conditions are unfavourable, at depth in a dormant state, and come to the surface to feed on the spring bloom in March/April • In the St Anns Bank region, reproduction, growth and development persist until fall. As the late *Calanus* stages descend to enter dormancy, they accumulate in deep waters such as the area of the Laurentian Channel included in the St Anns Bank AOI. • *Pseudocalanus* and Oithona are evenly distributed throughout the study region **Status and Use** • *Calanus finmarchicus* is a key species in the ecosystems of the Scotian Shelf and Gulf of St. Lawrence, due to role as prey species for fish, birds, and whales • No conservation status or fishery in region
Isopods (Various species)	**Typical Habitat** Preferred Substrate: varies Preferred Depth: varies **Biology and Ecology** • Various feeding methods: some eat dead or decaying plant and animal matter, others are grazers or strain food particles from the water around them, a few are predators, and some are internal or external parasites, mostly of fishes. • Entirely benthic. • Some species bore into the seabed, the ground or timber structures. • The eggs are brooded by the female, and hatch into post-larvae which resemble the adult form. **Status and Use** • No conservation status or fishery in region
Krill (*Meganyctiphanes norvegica, Thysanoessa inermis and T. longicaudata*)	**Typical Habitat** Preferred Substrate: pelagic Preferred Depth: varies **Biology and Ecology** • The largest and most important species on the Scotian Shelf and in the Laurentian Channel is *Meganyctiphanes norvegica*, followed by *Thysanoessa inermis* and *T. longicaudata*. • Can occur in great densities. • Large zooplankton (up to 4 cm in length) that form a major link in the food web between plankton and large predators such as fish and other high trophic levels (Sameoto and Cochrane 1996). • All are preyed upon by many species of fish (notably silver hake and redfish), seabirds, and whales (Sameoto and Cochrane 1996). • Feed on copepods and phytoplankton.

<table>
<tr><th>Species or Taxon</th><th>Details[1]</th></tr>
<tr><td></td><td>Highest concentrations of krill are found in the Shelf basins, but the slope of the Laurentian Channel is also known to host high concentrations (Sameoto and Cochrane 1996).
Considered an important trophic level connection because they feed on phytoplankton and to a lesser extent zooplankton, making them available to larger animals which feed on krill
Status and Use
No conservation status or fishery in region</td></tr>
<tr><td colspan="2">MOLLUSCS</td></tr>
<tr><td colspan="2">GASTROPODS</td></tr>
<tr><td>Whelks
(Buccinum spp.)</td><td>Typical Habitat Preferred Substrate: mud, sand, gravel, rock (Himmelman and Hamel 1993)
Preferred Depth: Tidal - 180 m
Biology and Ecology
Distributed in cold waters from Labrador to New Jersey
Abundant on Sudney Bight
Feeds on urchins, polychaetes, amphipods, crustaceans and fish eggs
Scavenges on animal carcasses
Prey species for lobster, cod, crab, seastars and dogfish
Waved whelks prefer colder water and tolerate salinities down to approximately 20 ppt (DFO 2009d).
Found at depths of more than 100 m and on various types of substrates (boulders, cobbles, mud), but greatest densities have been found on muddy bottoms at 15–30 m depth (DFO 2009d).
Status and Use
Waved whelk or common whelk (Buccinum undatum) is commercially fished in some parts of Atlantic Canada.
No commercial fishery within SEA region</td></tr>
<tr><td>BIVALVES</td><td></td></tr>
<tr><td>Sea scallop
(Placopecten magellanicus)</td><td>Typical Habitat Preferred Substrate: sand, gravel, pebble
Preferred Depth: 20 – 70 m
Biology and Ecology
Northwest Atlantic distribution from Labrador to North Carolina
Suspension feeders on phytoplankton and detritus
Prey species for crab, lobster, seastars, gastropods, cod, plaice and wolffish
Status and Use
Commercial species</td></tr>
<tr><td>Icelandic scallop
(Chlamys islandica)</td><td>Typical Habitat Preferred Substrate: sand, gravel, shell, boulder
Preferred Depth: more than 55 m
Biology and Ecology
Northwest Atlantic distribution
Inhabits area with strong currents and high salinity
Size portioning in relation to depth with larger individuals at higher depths
Suspension feeders on phytoplankton
Status and Use
Commercial species</td></tr>
<tr><td>Propellor clam</td><td>Typical Habitat Preferred Substrate: sand (Kenchington et al 2001)</td></tr>
</table>

Species or Taxon	Details[1]
(*Cyrtodaria siliqua*)	Preferred Depth: 120 – 150 m (Kenchington et al 2001) **Biology and Ecology** • Can reach high abundance on sandy bottoms (Kenchington et al 2001) • Population is dominated by clams older than 100 years (Kilada et al 2009) • Prey species for cod, American plaice and wolffish (Kilada et al 2009; Templeman 1985) **Status and Use** • Commercial species
Surf clam (*Spisula solidissima*)	**Typical Habitat** Preferred Substrate: silt, sand Preferred Depth: 8 – 66 m **Biology and Ecology** • Northwest Atlantic distribution from the Gulf of St. Lawrence to North Carolina • Prey species for benthic invertebrates (rock crabs, seastars, hermit crabs, moon snails, whelks) and groundfish (cod, flounder, sculpin, ocean pout) **Status and Use** • Commercial species • No conservation status in region
Horse Mussel (*Modiolus modiolus)*	**Typical Habitat** Preferred Substrate: hard substrates including shells and stones Preferred Depth: low tide mark -80m **Biology and Ecology** • A large mussel growing to 22 cm • Occurs along the Atlantic coast of North America, from the Arctic Ocean to Florida, as well as in the Pacific Ocean • Feed on phytoplankton • Can form large beds **Status and Use** • No conservation status or fishery in region
Blue mussel (*Mytilus edulis*)	**Typical Habitat** Preferred Substrate: hard substrate Preferred Depth: shallow waters **Biology and Ecology** • Native to the North Atlantic, but introduced elsewhere • Live in intertidal and subtidal areas attached to rocks and other hard substrates via strong thread-like structures they secrete (byssal threads) • Can detach and reattach to surfaces • Preyed upon by sea stars and sea gulls. • Filter feeders **Status and Use** • Commercial, Aquaculture species
American Oyster *(Crassostrea virginica)*	**Typical Habitat** Preferred Substrate: soft bottoms Preferred Depth: 2-10 m **Biology and Ecology** • Native to the eastern seaboard and Gulf of Mexico coast of North America • Lives in marine and brackish waters • Filter feeders of plankton and detritus • Filter feeders. • Can provide a key structural element within their ecosystem, making them a foundation species in many environments

Species or Taxon	Details[1]
	• Oyster beds provide key habitat for many species by creating hard substrate for attachment as well as shelter • Spawning is controlled by water temperatures **Status and Use** • Aquaculture species, Commercial species in Bras d'Or Lakes
CEPHALOPODS	
Short-finned squid (*Illex illecebrosus*)	**Typical Habitat** Preferred Temperature: 16.0 – 27.0°C Preferred Depth: NDA **Biology and Ecology** • Northwest Atlantic distribution from Greenland to Florida. Concentrated from Newfoundland to Cape Hatteras • Feed on euphausiids, fish and other squid • Undertakes diurnal vertical migrations **Status and Use** • Commercial species
ECHINODERMS	
ECHINOIDEA	
Green Sea Urchin (*Strongylocentrotus droebachiensis*)	**Typical Habitat** Preferred Substrate: rock Preferred Depth: intertidal to >1000 m **Biology and Ecology** • Occurs in northern waters of the Atlantic and Pacific Oceans • A herbivorous species usually associated with kelp beds • At high densities, they can create urchin barrens, bare of kelp • Based on DFO's multi-species survey, there are relatively high densities of sea urchins in much of the SEA Study Area. • Eaten by sea stars, crabs, large fish, mammals, birds, and humans. **Status and Use** • Commercial species
Sand dollar (*Echinarachnius parma*)	**Typical Habitat** Preferred Substrate: sand Preferred Depth: more than 800 m **Biology and Ecology** • Northwest Atlantic Distribution from Labrador to North Carolina • Burrows in soft substrates • Reaches densities of 100 individuals / m^2 • High abundance on sandy bottoms of the Grand Bank (Kenchington et al 2001) • Stomach gut contents include diatoms, sand grains, sponge spicules and detritus **Status and Use** • Ecologically important as food source for commercially important groundfish species
OPHIUROIDEA	
Brittlestars **various species** (*Ophiura sarsi, Ophiopholis aculeate, Amphipholis squamata)*	**Typical Habitat** Preferred Substrate: gravel, cobble, coralline algae, shell Preferred Depth: Intertidal - more than 300 m **Biology and Ecology** • Comprised of several species of brittle star (Daisy Brittle Star (*Ophiopholis aculeate, Amphipholis squamata*; *Ophiura* spp) • Distributed from the Arctic to Cape Cod region (Gosner 1979) • Feeds on small crustaceans, polychaetes and detritus

Species or Taxon	Details[1]
	• Important prey species important prey items for numerous commercially significant shellfish and finfish species. **Status and Use** • No conservation status or fishery in region
Basket star (*Gorgonocephalus arcticus*)	**Typical Habitat** Preferred substrate: variable substrate (Gosner 1979) Preferred Depth: Subtidal – more than 1,200m (Gosner 1979) **Biology and Ecology** • Primarily feeds on euphausids (Emson et al 1991) • Associated with deep sea corals (Rosenberg et al 2005) **Status and Use** • No conservation status or fishery in region
Sea stars (many species)	**Typical Habitat** Preferred substrate: variable substrate (Gosner 1979) Preferred Depth: intertidal – more than 1,200m (Gosner 1979) **Biology and Ecology** • Familiar star-shaped echinoderms • Opportunistic feeders, prey on benthic invertebrates • Some species associated with deep sea corals (Rosenberg et al 2005) • Very common in DFO Scotian Shelf surveys, with at least 23 species. Three most common are *Ctenodiscus crispatus, Psilaster Andromeda,* and *Crossaster papposus* • Some are considered keystone species within their ecosystems **Status and Use** • No conservation status or fishery in region
Orange footed sea cucumber (*Cucumaria frondosa*)	**Typical Habitat** Preferred Substrate: gravel, cobble, rubble (So et al 2009) Preferred Depth: 20 – 100 m (Hamel and Mercier 2010) **Biology and Ecology** • Distributed across the North Atlantic • Patchy distribution for inshore and offshore populations (So et al 2009) • Concentration of sea cucumbers on either side of the French corridor off St Pierre • Suspension feeder that consumes mainly phytoplankton and detritus • Preyed upon by seastars **Status and Use** • Commercial fishery
CNIDARIANS (except corals, which are disucssed in Section 3.2.6.4.1)	
Sea anemones (Actiniaria) Cerianthid anemone *Cerianthus borealis*,	**Typical Habitat** Preferred Substrate: cobble, rubble, boulder Preferred Depth: Variable **Biology and Ecology** • Variety of species found on Scotian Shelf • Feeds on echinoderms and other invertebrates **Status and Use** No conservation status or fishery in region
Lion's Mane or Red Jelly (*Cyanea capillata*)	**Typical Habitat** Preferred temperature : 5 - 20°C: Preferred Depth: Variable 20 – 40 m **Biology and Ecology** • Largest jellyfish in the world , reaching 2 m in diameter • Occurs in the northwest Atlantic Ocean from Labrador to Cape Hatteras. • Appears in swarms in the northern part of its range during late spring/summer and the presence of large individuals may persist into the fall.

Species or Taxon	Details[1]
	• May be found in bays and sounds and offshore in the open ocean (Gosner 1979). • Requires relatively warm water and higher salinity levels associated with deep water • Feeds on fish eggs and larvae **Status and Use**: No conservation status or fishery in region
Moon Jelly *(Aurelia aurita)*	**Typical Habitat** Preferred Substrate: 5 - 20°C Preferred Depth: Variable 20 – 40 m **Biology and Ecology** • Distribution extends from Greenland to the West Indies, but is relatively rare south of Cape Cod (Gosner 1979). • Highly adaptable to a wide range of environmental conditions. • Feeds on fish eggs and larvae **Status and Use**: • No conservation status or fishery in region
OTHER TAXA	
Sipunculan worms (*Sipuncula*)	**Typical Habitat** Preferred Substrate: mud, sand, rock, coral (Gosner 1979) Preferred Depth: intertidal to subtidal depths (Gosner 1979) **Biology and Ecology** • Burrowing worms • Many species are deposit feeders (McMahon et al 2006) • Preyed upon by groundfish and other invertebrates **Status and Use** • No conservation status or fishery in region
Polychaete worms (many species) tube-building polychaetes (Nothriidae)	**Typical Habitat** Preferred Substrate: silt (Houston and Haedrich 1984) Preferred Depth: more than 50 m **Biology and Ecology** • Distributed throughout the North Atlantic • Variety of species found on the Scotian Shelf • Prey species for groundfish and invertebrates **Status and Use** • Major component of marine benthic communities
Ascidians (sea squirts, tunicates, salps)	**Typical Habitat** Preferred Substrate: some attach to hard substrates, some pelagic Preferred Depth: varies **Biology and Ecology** • Sac-like marine invertebrate filter feeders • Most are sessile • Salps such as Thaliacea and Larvacea species swim freely in plankton • Some are colonial • May reproduce both asexually and sexually. • Preyed upon by nudibranchs, flatworms, molluscs, rock crabs, sea stars, fish, and birds. **Status and Use** • No conservation status or fishery in region • Some species are invasive and are fouling pests of shipping and aquaculture, discussed in Section 3.2.6.5
Chaetognaths	**Typical Habitat** Preferred Substrate: NA (pelagic)

Species or Taxon	Details[1]
(arrow worms)	Preferred Depth: varies **Biology and Ecology** • Marine worms that are a major component of plankton worldwide. • Prey on other planktonic animals • Some species are benthic, and can attach to algae and rocks. • Occur from surface tropical waters and shallow tide pools to the deep sea and polar regions. • Chaetognaths swim in short bursts • Some species use aneurotoxin to subdue prey. • All are carnivorous **Status and Use** • No conservation status or fishery in region
[1] Information is summarized from: Christian *et al.* (2010) unless otherwise noted. [2] Note that Porifera (Sponges) are not discussed in this table, as they are discussed separately in Section 3.2.6.4.2 Porifera (Sponges) .	

Molluscs

Molluscs are the largest marine phylum. They are a highly diverse group in terms of size, structure, behaviour, and habitat. The three main groups are discussed briefly in the following paragraphs. Important commercial molluscs are outlined in Table 3-4.

Gastropods (‘snails’) are molluscs which typically have a coiled external calcareous shell, though in some species such as slugs and nudibranchs this shell is minimal or lacking. Well-known marine gastropods include periwinkles, moon snails, limpets and whelks. Marine gastropods includes species which are herbivores, detritus feeders, predatory carnivores, scavengers and parasites.

Bivalves are a class of marine and freshwater molluscs that have laterally compressed bodies enclosed by a shell consisting of two hinged parts. They include familiar species such as clams, oysters, cockles, mussels, and scallops. Most bivalves are filter feeders. Many species bury themselves in the sediment (“infauna”) while other species such as scallops lie on the sea floor. Still others attach themselves to rocks (*e.g.* mussels) or bore into wood or stone, such as shipworms. Most have planktonic larvae. Many bivalve species have long played roles as important food source of coastal peoples. Species of commercial value are listed in Table 3-4.

Cephalopods include squid, octopus, and cuttlefish. They occupy most of the depths of the ocean. The short-finned squid is an important forage species and is often fished for bait in Atlantic Canada (Table 3-4).

Echinoderms

Echinoderms are recognizable by their (usually five-point) radial symmetry, and include such well-known animals as starfish, sea urchins, sand dollars, and sea cucumbers, as well as the sea lilies or "stone lilies". Echinoderms have a mesodermal skeleton composed of calcareous plates or ossicles. These ossicles may be fused together, as in the test of sea urchins, or may be flexible as in the arms of sea stars, brittle stars and crinoids. Echinoderms, particularly sea stars and brittle stars, are extremely widespread and abundant on the Eastern Scotian Shelf (Tremblay *et al.* 2007). The main groups present are discussed briefly below.

Sea urchins, sand dollars, and heart urchins are members of the class Echinoidea, which are generally small, spiny, globular or flattened animals which move slowly by means of hundreds of tiny, transparent, adhesive "tube feet". Urchins feed mostly on algae and can have dramatic impacts on kelp forests. They can also feed on sea cucumbers and a wide range of invertebrates. They are preyed upon by starfish, wolf eels, and other predators. Sand dollars are flattened disk-shaped echinoids which plow through sediments.

Brittle stars or ophiuroids are echinoderms closely related to starfish. Generally they have five long, slender, flexible arms which they use to crawl across the sea floor. Individuals may reach up to 60 cm (24 in) in length. They tend to attach themselves to the sea floor or to sponges or cnidarians, such as coral. Brittle stars can be found from the low-tide level and below (Gosner 1979). Basket Stars are a suborder of Brittle stars. They have many-branching arms, and generally live in deep sea habitats.

Crinoids, also known as sea lilies or feather stars are echinoderms which as adults live attached to the sea bottom by a stalk. They feed by filtering small particles of food from the sea water with their feathery arms. They have tube feet, which are covered with a sticky mucus that traps any food that floats past. They are poorly sampled by DFO surveys but are known to occur on the Scotian Shelf.

Sea cucumbers are member of the echinoderm class Holothuroidea. They have leathery skin and an elongated body, vaguely resembling a cucumber. They are abundant in deep waters, where they feed on detritus and other organic matter using short branched tentacles surrounding their mouths. Worldwide, many species are consumed by humans. At least three species have been reported from DFO surveys, with the Orange-footed sea cucumber (*Cucumaria frondosa*) being the most common by far.

Cnidarians

The Phylum Cnidaria includes organisms which are generally soft-bodied and alternate between generations of a free-floating stage, known as the medusa, and a sessile stage termed a polyp. They also use stinging cells (nematocysts) to capture their prey. Types of Cnidarians include hydroids, jellyfish, sea anemones, and corals. As important habit-forming species, corals are discussed in detail in Section 3.2.6.4.1.

Hydroids, members of the Class Hydrozoa, are small organisms in which the life history is dominated by the sessile polyp stage (Gosner 1979). Jellyfish are well-known and abundant members of the Class Scyphozoa, in which the life history is dominated by the free-swimming medusa stage (the "jellyfish"). The sessile polyp form is reduced to a small larval stage. Common jellyfish in coastal waters of the Study Area include the Lion's Mane (*Cyanea capillata*) and the Moon jelly (*Aurelia aurita*). Jellyfish prey on fish larvae and invertebrates, and are important prey themselves for endangered sea turtles (See Section 3.2.10 Sea Turtles).

Sea anemones are predatory animals belonging to the order Actiniaria. They consist of a sessile polyp attached at the bottom to the surface beneath it by an adhesive foot, called a basal disc, with a column-shaped body ending in an oral disc. They prey on small fish and shrimp. Tube-dwelling anemones belong to the order Ceriantharia and resemble sea anemones. They live buried in soft sediments, within tubes they make from secreted mucus. Both types of anemone lack a free-swimming medusa stage.

3.2.6.2 Abundance and Distribution of Key Commercial Invertebrate Species

The heterogeneous habitats and environmental conditions in the Study Area vary in their suitability to marine invertebrate species. As indicated previously, the Study Area is composed of two general marine habitats, the Scotian Shelf area and a Portion of the deep Laurentian Channel. Table 3-5 presents the 15 most abundant invertebrate species found in trawls that had a high degree of overlap with the SEA Area (based on the DFO RV survey data). Note that invertebrates were not recorded for the Laurentian Channel survey from 1997-2002, so complimentary information is not available for this area.

Table 3-5. Top 15 Most Abundant Invertebrate Species from RV Survey Trawls (2004-2014) that overlap the SEA Study Area

Common Name	Scientific name	# Caught	Average # Caught per tow	Percent of total catch of Species	Commercial Species
Northern Shrimp	*Pandalus borealis*	**650,762**	2308	56.50	Yes
Striped Pink Shrimp	*Pandalus montagui*	**265,194**	940	23.03	Yes
Shrimp Phasiphaea/pink glass shrimp	*Pasiphaea multidentata*	**12,210**	43	1.06	
Arctic argid shrimp	*Argis dentata*	**11,633**	41	1.01	
Brittle star	Ophiuroidea species	**10,191**	36	0.88	
A Pandalid Shrimp	*Pandalus sp.*	**8,660**	30	0.75	
Snow Crab	*Chionoecetes opilio*	**6,810**	24	0.59	Yes
Sea Pens	*Pennatulacea*	**5,179**	18	0.45	
Mud star	*Ctenodiscus crispatus*	**4,461**	16	0.39	
Green Sea Urchin	*Strongylocentrotus droebachiensis*	**3,704**	13	0.32	Yes
A Heart Urchin	*Brisaster fragilis*	**3,499**	12	0.30	
Shortfin Squid	*Illex illecebrosus*	**3,375**	12	0.29	Yes
Mysid shrimp	*Crangon* sp.	**2,869**	10.	0.25	
Spider Crab	*Hyas coarctatus*	**1,801**	6	0.16	
A spirontocarid shrimp	*Spirontocaris liljeborgii*	**1,751**	6	0.15	

Note that no DFO invertebrate data is available for the Laurentian Channel portion of the SEA Study Area

Areas of elevated commercial marine invertebrate densities were defined using data collected during the 2004-2014 Scotian Shelf DFO RV Surveys. Density distributions based of individuals per tow for these invertebrates has also been mapped in the Figures that follow. Five invertebrate species of commercial significance (American lobster, snow crab, northern pink shrimp, striped shrimp, and rock crab) are also described below. Note that lobster is an important and abundant commercial species in the SEA Study Area; however, it is poorly sampled by the DFO surveys and so is not within the top 15 species in Table 3-5. Rock crab, another commercial species within the SEA is also poorly surveyed and so is not mapped. Some SEA Study Area invertebrate species are of particular social and economic importance. These species include:

American Lobster

The American lobster (*Homarus americanus*) is found in waters ranging between –1.5 and 24 ºC (DFO 2009b). In summer they move to shallower, warmer waters; in winter, most move to deeper water to avoid ice, cold, and winter storms. Lobsters use a wide range of habitats, including sand, gravel, and cobble seabeds, but prefer bottom types with boulders and larger grain sizes (Tremblay *et al.* 2009). They are abundant in rocky, structurally complex habitats (Geraldi *et al.* 2009) which is abundant around Cape Breton Island and adjacent to the western mainland of Nova Scotia.

Snow crab

Snow crab are large cold-water crabs that support an important commercial fishery on the Eastern Scotian Shelf. They are sexually dimorphic, with only the larger males being caught in commercial fisheries (carapace width of 9.5 cm and over). Females are generally too small to be available to the gear (DFO 2009c). In the northwest Atlantic, snow crab range from northern Labrador to the Gulf of Maine. They are more common in colder waters of the Eastern Scotian Shelf than they are further south, on the Western Scotian Shelf for example. Snow crab have been a dominant macroinvertebrate on the Eastern Scotian Shelf since the decline of groundfish in the early 1990s (DFO 2010c). Their overall importance to the ecosystem is not clearly understood, but due to their high abundance, it is likely that they are an important predator in benthic systems in this region (Choi and Zisserson 2011). Within the SEA Study Area, snow crab are most abundant to the south of Cape Breton Island and in the Sydney Bight (
Figure 3-9). They are fished off Cape Breton Island.

Northern Shrimp

Northern shrimp (*Pandalus borealis*) are a major prey species on the eastern Scotian Shelf, in addition to supporting a commercial fishery. On the Scotian Shelf, this shrimp is the focus of a recently established offshore trawl fishery and a developing inshore trap fishery (Koeller 1995, 1996a). The main concentrations of northern shrimp are found on the eastern Scotian Shelf, in the Louisbourg, Canso and Misaine Holes (Koeller 1996b). DFO surveys with the SEA Study Area show the species to be most abundant south of Cape Breton Island, and along the Canso shore (Figure 3-10). Similar to populations elsewhere, northern shrimp on the Scotian Shelf reproduce annually, with spawning (egg extrusion) in the late summer-early fall and hatching in the late winter-early spring (Koeller 1996b). This species is found throughout the Scotian Shelf at depths of 150 m to 350 m (DFO 2012b).

Striped Shrimp

Striped shrimp (*Pandalus montagui*) are generally more widespread but less abundant than northern shrimp on the Scotian Shelf (Tremblay *et al.* 2007). They are also smaller and generally of less commercial value than Northern shrimp. DFO surveys with the SEA Study Area shown this species to be most abundant south of Cape Breton Island, and close to shore along the Sydney Bight (Figure 3-11).

Figure 3-9 Distribution and Abundance of Snow Crab, as determined by DFO RV surveys from 2004-2014.

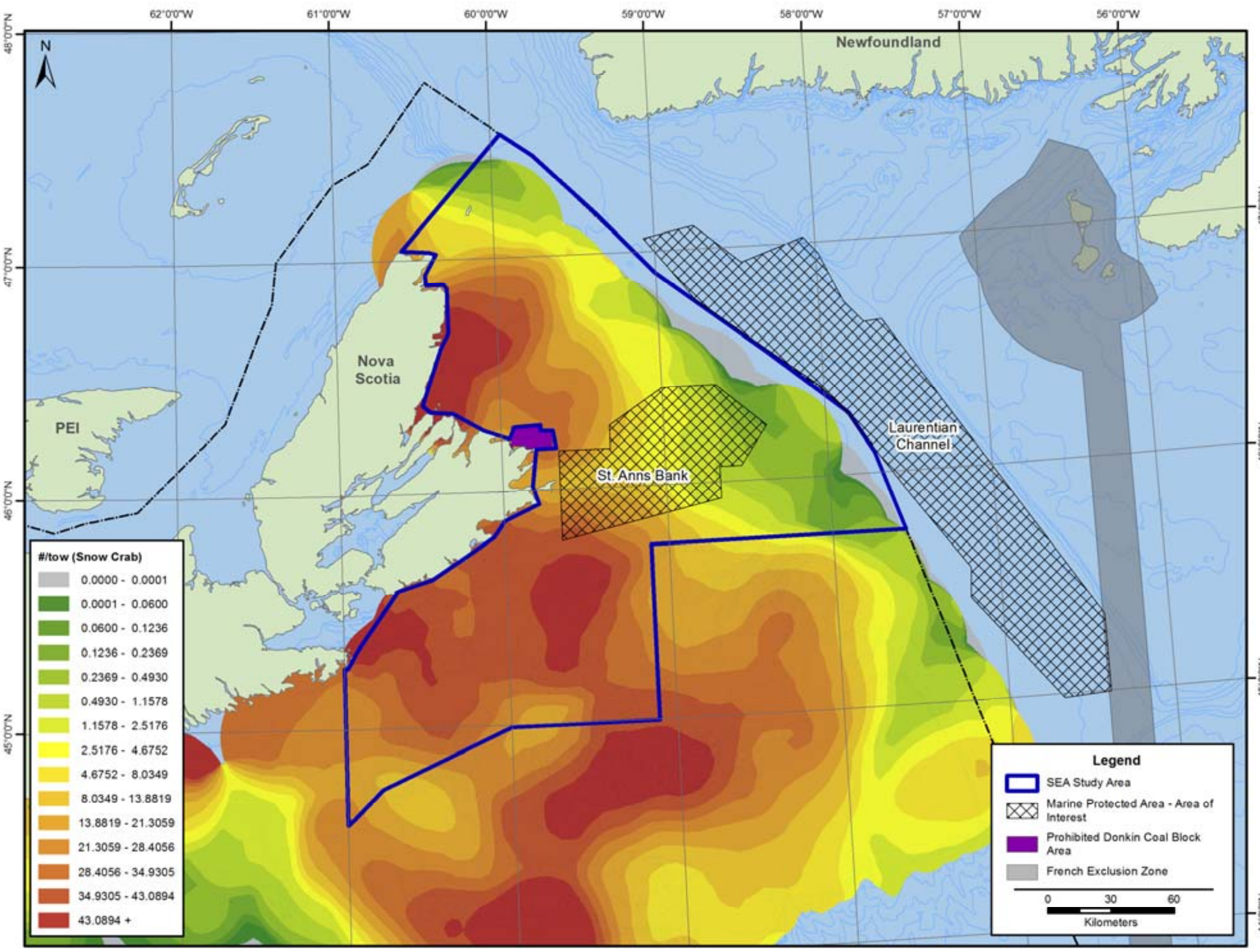


Figure 3-10 Distribution and Abundance of Northern Shrimp, as determined by DFO RV surveys from 2004-2014.

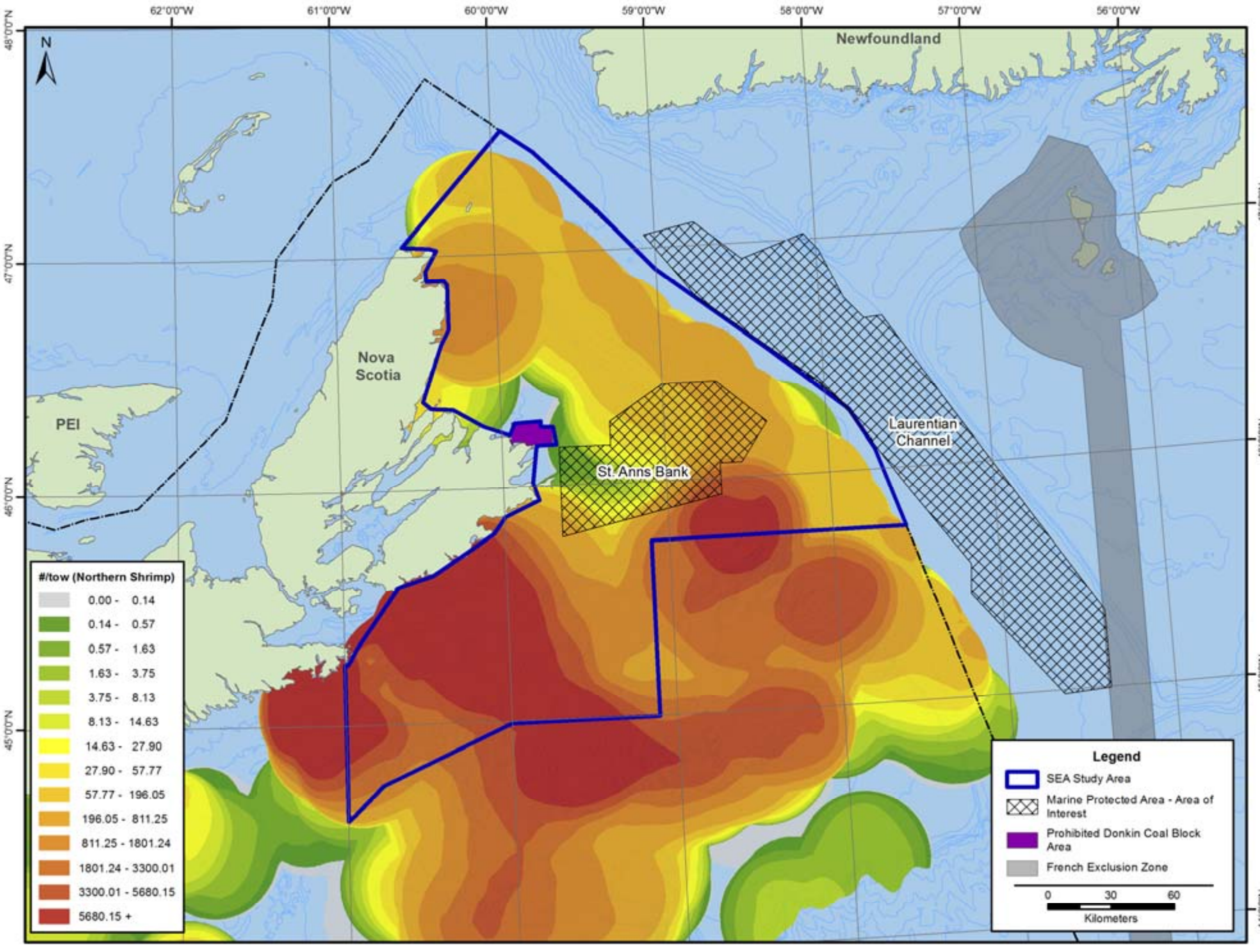
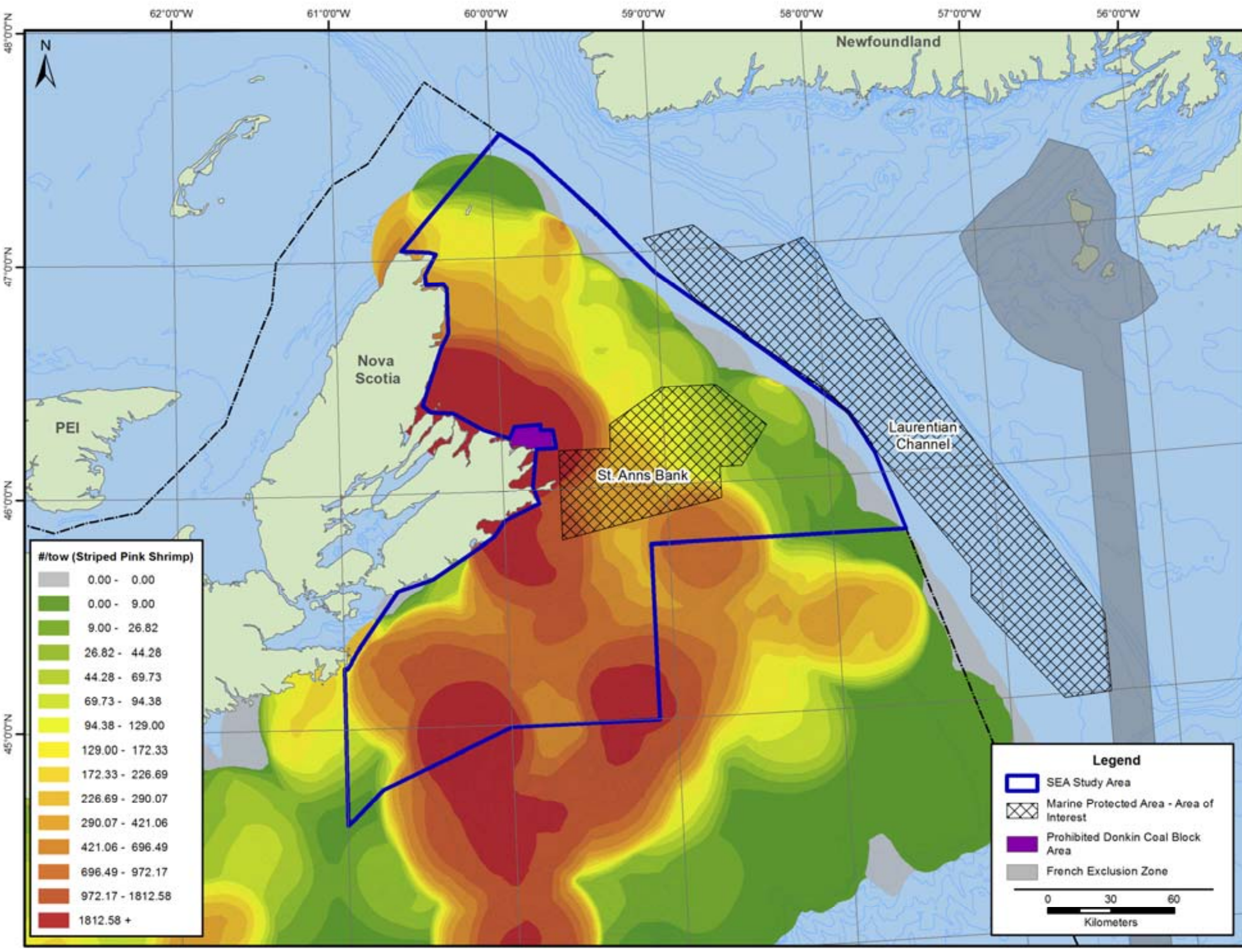


Figure 3-11 Distribution and Abundance of Striped Pink Shrimp, as determined by DFO RV surveys from 2004-2014.



3.2.6.3 Summary of Some Key Spawning Times for Select Marine Invertebrates

Time and locations of spawning activity vary across taxa. Key spawning times and areas for marine invertebrate species of commercial or ecological significance are outlined in Table 3-6.

Table 3-6. Spawning Periods and Reproductive Biology for Key Invertebrate Species (S= spawning period, E= extruded eggs carried by female)

Common Name	Scientific Name	J	F	M	A	M	J	J	A	S	O	N	D	Egg Dispersal Strategy	Larval Behavior
Whelk [1]	*Buccinum* spp.					S	S							Demersal	Demersal
Deep sea corals [2,3]	Various species			S	S	S								Variable	Variable
Sponges [4]	*Geodia* sp.				S	S								Pelagic	Pelagic
Short-finned squid [1,5]	*Illex illecebrosus*			S	S	S								Pelagic	Pelagic
Surf clam [1,6]	*Spisula solidissima*								S	S	S			Pelagic	Pelagic
American lobster [1]	*Homarus americanus*					S	S	E	E					Brooded	Pelagic
Snow crab [1,7]	*Chionoecetes opilio*				S	S								Brooded	Pelagic
Icelandic scallop [1,6]	*Chlamys islandica*								S	S				Pelagic	Pelagic
Northern shrimp [1,6]	*Pandalus borealis*			S	S	S	S		E	E				Brooded	Pelagic
Pink shrimp [8]	*Pandalus montagui*	E		S	S	S						E	E	Brooded	Pelagic
Sea scallop [1,6]	*Placopecten magellanicus*								S	S				Pelagic	Pelagic

3.2.6.4 Habitat-Forming Species

Some species of marine invertebrates, particularly sessile or relatively immobile species such as corals and sponges, can create habitat for other species by increasing habitat structure and benefiting local biodiversity (Kramp *et al.* 1932; Hecker and Blechschmidt 1979; Etnoyer and Warrenchuck 2007; Molodtsova and Budaeva 2007). This increased structure benefits marine fishes and invertebrates by providing protection from strong currents, refuge from predators, nurseries for larval and juvenile life stages, feeding areas, spawning areas, resting areas, and breeding areas (ICES 2009).

Marine species over five centimetres in height have been considered as structure-forming and capable of having a strong influence on biodiversity (Tissot *et al.* 2006). Species taller than 1 m can have very strong effects on the structure of benthic communities (Lissner and Benech, 1993 in Tissot *et al.*, 2006). However, factors such as complexity of morphology and population density, in addition to size determine whether a species can be considered habitat forming (Tissot *et al.* 2006).

Megafaunal invertebrates form structure if they aggregate in high numbers, especially in areas of low relief (Tissot *et al.* 2006). For example, high density "forests" of crinoids provide refuge and substrata for a wide variety of small fishes and invertebrates (Lissner and Benech 1993 in Tissot *et al.* 2006). Other studies have shown that very dense aggregations of species such as brittle stars on sand, brachiopods in boulder-cobble areas, and fields of sea urchins in sand and mud habitat, can provide space and structure for other organisms (*e.g.,* Metaxas and Giffin 2004, Brodeur 2001). It has also been suggested that large deposit-feeding sea cucumbers may also promote deep-sea benthic diversity by suppressing competitive exclusion among the smaller benthic species in surface sediments (Dayton and Hessler 1972).

Corals, sponges, and other habitat-forming species and features are discussed in further detail within the following subsections.

3.2.6.4.1 Corals

The term coral is used to describe several different orders within the Phylum Cnidaria. In general, corals are suspension-feeding organisms which live attached to the sea floor, consuming plankton and other particles in the water column. Most are colonial organisms, with many polyps sharing a common skeleton. They lack the medusa stage of other Cnidarians. Species which live in deep water do not contain symbiotic algae as tropical corals do, and so are not limited to the photic zone. Such corals are often referred to as deep sea or cold-water corals. Deep-water corals occur in Atlantic Canada at water depths in the general range of 200-1500 m. In general, very little is known about reproductive behaviours and strategies of cold-water corals; however some are known to have separate sexes which release gametes into the water column to be externally fertilized (Sun *et al.* 2009).

Deep-sea corals are important component to the ecology of the marine environment. They provide structural complexity on the seafloor, and therefore provide shelter, food, or substrate for epifaunal growth for other organisms (Watanabe *et al.* 2009) including commercial fish (Gilkinson and Edinger 2009). In addition, they have been shown to increase biodiversity and habitat heterogeneity in the deep sea (Buhl-Mortensen *et al.* 2010). A DFO report (2010a) concluded that "Corals and sponges form complex, three-dimensional biogenic structures that directly and indirectly influence the occurrence and abundance of many fish and invertebrate species." A total of 114 associated species have been identified to date on specimens of *Paragorgia* and *Primnoa* in Atlantic Canada (Buhl-Mortensen and Mortensen 2005). Large and stony corals are also considered to be important in providing habitat for other corals (see, *e.g.* Freiwald *et al.* 2004, Fuller *et al.* 2008a).

Deep sea corals in Atlantic Canada have been classified into five functional groups: 1) large gorgonians or antipatharian corals (larger Gorgonaceans), 2) small gorgonian corals (smaller Gorgonaceans), 3) cup corals (Scleractinia), 4) sea pens (Pennatulacea), and 5) soft corals (Alcyonacea). The first two groups are considered to be the most sensitive to disturbance because their carbonate skeletons cannot reattach to substrate if dislodged (Gilkinson and Edinger 2009). Most deep sea coral species occur in areas of hard substrates, such as cobble, boulder and consolidated sandstone, and in areas with high current speeds (MacIsaac *et al.* 2001; Mortensen and Buhl-Mortensen 2005). A notable exception is the sea pens, or Pennatulaceae, which prefer soft or clay bottom habitats (Mortensen and Buhl-Mortensen 2005).

Alcyonacea (Soft Corals, Mushroom Corals) are an order of coral species which do not produce calcium carbonate skeletons. Instead they contain tiny skeletal elements called sclerites, which give them some degree of structural support.

Large and small Gorgonians (Branching Corals, "Trees") are branched hard corals which live attached to hard substrates in area of high current. They produce calcium carbonate 'skeletons' and are vulnerable to damage from benthic fishing gear. Formerly classified as Gorgonaceans, these species are now considered part of Order Alcyonacea, but are still commonly referred to as Gorgonians to distinguish them from the 'typical' softer-bodied Alcyonacea.

Pennatulacea (Sea Pens) are colonial organisms which grow in the form of a stalk with a bulbous root which anchors them in soft substrates. Additional polyps which serve water intake, reproductive, and feeding roles branch out from this central stalk. Sea pens tend to grow in areas with soft clay or silt sediments, and can be abundant in some areas. They feed on plankton in the water column. Sea pens are recognized as important habitat for both fish and invertebrates (DFO, 2005).

Scleractinia (Stony Corals, "Spider Hazards", Cup Corals) are also sessile hard corals, but are generally not branched. Colonial, they consist of large numbers of polyps, cemented together by the calcium carbonate they secrete. They generally live attached to hard substrates in areas of high current.

While deep sea corals tend to grow much more slowly than tropical species, a few species do manage to form small reef-like structures over time (Wilson 1979; Gass and Roberts 2006). As generally slow-growing sessile organisms, corals are vulnerable to disturbance such as fishing and oil and gas activities (Campbell and Simms 2009, Watanabe *et al.* 2009). They are also thought to reproduce on an irregular basis, rather than at set times each year. The slow growth rate and potentially few reproductive episodes may make it difficult for corals to recover from damage caused by human activities.

Most species recorded off Nova Scotia are colonial organisms, with multiple tiny polyps sharing a common skeleton, while others are solitary species. Nova Scotia waters are home to two subclasses of corals, the Hexacorallia and the Octocorallia. The Hexaocrallina includes the order Scleractinia (stony corals or hard corals) and the order Antipatharia (black corals). The Octocorallia include the soft or leather corals (Alcyonaceans), the horny corals (Gorgonians) and the sea pens (Pennatulaceans). Species known to occur within the SEA Study Area are listed in Table 3-7.

While corals are often captured in DFO trawl surveys, many species are not easily identified to species level while at sea. Therefore much of the DFO data is presented at coarser levels of identification.

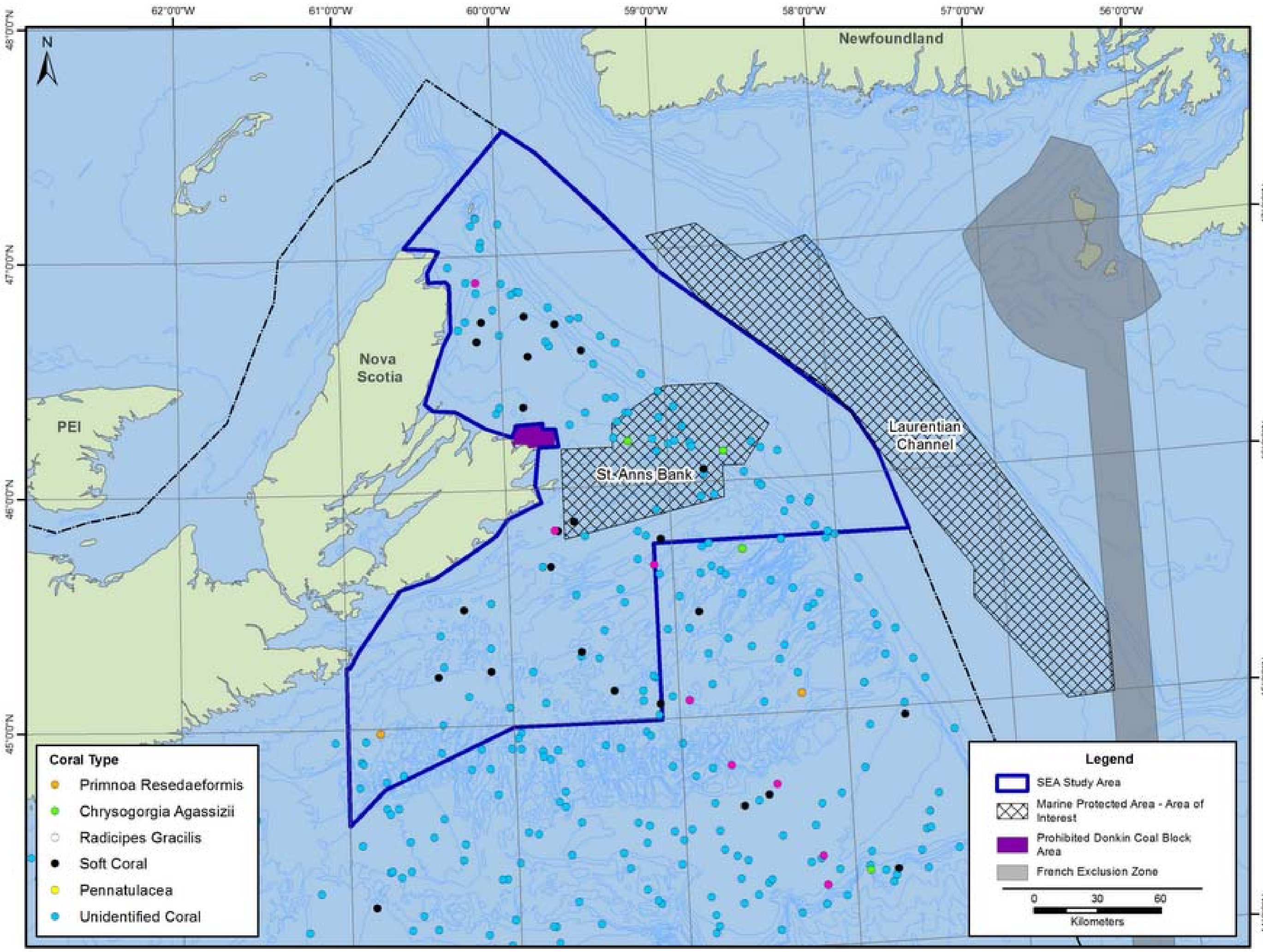
Table 3-7. Coral species reported from the Gulf and Scotian Shelf portions of the SEA Study Area (Source: Cogswell *et al.* 2009).

Order	Family	Genus and Species
Alcyonacea (Soft Corals, Mushroom Corals)	Alcyoniidae	*Gersemia rubiformis*
Alcyonacea[1] ("Gorgonians", Branching Corals, "Trees")	Paragorgiidae	*Paragorgia arborea*
	Plexauridae	*Paramuricea spp.* [2]
	Primnoidae	*Primnoa resedaeformis*
	Isididae	*Acanella arbuscula*
Pennatulacea (Sea Pens)	Pennatulacea	*Pennatulacea* [3]
	Pennatulidae	*Pennatula borealis*
	Anthoptilidae	*Anthoptilim grandiflorum*
	Halipteridaa	*Halipteris spp.* [2]
Scleractinia (Stony Corals, "Spider Hazards", Cup Corals***)***	Caryophillidae	*Lophelia pertusa*
	Flabelliadae	*Flabellum alabastrum*

[1]Species formerly known as Gorgonacea have been reclassified into Alcyonaea; however, the term Gorgonid is often still used.
[2] Indicates more than one species, though they have not been identified to species level
[3]The species is a member of the Order Pennatulacea, but could not be identified further.

Known distributions of corals in the SEA Study Area are mapped on Figure 3-12. The distribution of deep-water corals is patchy and influenced by several environmental factors including substrate, temperature, salinity and currents. In the northwest Atlantic, deep water corals appear to be distributed along the continental shelf edge and slope at depths greater than 200m mainly at the end of channels between fishing banks and in submarine canyons (Campbell and Simms 2009). Soft corals, in contrast, tend to be distributed in shallower waters.

Figure 3-12 Deep Sea Corals in the Study Area



The Coral Conservation Plan for the Maritimes Region (ESSIM 2006) identified certain corals as particularly vulnerable to human activity due to their size, morphology, and life history characteristics (ESSIM 2006). These are the large gorgonian corals, such as *Paragorgia arborea, Paramuricea sp.,* and *Primnoa resedaeformis*, and the reef-building coral *Lophelia pertusa*. All of these species have been reported from the Study Area though no *Lophelia* reefs are known to occur.

3.2.6.4.2 Porifera (Sponges)

Sponges are a diverse group of organisms from the phylum Porifera. They are primitive aquatic animals that lack organs but have specialized cells and a collagenous matrix. Their bodies are organized around interior canal systems, making them highly effective filter feeders (ICES 2009, Bergquist 1978). There are three main groups: Calcarea (calcareous sponges), Hexactinellida (glass sponges) and Demospongiae (silicious sponges). Habitat for sponges range from the inter-tidal zone to depths of several kilometres (ICES 2009).

Adult sponges are generally sessile and live on firm substrates. Sponges undergo both sexual and asexual forms of reproduction. They range in form from thin, encrusting species to animals that can branch or form large mounds. While most sponge species in the North Atlantic occur as isolated individuals, in some areas they can form dense multispecies communities (ICES 2009).

Sponges are known to be habitat forming-species, and often provide shelter to numerous other species living within and around their bodies (Fuller *et al.* 2008a), leading to increases in local biodiversity (Bett and Rice 1992, Klitgaard, 1995, Kunzmann 1996; Bo *et al.* 2012). The ability to provide habitat for other species depends on the size of the sponge, the size and number of its ostia (water channels) and the characteristics of the sponge's surface. One study found over 200 species occurring within 11 sponges in the North Atlantic (Klittgaard 1995). Like corals, sponges can also increase habitat structure if they aggregate in high numbers, especially in relatively flat areas (Tissot *et al.* 2006). These 'sponge grounds' can provide habitat for a number of invertebrates and fish species, in the form of spawning and nursery areas, feeding areas, and refuge from predators (Klitgaard 1995, Freese and Wing 2003, Amsler *et al.* 2009, Kenchington *et al.* 2013). Twenty-five sponge species have been identified as habitat-forming (ICES 2009). It has also been suggested, that since sponges filter large volumes of water every day, that they may link the pelagic microbial food web to the benthos (Pile and Young 2006).

Sponge species of the Northwest Atlantic are generally poorly known, and scientists capable of identifying them are scarce. Knowledge is increasing, however, as DFO regional multispecies trawl surveys now collect sponges, which will aid in improving knowledge of species occurrence and distribution in Atlantic Canada (Campbell and Simms 2009).

Off Canada's Atlantic coast, at least 34 species of sponge have been identified, although it is expected that this list will be substantially expanded in future years. Sponges are distributed throughout the SEA Study Area, from bank habitats to the Laurentian Channel. "Hotspots' of sponge occurrence are depicted in Figure 3-13. As of 2011, more than 30 different sponges had been recognized in snow crab surveys within the St Anns Bank AOI; however most have not yet been identified to the species level (Ford and Serdynska 2013). Some well-known species in the Northwest Atlantic include Russian Hats (*Vazella pourtalesi)*, various *Geodia* species, and *Thenea* species. All of these species are included in the ICES (2009) list of habitat-forming sponge species. DFO groundfish surveys have also reported a few occurrences of an unidentified species of *Rhizaxinella* on the Scotian Shelf. Sponge species encountered during the DFO groundfish surveys are depicted in Figure 3-14.

Figure 3-13 Hot spots of sponge biodiversity on the eastern Scotian Shelf, based on DFO snow crab survey data from 2004-2010. Figure from Ford and Serdynska 2013 (black polygon is outline of St Anns Bank proposed AOI).

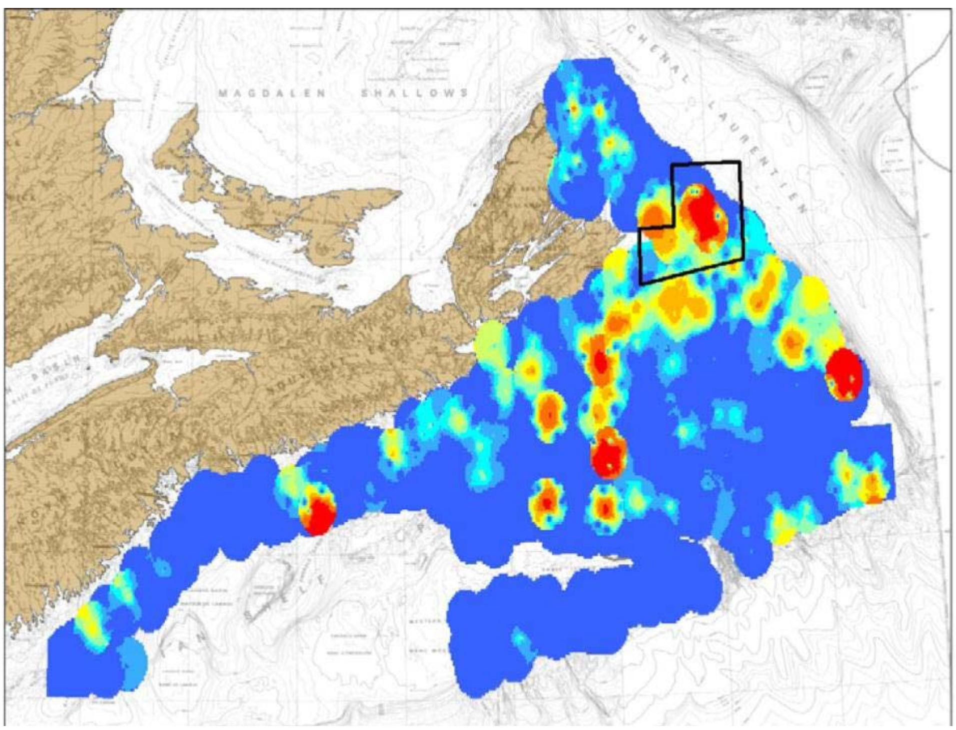
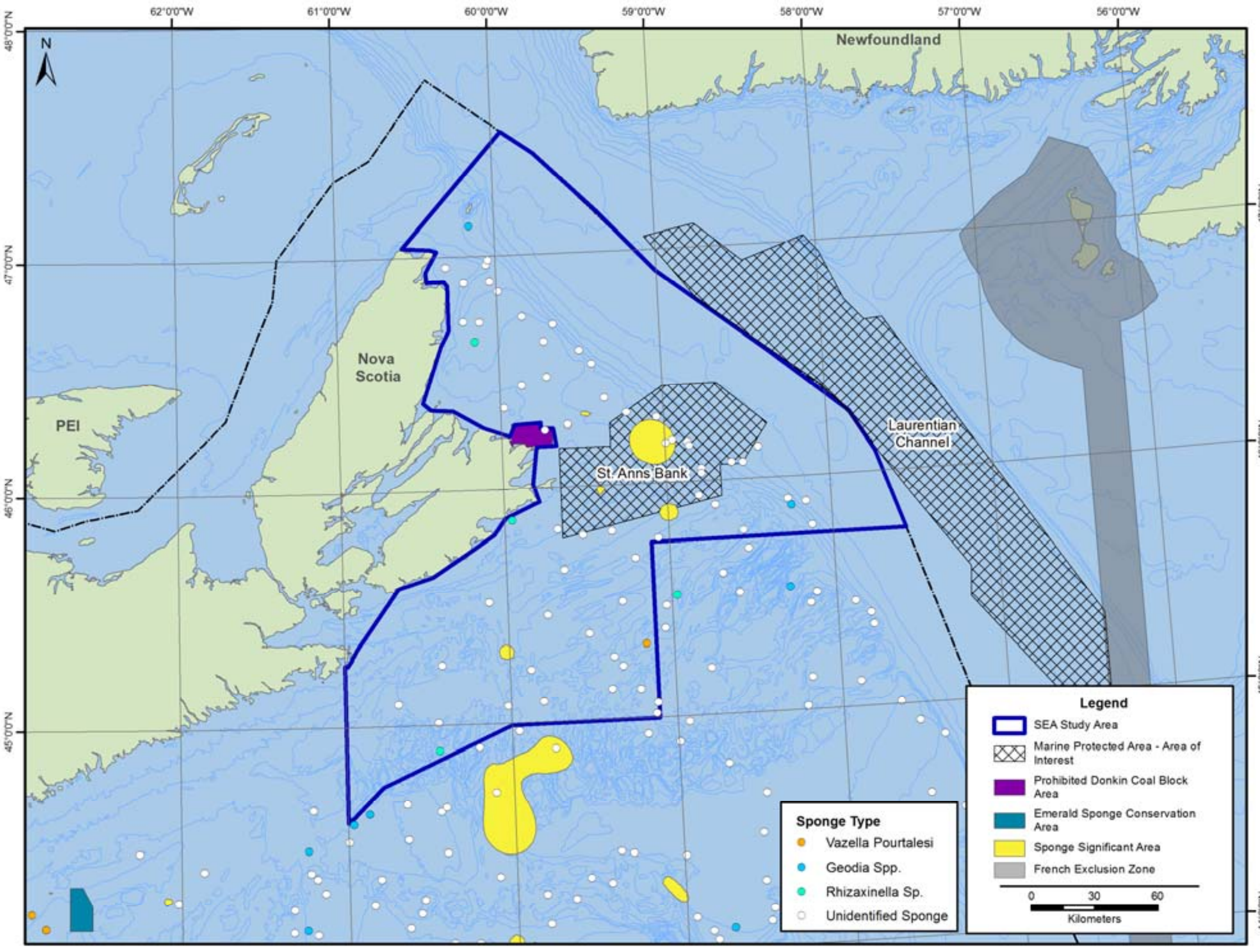


Figure 3-14 Location of Sponges in the SEA Study Area, as determined by DFO RV surveys (2004-2014), as well as Significant Sponge Areas (Kenchington *et al.* 2010)



Russian Hats (*Vazella pourtalesi*) are a large, barrel-shaped shelf species are considered to be a structure-forming species supporting vulnerable marine ecosystems (ICES 2009). A dense patch of this species recently discovered in Emerald Basin on the Scotian Shelf has been described as a globally significant and unique population (Fuller *et al.* 2008). *Vazella pourtalesi* (Russian Hat Sponge) is known to occur in the SEA Study Area (DFO 2010) and has been encountered during DFO RV surveys (Figure 3-14).

Geodia sponges are roughly globular species which in the North Atlantic appear to occur along the shelf edge, in gravel or hard bottom areas and have been found in areas in the Northeast Atlantic as well (Klittgaard and Tendal, 2004, Bruntse and Tendal 2001). They have been found along the Laurentian Channel Slope within the SEA Study Area (Figure 3-14).

Rhizaxinella species are stalked, oval, solid sponges. They tend to be deep water species. An unidentified species of *Rhizaxinella* has been found in the northern and southern portions of the SEA Study Area by DFO groundfish surveys.

Kenchington *et al.* (2010) identified areas of significant sponge concentrations in the Maritimes Region. Four of these areas occur within the SEA Study Area (Figure 3-14). Three of these, including the largest area, are wholly or partly within the proposed St Anns Bank AOI, while the fourth is south of Cape Breton Island. The largest area identified by Kenchington *et al.* (2010) is south of Cape Breton and just outside of the SEA Study Area.

Sponges are vulnerable to physical disturbance of the sea floor due to benthic fishing gear, as well as smothering by detritus and sediment. Three areas of significant sponge concentrations have been identified as protected areas. These are the Sambro Bank Sponge Conservation Area, the Emerald Bank Sponge Conservation Area, and the Scotian Shelf Sponge Significant Area. None of these are within or near the SEA Study Area.

3.2.6.4.3 Other Biogenic Habitat Types

A recent literature review by Kenchington (2014) resulted in a list of 14 benthic biogenic habitat types occurring within DFO Maritimes Region that that are considered to be structure-forming on the Scotian Shelf. These habitat types tend to locally increase species richness and/or contribute significantly to ecosystem function (*e.g.,* high productivity, provision of food, refugia from predation and/or the environment) (Kenchington 2014). The focus of this report was on species which are capable of forming large-scale habitat features, ranging from 10s of meters to 10s of kilometers. The report also identified four species groups which play key roles as bioturbators and four benthic physical features which may indicate potential Ecologically and Biologically Significant Areas (EBSAs) (EBSAs are areas considered particularly significant to species or ecosystems, and are discussed in more detail in Section 3.2.12.3). Most of these benthic habitat types are poorly documented, and insufficient data exists to map them.

The structure-forming benthic biogenic habitats, the key bioturbator species groups, and the benthic physical features of interest are discussed in Table 3-8 along with a general assessment of their possibility of occurring within the SEA boundaries. As they’re not mapped, and as knowledge of benthic communities in much of the eastern Scotian Shelf is sparse, the possibility that many of these habitats types occur within the SEA Study Area cannot be ruled out.

Table 3-8. Benthic EBSAs Potentially Occurring Within the Study Area.

Benthic EBSA Type	**Description**	**Occurrence within SEA Study Area**
Structure-Forming Benthic Biogenic Habitats (Kenchington 2014)		
Eelgrass (*Zostera marina*) Beds	• The dominant seagrass found in coastal and estuarine areas of the western North Atlantic. • Can form extensive beds over the full range of low intertidal to subtidal habitat (down to 12 m depth in some areas) and from sheltered areas to exposed coasts. • Important for sediment deposition, substrate stabilization, as substrate for epiphytic species, micro-invertebrates, and as habitat for many fish species. • Seagrass beds are very productive. • A major source of food for wildfowl. • Provides three dimensional structure aids in increasing biodiversity and productivity. • Eelgrass meets the criteria as an Ecologically Significant Species (DFO 2009). • Impacted by invasive green crab, wasting disease.	Confirmed
Kelp Forests	• Kelp species represent the largest and morphologically most complex brown algae. • Comprised of various species within Order Laminariales (*Laminaria longicruris and L. digitata, Alaria esculenta, Agarum cribosum and Saccorhiza dermatodea* are common species). • Kelp species are considered as Keystone Species or species whose presence affects the survival and abundance of many other species in the ecosystem. • Kelps are the most prominent constituents of the lower intertidal and subtidal Atlantic temperate rocky shores. • Kelp forests support a rich understorey of flora and fauna, and have been described as one of the most ecologically dynamic and biologically diverse habitats on the planet. • Kelp forests are susceptible to overgrazing by sea urchins.	Confirmed
Rhodolith Beds	• Certain coralline (Rhodophyta, Corallinaceae) algae grow unattached on the sea bed as free-living balls, branched twigs, or rosettes. • Rhodoliths can form extensive beds (aggregations) overlying calcareous sediments produced by the accumulation of eroding rhodolith fragments • Coralline algae may be one of the largest stores of carbon in the biosphere. • Complex habitat for a wide range of taxa with a variety of niches that support high associated invertebrate and algal biodiversity. • Maerl beds act as nursery areas for the juvenile stages of fish and invertebrate species.	Unlikely. Known from Labrador and eastern Newfoundland. Records from the late 19th century show rhodoliths to be present off Nova Scotia, although there are no recent records.

Benthic EBSA Type	Description	Occurrence within SEA Study Area
Horse Mussel (*Modiolus modiolus*) Beds	• Horse mussels may form dense beds or reefs, at depths up to 100m. • Occur mostly in fully saline conditions and often in tide-swept areas. • Coarse sediment banks formed by horse mussel beds form wave-like mounds or bioherms in the Bay of Fundy. • Byssal threads of *M. modiolus* have an important stabilising effect on the seabed, binding together living *M. modiolus*, dead shell and sediments. • As *M. modiolus* is a filter feeder, the accumulation of feces and pseudofeces represents an important flux of organic material from the plankton to the benthos. • Communities associated with *Modiolus* beds are diverse, with a wide range of epibiota and infauna, including hydroids, bryozoans, sponges, soft corals, brittlestars, bivalves and ascidians amongst others.	Unlikely. Though horse mussels are a common and widespread species on the Scotian Shelf, the bioherms they create have not been documented outside of the Bay of Fundy
Oyster Beds (*Crassostrea virginica*)	• Eastern oyster grows in both intertidal and subtidal areas in the Maritimes. • Influence nutrient cycling (benthic pelagic coupling), water filtration, habitat structure, biodiversity, and food web dynamics. • Oyster beds provide hard surfaces for the attachment of many other sessile marine organisms. • Oyster beds and reefs also provide refuges and feeding grounds for various mobile marine organisms such as crustaceans, worms, molluscs and fish.	Aggregations may occur anywhere on coast, particularly in warmer sheltered areas. Farmed in Aspy Bay
Sea Pen Fields	• Aggregations of sea pens provide important structure in low-relief sand and mud habitats. • Provide refuge for small planktonic and benthic invertebrates and fish larvae (redfish). • Alter water current flow, thereby retaining nutrients and entraining plankton near the sediment. • May be associated with corals living in soft sediments (*e.g. Acanella* sp., R*adicipes* sp. *Flabellum* sp.)	High
Soft Coral Gardens	• Soft corals do not produce external calcium carbonate skeletons • Commonly found over most of eastern Canada from the shallow subtidal to the continental slopes • Common species on the Scotian Shelf are Gersemia rubiformis (*Eunephthya rubiformis*), *Duva florida*, *Capnella glomerata* (Nephtheidae) and *Anthomastus grandiflorus* (Alcyoniidae) • Soft corals attach to hard substrate and can be found on bedrock or on cobbles embedded in muds or sands. • A preliminary examination of relationships between corals and groundfish in some NAFO divisions showed a statistically significant association of juvenile Northern shrimp and snow crab with soft corals.	High?
Large Corals on Hard Substrates	• Common large upright corals on the Scotian Shelf and slopes belong to the Cnidarian order Alcyonacea; Families Isididae, Primnoidae, Chrysogorgiidae, (Suborder Calcaxonia) and Paragorgiidae (Suborder Scleraxonia). • Commonly referred to as gorgonians, sea fans, horny corals and sea	Confirmed

Benthic EBSA Type	Description	Occurrence within SEA Study Area
	feathers. • Both live and dead corals provide structural habitat that can be used by other species. • Branches can reach up into stronger currents above the benthic boundary layer and feeding advantages are shared with attached filter-feeding organisms. • Associated species can also feed on detritus and micro-organisms trapped in coral mucous. • Species greater than 1 m in height can profoundly affect benthic community structure. • The arboreal-like structure of gorgonians provide habitat for both commercial (redfish) and non-commercial species.	
Lophelia pertusa Reefs	• Major reef-building deep-water coral species in the north Atlantic. • *L. pertusa* occurs along the continental slopes and banks (200 to 1000 m general depth range) of Canada but expansive reef structures and bioherms have not been identified in Canadian waters. • A small reef, heavily damaged by the redfish fishery, was found on the Scotian Shelf on SE Banquereau and has been protected as a Coral Conservation Area. Small colonies have been located in the Gully Marine Protected Area. • Dense aggregations of large structure-forming species which can alter bottom currents and provide niche space for other organisms	Possible (*L. pertusa* recorded within site, known reef south of SEA Study Area)
Sponge Aggregations	• Most live on hard substrates such as rock, gravel and corals. • A small number are soft bottom dwellers, • Aggregations in this region are principally composed of sponges from two classes: Hexactinellida and Demospongiae • The glass sponge beds (*Vazella pourtalesi*) on the Scotian shelf are globally unique in that there are no other known aggregations of this species. • Sponge habitats are known to locally enhance biodiversity (species richness and abundance) and may provide rich feeding grounds for juvenile fish.	Likely
Tube-Dwelling Anemone Fields	• The Order Ceriantharia includes the solitary tube-dwelling anemone-like forms which burrow in soft bottoms • The most common larger tube dwelling anemone on the Scotian Shelf, *Pachycerianthus borealis* (syn. *Cerianthus borealis*), forms dense aggregations on bare sandy or muddy bottoms, and is considered a key structure-forming species. • Juvenile redfish (*Sebastes fasciatus),*) have been associated with dense patches of tube-dwelling anemones in the Gulf of Maine.	Possible
Erect Bryozoan Turf	• Bryozoans are mostly colonial animals composed of clonal zooids which are not capable of living independently. • *Flustra foliacea* or lemon weed is a common bryozoan in the Bay of Fundy that forms extensive habitat near Digby, Nova Scotia. • Form ramified structures in a variety of marine environments that can be ecologically important in providing substrata for epizoans and hiding places for motile organisms, including ophiuroids and small fish.	Unlikely

Benthic EBSA Type	Description	Occurrence within SEA Study Area
Stalked Tunicate Fields	• Marine suspension feeders. • "Sea potato" or "sea onion" *Boltenia ovifera* and other large species are often found in groups where they form significant habitat. • Stalked tunicate fields are known to provide habitat to juvenile crabs. • Some sea squirts (*i.e. Boltenia ovifera*) support other invertebrate fauna attached to the stems and holdfasts. • Some tunicates are considered invasive species	Possible
Crinoid fields	• Fragile organisms that may live attached to the sea bottom by a stalk that raises them off the sea floor. • Feed by filtering small particles of food from the sea water with their feather like arms. The tube feet are covered with a sticky mucus • Some species are highly aggregated and can provide refuge and substrata for a wide variety of small fishes and invertebrates	Possible, but no published evidence of large aggregations to date.
Bioturbators		
Xenophyophore Fields	• Xenophyophores are large multinucleate single cellular organisms belonging to the phylum Foraminifera • suspension or surface deposit feeders • Distribution is associated with food supply and they achieve their greatest abundance in areas of high particulate flux or deposition. • One species, *Syringammina* sp, is the most abundant megafauna in the Gully between 1000-2500 m • They rework sediments, providing a habitat for other organisms	SEA Study Area likely too shallow
Brittle Star Beds	• Vary in size, with the largest covering hundreds of square metres of sea floor and containing millions of individuals. • Patchy internal structure, with localized concentrations of higher animal density. • *Ophiura sarsii* is common on the Scotian Shelf where it occurs on soft sediments to depths of up to 2,000 m. • Peak abundance appears to occur between depths of 250 and 650 m where densities greater than 300 animals/m^2 have been reported • Ophiurids are also important ecosystem engineers, reshaping the sediment surface as they move and influencing the distribution of other organisms.	Likely
Sublittoral Clam Beds	• Sublittoral clam beds are common on the Scotian Shelf. • Currently a commercial fishery for the Arctic Surfclam (*Mactromeris polynyma*) and a licence for Ocean Quahogs (*Arctica islandica*) on the Scotian Shelf. • Greenland Smoothcockles (*Serripes groenlandicus*) and Northern Propellerclams (*Cyrtodaria siliqua*) are currently caught as a by-catch in the Arctic Surfclam fishery. • As they burrow, clams living in marine sediments influence oxygen levels in sediments, cause redistribution and decomposition of organic matter, disturb the natural deposited stratification, facilitate the horizontal movement of particles, restyle the micro-topography of the sediment and alter the amount of suspended particles in the water.	Very Likely

Benthic EBSA Type	Description	Occurrence within SEA Study Area
	• Clams must renew their burrow water through bioirrigation. • Burrowing and bioirrigation alter the sediment porosity, pH and microbial activity and can secondarily impact benthic communities	
Sand Dollar Beds	• Found on moderately sorted fine to medium sand bottoms with strong currents from the low intertidal to a depth of 1,500 m. • Sable Island Bank has been shown to have densities up to 180 individual/m^2. • Spines allow them to slowly burrow through sediments, and have been shown to modify at least a third of the total surface in a study area on Sable Island Bank.	Very Likely
Physical Features Supporting EBSAS		
Sublittoral Glacial Erratics and Moraines	• Glacial erratics are rocks that are transported by glacial ice over large distances and deposited in areas where they differ from the surrounding substrate. • Common on the Scotian Shelf and in the Gulf of Maine. • Provide hard substratum for colonization and increase habitat heterogeneity and species richness.	Most likely
Canyons Excising Continental Shelf	• Submarine canyons are common features along the continental margins of the world's oceans. • Many are characterized by V-shaped sections with steep gradients, incised into the bedrock and sediments of continental shelves and slopes. • Generate complex water flows, channel occasional turbidity currents and focus internal tides that resuspend sediment and organic matter, which is advected to deeper water. • Can be of considerable importance to the community structure and functioning of marine ecosystems • Eastern continental margin of North America has a higher concentration of shelf-break canyons than many other parts of the world. One of the largest is The Gully, at the edge of the Scotian Shelf east of Sable Island. • Can serve as species oases in the sea by channeling ocean currents, capturing and trapping sinking particles, funneling migrating animals, and generally providing a varied physical landscape. As a result, canyons promote high species diversity.	No large canyons within SEA Study Area
Steep Slopes (Cliffs)	• Vertical rock faces are defined as having an angle of 70° or greater • Such underwater cliffs support solitary cup corals (*Desmophyllum* spp.), file shells (*Acesta* sp.), large gorgonian corals (*e.g., Paragorgia arborea, Paragorgia johnsonii, Primnoa resaedeformis*), sponges and other invertebrates.	Unlikely
Pockmarks	• Craters in the seabed caused by fluids (gas and liquids) erupting and streaming through the sediments. • The craters off Nova Scotia are up to 150 m in diameter and 10 m deep and are formed in seabed material consisting of soft silty clay (LaHave clay). • It has been suggested that sedimentary microbial metabolism was different inside than outside pockmarks.	Likely, as they are widespread on the Scotian Shelf

Descriptions from Kenchington 2014

3.2.6.5 Invasive Marine Species

Marine invasive species are species which have been transported to areas outside of their original habitat via human activities, and which have become established and become a nuisance or threat within their new ecosystem. Invasive species can threaten aquatic ecosystems, occupying habitats or out-competing native species. These species may show rapid population growth in the absence of natural predators and may soon become established to the point where eradication is impossible.

There are at least 18 aquatic invasive species that are established on the Scotian Shelf. A listing of these species is provided in Table 3-9. Several of these species, such as *Codium*, Green Crab, Coffin Box Bryozoan, and Vase Tunicate, are known to have affected the ecosystem and/or the economy of the region.

Table 3-9 Invasive Marine Species known to be Present on the Scotian Shelf (source: Invasive Species: State of the Scotian Shelf Report)

Taxon	Species	Common name(s)	Date and Place of First Report	Reference
Bacillariophyta	*Coscinodiscus wailesii*	A bloom-forming diatom	2000, central and western Scotian Shelf	Head and Harris 2001
Chlorophyta	*Codium fragile fragile*	Codium, Oyster thief, Sputnik weed, Green fleece	1989, Mahone Bay	Bird *et al.* 1993
Phaeophyta	*Fucus serratus*	Serrated rockweed	1903, Mulgrave	Bell and MacFarlane 1933
	Colpomenia peregrina		1960, Atkins Point (Halifax Co.)	Bird and Edelstein 1978
Rhodophyta	*Bonnemaisonia hamifera*	Hookweed, Pink cotton wool	Late 1960s, Bras d'Or Lakes and Atlantic coast	Chen *et al.* 1969; McLachlan and Edelstein 1971
	Furcellaria lumbricalis		1989, Chedabucto Bay area	Novaczek and McLachlan 1989
	Neosiphonia harveyi		1992, Mahone Bay	McIvor *et al.* 2001
	Seirospora interrupta		1983, St. Margarets Bay	Bird and Johnson 1984
Trematoda	*Convoluta convoluta*		1995, near Halifax	Rivest *et al.* 1999
Mollusca	*Ostrea edulis*	European oyster	1978-1980, Ketch Harbour and East Dover (intentional introduction)	Muise *et al.* 1986
Crustacea	*Caprella mutica*	Japanese skeleton shrimp	2005, Mahone Bay	A. Locke, pers. obs.
	Praunus flexuosus	Bent mysid	Before 1980, Nova	Mauchline 1980

Taxon	Species	Common name(s)	Date and Place of First Report	Reference
			Scotia zooplankton	
	Carcinus maenas	Green crab	1954, Wedgeport	MacPhail and Lord 1954
Bryozoa	*Membranipora membranacea*	Coffin box bryozoan, lacy crust	1992, Mahone or St. Margarets Bay	Scheibling *et al.* 1999
Ascidia	*Ciona intestinalis*	Vase tunicate	Population outbreak 1997, Lunenburg; may have been present earlier	Cayer *et al.* 1999
	Botryllus schlosseri	Golden star tunicate	Present "for several decades", Atlantic coast and Bras d'Or Lakes	Carver *et al.* 2006a
	Botrylloides violaceus	Violet tunicate	2001, Lunenburg and Mahone Bay	Carver *et al.* 2006b
Nematoda	*Anguillicoloides crassus*	A swim bladder worm	2007, two localities in Cape Breton	Rockwell *et al.* 2009.

3.2.7 Marine Fish

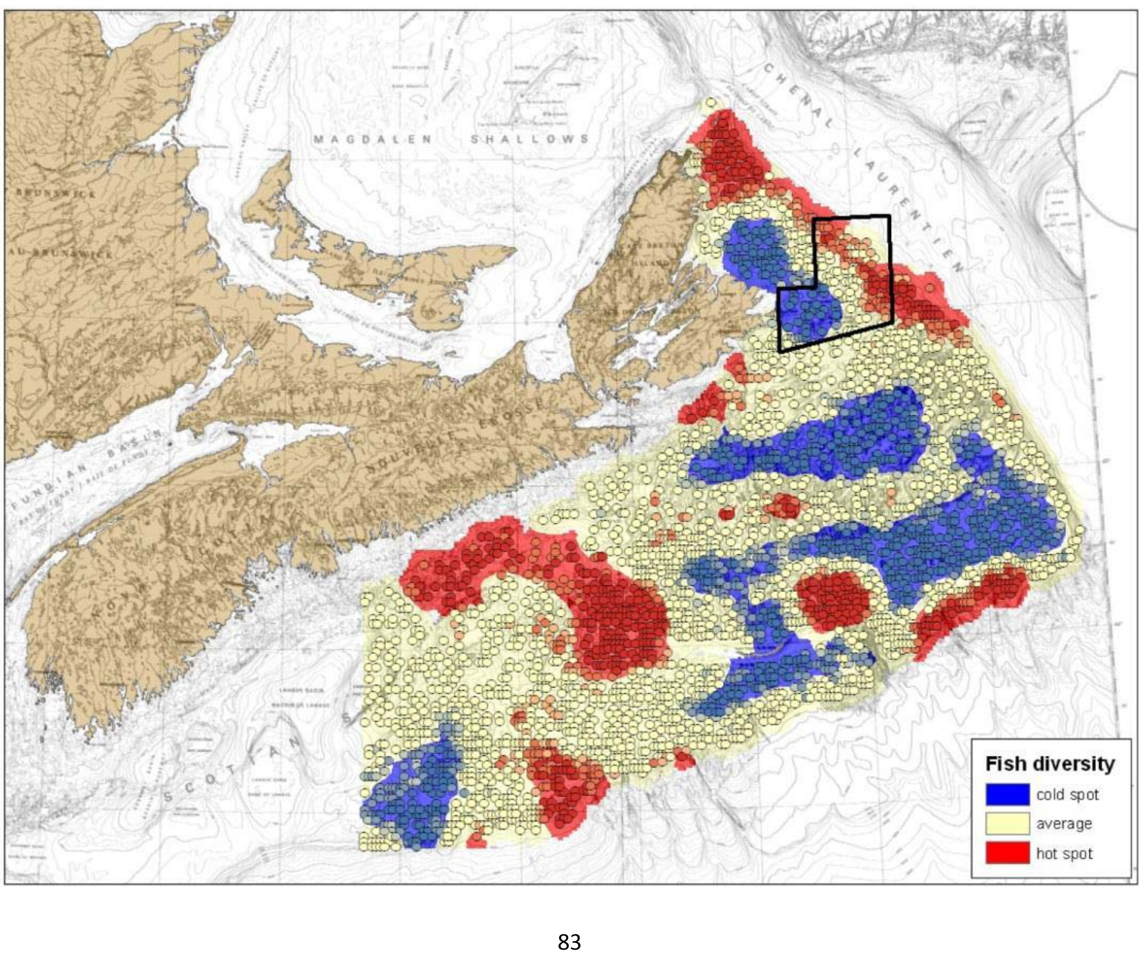
Fish are an integral part of the ecosystem within the Study Area. They have historically supported large commercial fisheries, and many species continue to support commercial, aboriginal, and recreational fisheries today. A wide range of marine fish species are known to occur within the SEA Study Area, with over 139 species reported from the eastern Scotian Shelf alone. The fish species and/or species groups (assemblages) present within an area vary depending on factors such as habitat and season. Physical aspects of the marine environment which determine suitability of habitat for fish species include depth and temperature and, to a lesser extent, sediment type (Mahon and Smith 1989). In addition, larval and juvenile fish may utilize different habitats (nursery habitat) than adults (Zeller and Pauly 2000). Fish species may therefore use various habitats within the SEA Study Area as spawning, nursery, rearing, and/or foraging habitats throughout the year. Much information on the biology and distribution of groundfish on the Scotian Shelf is documented in Breeze *et al.* (2002), Bundy (2004), Zwanenburg *et al.* (2006) and Horsman and Shackell (2009). Information on select demersal fish species of the Laurentian Channel is available in Kulka and Templeman (2013). Fish migration within the SEA Study Area is discussed in more detail in Section 3.2.7.6.

This section provides an overview of some of the important marine fish species in the region, including general (and summarized) information on their life histories, habitat preferences and reproduction patterns. Fish abundance data for the Study Area is available from annual DFO Research Vessel groundfish surveys, which have been conducted using a standardized protocol since 1970. These summer surveys provide information on distribution and abundance of marine species as determined by otter trawl surveys. These surveys are primarily aimed at demersal (groundfish) species, though the nature of the survey method often results in significant captures of pelagic species, particularly small schooling species. The surveys follow a stratified random sampling design, and include sampling of fish and invertebrates using a bottom otter trawl (DFO 2103) between depths of about 30 m to 400 m (Halliday and Kohler 1971). Note that this survey generally does not sample anything smaller than four centimetres in length, and does not sample organisms buried in the sea floor.

Over the past 10 years of DFO RV groundfish trawl surveys (2004 to 2014), the 15 most common fish species taken (abundance) in the Scotian Shelf portion of the Study Area in descending order are: redfish, sandlance, American plaice, Atlantic herring, capelin, witch flounder, shanny, Atlantic cod, Greeenland halibut, white hake, thorny skate, snake blenny, pollock, longfin hake, and vahls eelpout. The Laurentian Slope and Channel, is home to an assemblage of fish species preferring deeper waters. The most recent DFO RV data set for the Laurentian Channel portion of the Study Area found the following 15 species to be most abundant: deepwater redfish, black dogfish, longfin hake, common grenadier, witch flounder, white hake, barracudina, capelin, hagfish, lanternfish (various species), Greenland halibut, thorny skate, smooth skate, fourbeard rockling, and American plaice.

The DFO RV groundfish survey data has been used to identify areas supporting various levels of fish diversity. Figure 3-15 depicts areas considered to be 'hotspots' for fish diversity (Ford and Serdynska 2013).

Figure 3-15 Fish biodiversity 'hot spots' on the eastern Scotian Shelf, based on DFO RV survey results. (Adapted from Ford and Serdynska 2013). Black polygon is the border of the St Anns Bank proposed Area of Interest.



Hot spots of fish diversity occur south and northeast of Cape Breton as well as along the slope of the Laurentian Channel, (note that DFO does not conduct annual RV surveys within the Channel, as the water is too deep for this survey).

Fish species commonly occurring within the SEA Study Area are discussed in the following subsections on Demersal, Pelagic, and Diadromous Fishes.

3.2.7.1 Demersal Fishes

Demersal fish species are fish that live near the seafloor for the majority of their adult lives. They are commonly referred to as groundfish and historically supported the largest fisheries in the western Atlantic Ocean. Common families occurring on the Scotian Shelf include the codfishes (Family Gadidae), flounders (Family Pleuronectidae), wolffishes (Family Erythrinidae), redfishes (Family Sebastidae), skates (Family Rajidae), sculpins (Family Triglidae), grenadiers (Family Macrouridae) and hagfish (Family Myxinidae).

Table 3-10 provides an overview of the typical habitats, biology and ecology, conservation status, and human use of demersal fish species commonly encountered during RV surveys in the Scotian Shelf and Laurentian Channel portions of the SEA Study Area. It also indicates which area of the Study Area the species was frequently encountered in, and notes any Ecologically and Biologically Significant Areas (EBSAa) each species is known to utilize. EBSAs are discussed further in Section 3.2.12.

Table 3-10. Overview of Common Demersal Fish Species (By Family) in the Study Area

Family and Species	Ecology, Status, and Use
Agonidae (Poachers)	
Atlantic Poacher (*Leptagonus decagonus*)	**Typical Habitat** Preferred Temperature: -1.7 - 4°C Preferred Depth: 0 to 930 m **Biology and Ecology** • Inhabits muddy bottoms at temperatures of 4.4 to -1.7 °C. • Benthic, possibly bathypelagic. • Feeds on pelagic and benthic crustaceans and polychaetes. **Region of Study Area** • Common on Scotian Shelf **Status and Use** • No conservation status or fishery in region
Alligatorfish (*Aspidophoroides monopterygius*)	**Typical Habitat** Preferred Temperature: NA°C Preferred Depth: 50-200 m **Biology and Ecology** • Ecology is poorly known • Known to feed on invertebrates (mostly amphipods and euphasiids) (Arbour *et al.* 2010). • Spawn in mid to late autumn (Arbour *et al.* 2010). • Deep water species (Scott and Scott 1988) • Occur from coast to 200 m depth

Family and Species	Ecology, Status, and Use
	Region of Study Area • Common on Scotian Shelf **Status and Use** No conservation status or fishery in region
Ammodytidae (sand lances)	
Northern sand lance (*Ammodytes dubius*)	**Typical Habitat** Preferred Temperature: 3.0 – 6.0°C Preferred Depth: 73 – 90 m **Biology and Ecology** • Adults burrow into sandy or fine gravel bottoms to avoid predation • Feeds on plankton, particularly copepods **Region of Study Area** • Common on Scotian Shelf, infrequent in Laurentian Channel. **Status and Use** • No conservation status or fishery in region • Ecologically important as a forage fish species
Anarhichadidae (Wolffishes)	
Atlantic /Striped wolffish (*Anarhichas lupus*)	**Typical Habitat** Preferred Temperature: 1.0 – 4.0°C (Kulka *et al.* 2004) Preferred Depth: 25 - 250m (Kulka *et al.* 2004) **Biology and Ecology** • Occurs on both sides of the North Atlantic Ocean • Areas of concentration on the Grand Bank include the Northeast Newfoundland Shelf and the northern edge of the Grand Bank (Kulka *et al.* 2003a) • Associated with a variety of substrates (Kulka *et al.* 2004) • Feeds on benthic invertebrates (echinoderms, molluscs, crustaceans) and some fish • Commonly an inhabitant of deep water along the shelf (Dutil *et al.* 2010) **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel • Ecologically and Biologically Significant areas for this species include Cabot Strait, the Canso Ledges, and St Anns Bank **Status and Use** • SARA (Special Concern) and COSEWIC (Special Concern) status
Cottidae (Sculpins)	
Hookear sculpins- includes Atlantic hookear sculpin *(Artediellus atlanticus*) and snowflake hookear sculpin (*A. uncinatus*.)	**Typical Habitat** Preferred Temperature: NDA Preferred Depth: 0 – 384 m **Biology and Ecology** • Distributed off Nova Scotia and Newfoundland and into the Gulf of St. Lawrence • Inhabits soft bottom areas • Feeds on benthic invertebrates **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel **Status and Use** • No conservation status or fishery in region
Mustache sculpin (*Triglops murrayi*)	**Typical Habitat** Preferred Temperature: NA°C Preferred Depth: variable **Biology and Ecology**

Family and Species	Ecology, Status, and Use
	• Ecology poorly known • Prefers sandy bottoms • Feeds on polychaetes and crustaceans **Region of Study Area** Common on Scotian Shelf **Status and Use** No conservation status or fishery in region
Lophiidae (monkfish and sea-devils)	
Monkfish **(*Lophius americanus*)**	**Typical Habitat** Preferred Temperature: 6-10°C Preferred Depth: 0-320 **Biology and Ecology** • Areas of concentration include the Laurentian Channel (Kulka *et al.* 2003a) • Feeds on fish (herring, sand lance, smelt, cod, haddock, cunner, sculpin, flounder, skates) and invertebrates (crab, squid, molluscs, echinoderms, polychaetes) • Migrates to shallow waters in summer and deeper waters in winter. **Region of Study Area** Common on Scotian Shelf and Laurentian Channel **Status and Use** Commercial fishery No conservation status in region
Gadidae (Codfishes)	
Atlantic cod **(*Gadus morhua*)**	**Typical Habitat** Preferred Temperature: 0.5 - 10°C Preferred Depth: 150 – 200 m **Biology and Ecology** • Occurs on both sides of the North Atlantic • Feeds on fish and benthic invertebrates • Found in cool-temperature to subarctic waters from inshore regions to the edge of the continental shelf • Occurs throughout the Atlantic Canada with regionally unique stocks • Juvenile cod are abundant in inshore areas (Gregory and Anderson 1997) • The Cabot Strait is a significant mixing area for three Atlantic cod populations or stocks (DFO 2011d): Southern Gulf of St. Lawrence - 4T plus 4Vn (November–April) , Eastern Cape Breton - 4Vn resident , and Eastern Scotian Shelf - 4VsW **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel • Ecologically and Biologically Significant areas for this species include Cabot Strait, Western Sydney Bight, Bird Islands, the Canso Ledges, the Laurentian Channel, St. Anns Bank, Misaine Bank, and Middle Bank (See Section 3.2.1.2.3) **Status and Use** • COSEWIC (Endangered) • Recreational and limited commercial fishery, historically very important commercial species • Culturally and ecologically important species
Haddock **(*Melanogrammus***	**Typical Habitat** Preferred Temperature: 1.0 - 13.0 °C Preferred Depth: 27 – 366 m

Family and Species	Ecology, Status, and Use
***aeglefinus*)**	**Biology and Ecology** • Areas of concentration include the Laurentian Channel Slope (Kulka *et al.* 2003a). • Bottom feeding fish that consume crustaceans, molluscs, echinoderms, polychaetes and fish • Occurs in a variety of habitats; juveniles have higher survival rates when they settle on sand or gravel bottoms **Region of Study Area** • Common on Scotian Shelf **Status and Use** Commercial fishery
Pollock **(*Pollachius virens*)**	**Typical Habitat** Preferred Temperature: 7.2 – 8.6 °C Preferred Depth: 110 - 181 m **Biology and Ecology** • Juveniles are common in shallow inshore waters, while adults live in deeper inshore waters or on offshore banks • Feeds mainly on copepods **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel **Status and Use** No conservation status or fishery in region
Fourbeard rockling **(*Enchelyopus cimbrius*)**	**Typical Habitat** Preferred Temperature: Preferred Depth: 55 – 550 m. **Biology and Ecology** • Rocklings seek shelter in partially concealed burrows in bottom mud. • Widely distributed in shore waters of the eastern and western North Atlantic. • Spawning period runs from late May or early June until August, September, or even October depending on the water temperature. • Spawning reached a peak when ocean temperature reached 9 to 10°C. **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel **Status and Use** Not commercially significant in the region
Lotidae (Hakes and Turbots)	
Longfin hake **(*Physis chesteri*)**	**Typical Habitat** Preferred Temperature: 3.5 – 6.5°C (Methven and McKelvie 1986) Preferred Depth: 300 – 450 m (Methven and McKelvie 1986) **Biology and Ecology** • Occurs along Labrador to the southern edge of the Grand Bank • Feeds mainly on invertebrates (shrimp, euphausiids and amphipods) and vertically migrating fishes (hatchetfish and lanternfish) **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel **Status and Use** No conservation status or fishery in region
Silver hake **(*Merluccius biolinearis*)**	**Typical Habitat** Preferred Temperature: 6.0 – 8.0°C Preferred Depth: 55 – 375 m **Biology and Ecology**

Family and Species	Ecology, Status, and Use
	• Benthic species that prefers warm waters • Migrates to shallow inshore areas in the spring and offshore in the fall • Undergoes vertical feeding migrations • Opportunistic feeders that consume pelagic fishes (other gadoids, Atlantic herring, myctophids, smelt, mackerel, sand lance) and squid • Silver hake are cannibalistic **Region of Study Area** • Common on Scotian Shelf **Status and Use** Commercial fishery
White hake (*Urophycis tenuis*)	**Typical Habitat** Preferred Temperature: 4.0 – 8.0°C (Kulka *et al.* 2005) Preferred Depth: 50 – 600 m **Biology and Ecology** • Inhabits areas with mud bottoms • Areas of concentration include the Laurentian Channel slope (Kulka *et al.* 2003a) • Young hake utilize sand-hiding behavior • Feeds mainly on fish (herring, mackerel, other hake species) **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel • Ecologically and Biologically Significant areas for this species include Bird Islands, the Canso Ledges, and the Laurentian Channel (See Section 3.2.12.3) **Status and Use** • Commercial fishery in region • COSEWIC (Threatened) status
Macrouridae (Grenadiers)	
Marlin-spike, Common Grenadier (*Nezumia bairdi*)	**Typical Habitat** Preferred Temperature: 3.0 – 8.0°C Preferred Depth: 183 – 732 m **Biology and Ecology** • Benthic species that usually lives on mud bottoms • Distributed in the Gulf of St. Lawrence and Bay of Fundy. Distributed from the southwestern Grand Bank, to the banks of the Scotian Shelf and southward along the continental slope of the West Indies • Feeds on benthic euphausiids and amphipods. • Preyed upon by swordfish **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel **Status and Use** • No conservation status or fishery in region
Myxidae (Hagfish)	
Atlantic hagfish (*Myxine glutinosa*)	**Typical Habitat** Preferred Temperature: <12°C Preferred Depth: >30 m **Biology and Ecology** • Widely distributed in Arctic seas southward along both coasts of the North Atlantic. • Throughout the Canadian area, distributed off all coasts and in the Gulf of the St. Lawrence, over soft bottom. • Spawning occurs throughout the year.

Family and Species	Ecology, Status, and Use
	• Hagfish eggs are seldom found in the wild but have been taken in the Bay of Fundy, on Georges Bank, and off the south coast of Newfoundland. **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel **Status and Use** • No conservation status in region • Commercial species
Pleuronectidae (Right-eye Flounders)	
American plaice (*Hippoglossoides platessoides*)	**Typical Habitat** Preferred Temperature: 0.0 - 1.5°C Preferred Depth: 90 – 250 m **Biology and Ecology** • Occurs on both sides of the Atlantic • Feeds on polychaetes, echinoderms, molluscs, crustaceans and fish • Tolerates salinities as low as 20 – 22 ppt • Widely distributed on the shelf **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel • Ecologically and Biologically Significant areas for this species include Cabot Strait, Western Sydney Bight, and Misaine Bank (See Section 3.2.12.3). **Status and Use** • COSEWIC (Threatened) status. • Commercial fishery
Witch flounder (*Glyptocephalus cynoglossus*)	**Typical Habitat** Preferred Temperature: 2 - 6°C Preferred Depth: 185 – 366 m **Biology and Ecology** • Benthic species that prefers living over mud or mud-sand bottoms • Areas of concentration include Laurentian Channel (Kulka *et al.* 2003a) • Captured at average depths of 432 and 487m in the Orphan Basin during the spring and fall respectively (LGL 2012) • Feeds mainly on polychaetes, amphipods, molluscs and small fishes • Does not undergo extensive migrations **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel **Status and Use** • No conservation status or fishery in region
Greenland halibut (*Reinhardtius hippoglossoides*)	**Typical Habitat** Preferred Temperature: 0.0 - 4.5 °C Preferred Depth: 200 – 800 m **Biology and Ecology** • Bathypelagic predator that feeds fish (capelin, Atlantic cod, polar cod, roundnose grenadier, redfishes, sand lance), and invertebrates (shrimp, squid, benthic invertebrates) • Spends considerable time in the pelagic zone (Morgan *et al.* 2013) **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel **Status and Use** • Commercial fishery
Rajidae (Skates and Rays)	
Smooth skate	**Typical Habitat** Preferred Temperature: 2.7 - 10.0°C (Kulka *et al.* 2006)

Family and Species	Ecology, Status, and Use
(***Malacoraja senta***)	Preferred Depth: 70 – 480 m **Biology and Ecology** • Generally occur on soft mud and clay substrates over a range of depths (COSEWIC 2012a) • Feed mainly on crustaceans, euphausiids, mysids and some fish • Egg capsules are eaten by gastropods, halibut, monkfish and Greenland sharks (COSEWIC 2012a) **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel **Status and Use** • COSEWIC (Endangered)
Thorny skate (***Amblyraja radiata***)	**Typical Habitat** Preferred Temperature: -1.4 - 14°C Preferred Depth: 18 – 966 m **Biology and Ecology** • Occurs on both sides of the North Atlantic • Boreal to Arctic species that inhabits offshore areas with hard and soft bottoms • Feeds mainly on polychaetes amphipods, decapods and fishes • Egg capsules are consumed by Greenland sharks and halibut **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel • Ecologically and Biologically Significant areas for this species include Misaine Bank (See Section (See Section 3.2.12.3). **Status and Use** • COSEWIC (Special Concern) • Commercial fishery
Sebastidae (Redfishes)	
Redfish (***Sebastes mentella, S. fasciatus, S. marinus)***	**Typical Habitat** Preferred Temperature: 3.0 - 8.0°C Preferred Depth: 100 – 700 m **Biology and Ecology** • In the western Atlantic, redfish species range from Baffin Island in the north to the waters off New Jersey in the south • Areas of concentration include the Laurentian Channel slope • Bathypelagic or pelagic feeders that primarily consume amphipods, copepods, euphausiids • The three redfish species that occur in the Northwest Atlantic include *Sebastes mentella*, *S. fasciatus*, and *S. marinus*. • *S. mentella* is typically distributed deeper than *S. fasciatus* (Gascon 2003) **Region of Study Area** • Common on Scotian Shelf and Laurentian Channel • Ecologically and Biologically Significant areas for this species include Cabot Strait, Western Sydney Bight, and Laurentian Channel (See Section 3.2.12.3).) **Status and Use** • S. mentella - COSEWIC (Threatened) • *S. fasciatus* – COSEWIC (Threatened) • Commercial fishery
Squalidae (Dogsharks)	
Spiny dogfish (***Squalus acanthias***)	**Typical Habitat** Preferred Temperature: 6.0 – 15.0°C Preferred Depth: 100 – 250 m (Kulka 2006) **Biology and Ecology**

Family and Species	Ecology, Status, and Use
	• Widely distributed in coastal waters of temperate seas throughout the world • Small, schooling shark that frequents coastal and inshore waters. This species is tolerant of low salinities and may ascend estuaries • Resident population that migrates between inshore and offshore areas in Canadian waters • Opportunistic feeder that consumes mainly small fishes. Juvenile dogfish are prey to various fish and sharks • Spiny dogfish are slow-growing and long-lived **Status and Use** • COSEWIC (Threatened) • Commercial fishery
Black dogfish (*Centroscyllium fabricii*)	**Typical Habitat** Preferred Temperature: 3.5 – 4.5 °C Preferred Depth: 350 - 500m (Kulka 2006) **Biology and Ecology** • Distributed along the Canadian slope, with concentrations in the Laurentian Channel (Kulka 2006) • Feeds mainly on squid, crustaceans, jellyfish and small redfish • Small, deepwater shark occurring near bottom, at times forming schools **Region of Study Area** • Common in Laurentian Channel • Ecologically and Biologically Significant areas for this species include the Laurentian Channel (See Section 3.2.12.3). **Status and Use** • No conservation status or fishery in region
Stichaeidae (Pricklebacks)	
Daubed Shanny (*Lumpenus maculatus*)	**Typical Habitat** Preferred Temperature: NA Preferred Depth: 2 - 607 m (Coad and Reist 2004) **Biology and Ecology** • Circumglobal: Arctic to temperate waters • Inhabits sandy bottoms (Eschmeyer, *et al.* 1983); mud to pebble bottom, usually in less than 170 meters (Mecklenburg and Sheiko 2004). • Benthic (Coad and Reist 2004). • Feeds on polychaetes and crustaceans (Makushok 1986). **Region of Study Area** • Common in Scotian Shelf **Status and Use** • No conservation status or fishery in region
Snake blenny (*Lumpenus lumpretaeformis*)	**Typical Habitat** Preferred Temperature: °8°C - 14°C (Nash 1980) Preferred Depth: 30-373 m (Coad and Reist 2004) **Biology and Ecology** • Non-migratory • Live in y-shaped tubes in the mud, which are believed to be used for parental care of the eggs • Feeds on small crustaceans, mollusks, brittle stars and worms (wheeler 1992). • Spawns in winter in deep water **Region of Study Area** • Common on Scotian Shelf

Family and Species	Ecology, Status, and Use
	Status and Use • No conservation status or fishery in region
Zoarcidae (Pouts)	
Vahl's/ Checkered eelpout (*Lycodes vahlii*)	**Typical Habitat** Preferred Temperature: 2.0 – 4.5°C Preferred Depth: 200 – 600 m **Biology and Ecology** • Occurs on both sides of the Atlantic Ocean • Feeds on polychaetes, small crustaceans and mollusks **Region of Study Area** • Common in Laurentian Channel and Scotian Shelf **Status and Use** • No conservation status or fishery in region

Many species are present in low numbers seasonally or throughout the year. While such species may not be encountered often, they still contribute to biodiversity and to the ecological functioning of their environment. Table 3-11 provides a list of additional demersal fish species that have been infrequently encountered (less than 100 times in 10 years) during RV surveys within this area.

Table 3-11.Other Demersal Fish Species (By Family) Reported from the Study Area (Based on DFO RV data for Scotian Shelf from 2004-2014 and Laurentian Channel from 1997-2002)

Family	Common Name (*Scientific Name)*	Region
Argentinidae (Argentines)	Atlantic Argentine (*Argentina silus)*	Scotian Shelf, Laurentian Channel
Carangidae (Jacks, pompanos, jack mackerels, runners, and scads)	Blue Runner (*Caranx crysos)*	Laurentian Channel
Cottidae (Sculpins)	Deepsea Arctic Sculpin *(Cottunculus microps)*	Laurentian Channel
	Unidentified Sculpin *(Triglops* sp.*)*	Laurentian Channel
Cyclopteridae (Lumpsuckers)	Lumpfish (*Cyclopterus lumpus)*	Laurentian Channel
Gadidae (Cods)	Arctic Cod *(Boreogadus saida)*	Laurentian Channel
	Haddock *(Melanogrammus aeglefinus)*	Laurentian Channel
Liparidae (Snailfishes)	Lowfin Snailfish *(Paraliparis calidus)*	Scotian Shelf
	Atlantic Snailfish *(Liparis atlanticus)*	Scotian Shelf
	Gelatinous Snailfish *(Liparis fabricii)*	Scotian Shelf
	Unidentified snailfish *(Liparis sp.)*	Scotian Shelf
Lotidae (Hakes and Turbots)	Silver Hake *(Merluccius bilinearis)*	Laurentian Channel
Nemichthyidae (Snipe eels)	Atlantic Snipe Eel *(Nemichthys scolopaceus)*	Laurentian Channel
Notacanthidae (Deep-sea spiny eels)	Large Scale Tapirfish *(Notacanthus nasus/ Notacanthus chemnitzii)*	Laurentian Channel

Family	Common Name (*Scientific Name)*	Region
Peristediidae (Armored searobins)	Armored Searobin (*Peristedion miniatum)*	Scotian Shelf
Petromyzontidae (Lampreys)	Sea Lamprey *(Petromyzon marinus)*	Laurentian Channel
Pleuronectidae (Right-eye Flounders)	Atlantic Halibut *(Hippoglossus hippoglossus)*	Laurentian Channel
	Yellowtail Flounder *(Limanda ferruginea)*	Laurentian Channel
Rajidae (Skates and Rays)	Spinytail Skate *(Bathyraja spinicauda)*	Laurentian Channel
	Winter Skate *(Leucoraja ocellata)*	Laurentian Channel
Sebastidae (Redfishes)	Blackbelly Rosefish *(Helicolenus dactylopterus)*	Scotian Shelf
	Deepwater Redfish (*Sebastes marinus)*	Laurentian Channel
Synaphobranchidae (Cutthroat eels)	Snubnose Eel *(Simenchelys parasiticus)*	Laurentian Channel
Zoarcidae (Eelpouts)	Unidentified Eelpout *(Lycodes sp.)*	Laurentian Channel
	Ocean Pout (*Macrozoarces americanus)*	Laurentian Channel
	Western North Atlantic Eelpout *(Lycenchelys paxillus)*	Scotian Shelf

3.2.7.2 Pelagic Species

Pelagic fish species are those which spend most of their time in the pelagic zone and the upper layers of the water column above the sea floor. Fish species' presence varies considerably with depth. Common large pelagic species include tunas, swordfish, and sharks while well-known small species include Atlantic herring and Atlantic mackerel. The large pelagic species often tend to be apex predators, while small species are integral to the marine ecosystem due to their role in capturing energy from lower trophic levels (phytoplankton, zooplankton, and small planktivorous fish) and transferring it to higher level carnivores including mammals, birds, and numerous species of pelagic and demersal fish and marine invertebrates (Read and Brownstein 2003). Small pelagic fish also provide a link between coastal and pelagic systems by transporting energy and biomass from coastal to offshore areas on a seasonal basis (Gottleib 1998).

Table 3-12 provides an overview of the typical habitats, biology and ecology, conservation status, and human use of pelagic fish species which commonly occur on the Scotian Shelf and Laurentian Channel. Note that as the DFO RV surveys primarily target groundfish, pelagic fish species are poorly assessed by these surveys. Table 3-12 therefore includes many other species known to be abundant in the Study Area (*i.e.* large pelagic species such as tunas, sharks, and swordfish).

Table 3-12. Overview of Common Pelagic Fish Species Occurring in the Study Area

Species	Ecology, Status, and Use	
Argentinidae (Argentines)		
Atlantic argentine (*Argentina silus*)	**Typical Habitat**	Preferred Temperature NA Preferred Depth: 55–550 m

Species	Ecology, Status, and Use
	Biology and Ecology • A deepwater fish concentrated mainly in warmer waters of continental shelves and in deepwater basins • The Atlantic argentine lives in schools near the bottom of the ocean • Adults live in deep waters, while immature fish prefer shallower areas • Prey species include small fishes, squids, crustaceans, arrow worms, and comb jellies. • There is little information on the time of spawning on the North American side of the Atlantic Ocean • Research has suggested that spawning takes place on the Scotian Shelf in March and April. **Region of Study Area** • Common in Laurentian Channel **Status and Use** • No conservation status or fishery in region
Cetorhinidae	
Basking shark (*Cetorhinus maximus*)	**Typical Habitat** Preferred Temperature: 8.0 – 12.0°C Preferred Depth: 0 – 750 m **Biology and Ecology** • Species is highly migratory; occurring in coastal warm waters in eastern Canada during the summer and fall • Distributed mainly off southern Newfoundland, on the Scotian Shelf and in the Gulf of Maine (DFO 2008) • Pelagic, filter feeding shark that mainly feeds on plankton. **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel **Status and Use** • No conservation status or fishery in region
Clupeidae (Herrings)[1]	
Atlantic herring (*Clupea harengus harengus*)	**Typical Habitat** Preferred Temperature: 5.0 – 9.0°C Preferred Depth: 0 – 200 m **Biology and Ecology** • Occurs on both sides of the North Atlantic Ocean • Feeds on phytoplankton, copepods and euphausiids • Primarily pelagic, and often in schools, occurring in the shallow inshore waters, or offshore • Undertakes annual migrations to spawning grounds, feeding areas and wintering areas • Multiple stocks / populations occur in Canadian waters • It occurs in commercial quantities along the coast of southern Labrador, around the coast of Newfoundland and offshore banks, in the Gulf of St. Lawrence, along the coast of Nova Scotia and offshore banks, and the Bay of Fundy • Ecologically important; important food source for fishes, marine birds and marine mammals. • Occurs on both sides of the North Atlantic. • Atlantic herring are demersal spawners depositing their adhesive eggs on stable bottom substrates (Scott and Scott 1988; Reid *et al.* 1999). • Spawning may occur in offshore waters or shallow coastal waters • In the case of coastal spawning, spring spawning generally takes place in shallower waters than fall spawning. **Region of Study Area**

[1] Anadromous species are discussed in Section **Error! Reference source not found.**

Species	Ecology, Status, and Use
	• Common in Scotian Shelf and Laurentian Channel • Ecologically and Biologically Significant areas for this species include the Western Sydney Bight, Aspy Bay, the Bird Islands, Indian Bay/Lingan Bay, Big Glace Bay, and the Canso Ledges. **Status and Use** • Commercial Fishery in region
Lamnidae (mackerel sharks or white sharks)	
Blue shark (*Prionace glauca*)	**Typical Habitat** Preferred Temperature: 7.0 – 16.0°C Preferred Depth: 10 – 220 m (Carey and Scharold 1990) **Biology and Ecology** • Wide-ranging pelagic species in temperate waters • Worldwide distribution in inshore and offshore waters • Undertakes large vertical migrations at night • Feeds mainly on fish (herring, hake, cod, haddock, pollock, mackerel, butterfish, sea raven, flounders) and squid **Region of Study Area** • Occurs on Scotian Shelf **Status and Use** • COSEWIC (Special Concern) and IUCN (Near Threatened) status
Porbeagle shark (*Lamna nasus*)	**Typical Habitat** Preferred Temperature: 6.0 – 16.0°C Preferred Depth: 0 – 710 m **Biology and Ecology** • Common on continental shelves with occurrences offshore • Distributed in Atlantic, Pacific and Indian Oceans • Occurs in Canadian waters during spring, summer and fall **Region of Study Area** • Occurs on Scotian Shelf **Status and Use** • COSEWIC (Endangered)
Shortfin mako shark (*Isurus oxyrinchus*)	**Typical Habitat** Preferred Temperature: 17.0 – 22.0°C Preferred Depth: 100 – 150 m (Bianchi *et al.* 1999) **Biology and Ecology** • Extremely active species, considered the fastest shark • Feeds on fish (mackerel, tuna, swordfish, bonito) • Estimate lifespan of 24 years with maximum life expectancy of up to 45 years (DFO 2010b) • Circumglobal distribution in temperate and tropical waters • Individuals in Canadian waters part of the North Atlantic Population • Migrate to Atlantic Canadian waters in late summer and fall (DFO 2010b) **Region of Study Area** • Occurs on Scotian Shelf **Status and Use** • COSEWIC (Threatened)
White shark (*Carcharodon carcharias*)	**Typical Habitat** Known Temperature: 5 to 27°C (Nakaya 1994, Boustany *et al.*2002) Known Depths: from surface to 1,280 m (Bigelow and Schroeder 1948). **Biology and Ecology** • A wide-ranging, nomadic species, occupying inshore and offshore waters of sub-polar to tropical seas of both hemispheres, from the intertidal to the upper continental slope and

Species	Ecology, Status, and Use
	mesopelagic zone. • In Atlantic Canada, reported from the Northeast Newfoundland Shelf, the Strait of Belle Isle, the St. Pierre Bank, Sable Island Bank, the Forchu Misaine Bank, in St. Margaret's Bay, off Cape La Have, in Passamaquoddy Bay, in the Bay of Fundy, in the Northumberland Strait, and in the Laurentian Channel as far inland as the Portneuf River Estuary (COESWEIC 2006) . These are likely seasonal migrants belonging to a widespread Northwest Atlantic population. • Reproductive mode is ovoviviparous. Gestation period suspected to be about 14 months, based on related shortfin mako. • Litter size varies from 2 to 10 with fecundity increasing with size of the female. • Males reach sexual maturity at 8 to 10 years, and 3.5 to 4.1 m while females mature by 12 to 18 years and a length of 4 to 5 m. • Longevity in this species is estimated to be 23-60 years. • An apex predator with a wide prey base feeding primarily on teleost fish, elasmobranchs, and marine mammals, as well as cephalopods, other molluscs, decapods, marine birds, and reptiles. • Data specific to Canadian waters is limited • Humans are the most significant predators of white sharks, taking largely unmonitored numbers as sport fish and commercial bycatch as well as targeting them for their lucrative jaws, teeth, and fins (Compagno *et al.* 1997). **Region of Study Area** • Occurs on Scotian Shelf **Status and Use** • SARA (Endangered), COSEWIC (Endangered)
Molidae (Sunfish)	
Sunfish (*Mola mola*)	**Typical Habitat** Preferred Temperature: >10°C Preferred Depth: 0-600 m **Biology and Ecology** • Heaviest known bony fish in the world, with average adult weight of 1,000 kg. Average length of 1.8 m • Native to tropical and temperate waters around the globe. • Head very large proportionately, main body flattened laterally. • Known to bask on side at sea surface, possibly to aid in thermoregulation • Consumes mainly large amounts of jellyfish, will also prey on salps, squid, crustaceans, small fish, fish larvae, and eel grass. • Adults spend significant depths greater than 200 m, occupying both the epipelagic and mesopelagic zones. • The sunfish lacks a swim bladder. • Many areas of sunfish biology remain poorly understood • Females of the species can produce more eggs than any other known vertebrate, up to 300,000,000 at a time. **Region of Study Area** • Occurs on Scotian Shelf **Status and Use** • Used as food in other parts of world • No commercial fishery or conservation status in region
Myctophidae	
Lanternfish (Myctophidae)	**Typical Habitat** Preferred Temperature: 4.0 – 16.0°C Preferred Depth: 30 – 1,200 m **Biology and Ecology**

Species	Ecology, Status, and Use
(various species)	• Opportunistic planktivores feeding on copepods, euphausiids, ostracods, fish eggs and larvae • Characterized by light organs on the head and body • Undertakes diurnal vertical migrations. **Region of Study Area** • Occurs on Scotian Shelf and in Laurentian Channel **Status and Use** • No conservation status or fishery in region • Ecologically important as forage fish species at depth
Osmeridae (Smelts)	
Capelin ***(Mallotus villosus*)**	**Typical Habitat** Preferred Temperature: -1.0 – 6.0°C (Rose 2005) Preferred Depth: 0 – 280 m **Biology and Ecology** • Inhabits cold deep waters, in the Atlantic Ocean on the offshore banks and in coastal areas • Seasonal migrations to inshore spawning areas • The largest concentrations in Canadian waters are found off Newfoundland and the Labrador Coast • Feeds on planktonic organisms, mainly euphausiids and copepods • Important food source for other fish, marine birds and marine mammals. Preyed upon heavily by Atlantic cod **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel **Status and Use** • Commercial fishery • Ecologically important as a forage fish species
Paralepididae (Barracudinas)	
White barracudina **(*Arctozenus /Notolepsis rissoi*)**	**Typical Habitat** Preferred Temperature NA Preferred Depth: 200 – 1,000 m **Biology and Ecology** • Distribution is worldwide from Arctic to Antarctic. • Lives in small schools, or alone, throughout the mid-depths of the North Atlantic Ocean • Spawning is said to take place in temperate to subtropical areas. • only known member of its genus • Spawning season is assumed to extend from January or February to September, with height of spawning in May. Eggs have not been seen. • Important prey for commercial species as Atlantic cod, pollock, swordfish, and redfishes, as well as cephalopods, common dolphins, and albacore. **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel **Status and Use** • No conservation status or fishery in region
Somniosidae (Sleeper sharks)	
Greenland shark **(*Somniosus microcephalus*)**	**Typical Habitat** Preferred Temperature 2.3°C Preferred Depth: 0 -2,200 m **Biology and Ecology** • Live farther north than any other shark species. • One of the largest living species of shark, up to 6.4 m (1,000 kg) • An apex predator which mostly eats fish, such as smaller sharks, skates, eels, herring, capelin, arctic char, cod, redfish, sculpins, lumpfish, wolffish and flounders. • May also prey on seals, as suggested by bite marks on dead seals at Sable Island. Also known

Species	Ecology, Status, and Use
	to scavenge on dead large land mammals • Reproductive biology poorly known **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel **Status and Use** • No conservation status or fishery in region
Scombridae (Mackerels, tunas, and bonitos)	
Atlantic bluefin tuna (*Thunnus thynnus*)	**Typical Habitat** Preferred Temperature: Tolerates 1-31°C Preferred Depth: of 27 – 183 m **Biology and Ecology** • Moves northward into Canadian waters in summer and southward again in late fall. • Occur over the continental shelf, off Newfoundland, and in the Gulf of St. Lawrence, often in schools of less than 50 fish. • Using a concurrent heat-exchange system, the bluefin can maintain muscle temperatures 10 – 15°C above the temperature of the surrounding water. • Bluefin tunas undertake extensive migrations, moving from the waters off Florida and the Gulf of Mexico as far as Newfoundland and the Gulf of St. Lawrence. • Bluefin tuna do not reproduce in Canadian waters. Two major spawning areas in the western Atlantic are the Straits of Florida and the Gulf of Mexico. • Spawning occurs during April, May, and June in subsurface waters. At temperatures of 24.9 – 29.5°C in the Straits of Florida, hatching of eggs occurs in a few days. • The diets of fish landed in eastern Nova Scotia were dominated by herring and mackerel (Pleizier *et al.* 2012). **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel **Status and Use** • COSEWIC (Endangered). • Commercial fishery in Study Area
Atlantic mackerel (*Scomber scombrus*)	**Typical Habitat** Preferred Temperature: 9.0 – 12.0°C Preferred Depth: 70 – 200 m **Biology and Ecology** • Occurs on both sides of the North Atlantic Ocean • Pelagic, schooling species common to temperate waters • Distributed in Canadian coastal and inshore waters during summer and fall • Plankton feeder; filters organisms from water with gill rakers **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel • Ecologically and Biologically Significant Areas for this species include the Cabot Strait and Western Sydney Bight. **Status and Use** • Commercial fishery in region
Yellowfin tuna (*Thunnus albacares*)	**Typical Habitat** Preferred Temperature 18-26°C Preferred Depth: top 100 m of water column **Biology and Ecology** • Among the larger tuna species • Second dorsal fin and the anal fin, as well as the finlets between those fins and the tail, are bright yellow • Mostly stay within the top 100 m of water column

Species	Ecology, Status, and Use
	• Epipelagic fish that inhabit the mixed surface layer of the ocean above the thermocline • Schooling species, may travel with other tuna species or dolphins • Prey include other fish such as flying fish, sauries, mackerel, lanternfishes, as well as pelagic crustaceans, and squid **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel **Status and Use** • Commercial fishery
Albacore tuna (*Thunnus alalunga*)	**Typical Habitat** Preferred Temperature: 15.6 – 19.4°C Preferred Depth: 0 – 600 m (Collette and Nauen 1983) **Biology and Ecology** • A cosmopolitan species • Captured off Cape Breton • Epipelagic and mesopelagic oceanic species • Feeds on pelagic fish, crustaceans and squid (Pusineri *et al.* 2005) • Forms mixed schools with skipjack tuna, yellowfin tuna and bluefin tuna (Collette *et al.* 2011) **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel **Status and Use** • Commercial fishery
Bigeye tuna (*Thunnus obesus*)	**Typical Habitat** Preferred Temperature: 13.0 – 29.0°C Preferred Depth: 0 – 250 m **Biology and Ecology** • Worldwide distribution; Atlantic, Indian and Pacific Oceans (FAO 2013) • Young fish school with other tuna species in surface waters (DFO 1998) • Migrates through temperate waters after spawning • Feeds on fish and squid (Logan *et al.* 2012) **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel **Status and Use** • May be caught with other tunas, not a targeted species
Scomberesocidae (Sauries)	
Atlantic saury (*Scomberesox saurus saurus*)	**Typical Habitat** Preferred Temperature: 8.0 - 25.0°C Preferred Depth: 0 – 30 m (Wisner 1990) **Biology and Ecology** • Occurs in warm temperate waters • Schooling species that undertakes diurnal vertical migrations • North to south migrations are associated with changes in water temperatures. • Feeds mainly on zooplankton including copepods, euphausiids, amphipods, and fish eggs and larvae **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel **Status and Use** • No conservation status or fishery in region
Xiphidae (Swordfishes)	
Swordfish (*Xiphias gladius*)	**Typical Habitat** Preferred Temperature: 8.0 – 27.0°C Preferred Depth: 0 – 500 m

Species	Ecology, Status, and Use
	Biology and Ecology • Occurs in Canadian waters between June and November • Opportunistic feeders of fish (mackerel, hake, redfish, herring, lanternfish) and squid • Distributed throughout a variety of depths • Undertakes diurnal vertical migrations • Young swordfish preyed upon by blue sharks, tunas and marlins **Region of Study Area** • Occurs on Scotian Shelf and Laurentian Channel **and Use** • Commercial fishery

Pelagic fish species assemblages within an area vary seasonally throughout the year, both in terms of the species present and the relative abundance of each species. While some pelagic species occur seasonally in large schools, others may be much less abundant and occur year-round. All species, no matter their abundance, contribute to local biodiversity and play roles in the local ecosystem. While the previous table described pelagic fish species frequently encountered during DFO surveys or otherwise known to occur frequently within the SEA Study Area, Table 3-13 provides a list of additional pelagic fish species that have been infrequently encountered (less than 100 times in 10 years) during RV surveys within this area.

Table 3-13. Other Pelagic Fish Species Reported from the Study Area[1] (Excludes anadromous species, which are discussed elsewhere).

Family	Common Name (*Scientific Name*)	Region of Study Area
Argentinidae (Argentines)	Argentine (*Argentina silus*)	Laurentian Channel
Bathylagidae (Deep-sea smelts)	Goiter Blacksmelt (*Bathylagus euryops*)	Laurentian Channel
Carangidae (Jacks, pompanos, jack mackerels, runners, and scads)	Blue Runner (*Caranx crysos*)	Laurentian Channel
Ceratiidae (Warty Seadevils)	Warted Sea Devil (*Cryptopsaras couesi)*	Laurentian Channel
Chiasmodontidae (snaketooth fishes)	Black swallower (*Chiasmodon niger*)	Laurentian Channel
Clupidae (Herrings)	Atlantic Herring (*Clupea harengus*)	Laurentian Channel
Cottidae (Sculpins)	Deepsea Arctic Sculpin (*Cottunculus microps*)	Laurentian Channel
	Triglops Sculpins (T*riglops* sp_)	Laurentian Channel
Cyclopteridae (Lumpsuckers)	Lumpfish (*Cyclopterus lumpus*)	Laurentian Channel
Gadidae (Codfishes)	Haddock (*Melanogrammus aeglefinus*)	Laurentian Channel
	Arctic Cod (*Boreogadus saida*)	Laurentian Channel
Gonostomatidae (bristlemouths, lightfishes, or anglemouths)	Bristlemouth (*Cyclothone* sp.)	Scotian Shelf

Family	Common Name (*Scientific Name*)	Region of Study Area
Lotidae (Hakes and Turbots)	Silver hake (*Merluccius bilinearis*)	Laurentian Channel
Myctophidae (Lanternfishes)	Glacier Lantern Fish (*Benthosema glaciale*)	Scotian Shelf
	Lancet fish(*Notoscopelus elongatus kroyeri*)	Scotian Shelf
Nemichthyidae (Snipe eels)	Atlantic Snipe Eel (*Nemichthys scolopaceus*)	Laurentian Channel
	Shortnose Snipe Eel (*Serrivomer beani*)	Laurentian Channel
Pleuronectidae (Right-eye Flounders)	Yellowtail Flounder (*Limanda ferruginea*)	Laurentian Channel
	Atlantic Halibut (*Hippoglossus hippoglossus*)	Laurentian Channel
Rajidae (Skates and Rays)	Winter Skate (*Leucoraja ocellata*)	Laurentian Channel
Sebastidae (Redfishes)	Golden Redfish (*Sebastes marinus*)	Laurentian Channel
Sternoptychidae (deep-sea hatchetfishes)	Mueller's pearlside (*Maurolicus muelleri*)	Scotian Shelf
	Hatchetfish (*Polyipnus asteroides*)	Scotian Shelf
	Unidentified Hatchetfish (*Polyipnus sp.)*	Laurentian Channel
Stichaeidae (Pricklebacks)	Stout eelblenny (*Lumpenus medius)*	Scotian Shelf
Stomiidae (dragonfishes)	Loosejaw (*Malacosteus niger*)	Laurentian Channel
	Scaly Dragonfish (*Stomias boa*)	Scotian Shelf
Stromateidae (butterfishes)	Butterfish (*Peprilus triacanthus*)	Laurentian Channel
Zoarcidae (Eelpouts)	Atlantic Soft Pout (*Melanostigma atlanticum*)	Scotian Shelf
	Unidentified Eelpout (*Lycodes* sp.)	Laurentian Channel
	Ocean Pout (Common) (*Macrozoarces americanus*)	Laurentian Channel

[1]Based on DFO RV data for Scotian Shelf from 2004-2014 and Laurentian Channel from 1997-2002

3.2.7.3 Diadromous Species in the Study Area

In addition to the pelagic and demersal fish species discussed above, several fish species occurring in the Study Area, utilize both freshwater and marine habitat throughout their life history. This behaviour, known as diadromy, allows species to benefit from locally abundant resources found within each habitat type. Fish species occurring in the Study Area are known employ two type of diadromous lifestyles. Fish which mature in marine water and migrate up freshwater systems to spawn are known as anadromous fishes. Familiar species include salmon, trout, and gaspereau. The sole catadromous fish occurring in the Study Area, the American eel, matures in freshwater and migrates to the Sargasso Sea of the Atlantic Ocean to spawn.

An overview of the life history habitat preferences, status, and human use of diadromous and catadromous fishes occurring within the Study Area is provided in Table 3-14.

Table 3-14. Overview of Anadromous and Catadromous Fishes occurring within the Study Area

Species	Overview
Atlantic salmon **(*Salmo salar*)** **Eastern CB Population,**	**Typical Habitat** Preferred Temperature: 2.0 – 9.0°C Preferred Depth: 1 – 10 m **Biology and Ecology**

Species	Overview
Nova Scotia Southern Uplands, Gaspé-Southern Gulf of St. LawrenceSouth Newfoundland populations[2]	• Occurs on both sides of the North Atlantic Ocean • Anadromous species; lives in fresh water and estuaries the first 2 to 7 years of life before migrating to sea • Cool rivers with extensive gravelly bottom headwaters are important habitat • When about 15 cm long, young salmon migrate to sea, where they may live for 1, 2, or more years before returning to freshwater • Important Ecologically and Biologically Significant Areas in the SEA Study are that are known to be utilized by spawning Atlantic salmon include Aspy Bay, Ingonish Bays, Indian Bay/Lingan Bay, and Big Glace Bay **Status and Use** • COSEWIC (Special Concern, Threatened, Endangered) • Recreational fishery • Historical commercial fishery
Striped bass (*Morone saxatilis*)	**Typical Habitat** Preferred Temperature: Spawn at around 13-14.5 °C Preferred Depth: Varies **Biology and Ecology** • Anadromous • Distributed along the North American Atlantic coast from St. Lawrence River to Florida. • An anadromous and coastal schooling species that inhabits mainly inshore waters. • Spawning always occurs in spring in fresh water, in most cases relatively far upriver • In the Gulf of St. Lawrence watersheds spawning occurs in May and June. **Status and Use** • Recreational fishery
Rainbow /American Smelt (*Osmerus mordax*)	**Typical Habitat** Preferred Temperature: 7-8 °C (Brandt *et al.* 1980) Preferred Depth: varies with temperature **Biology and Ecology** • Anadromous • Pelagic, schooling species that spends most of its time in shallow nearshore waters. • In summer, schools move to deeper, cooler, waters; in the fall they enter bays and estuaries where they actively feed until the onset of winter (Scott and Scott 1988). • Large schools may occur in rivers and estuaries during spawning migrations in spring. • Most spawning occurs in fast flowing, turbulent water in stream sections dominated by rocks, boulders, and aquatic vegetation, about the time ice breaks up in late winter • After hatching, larvae are transported to the estuary where they develop. • Smelt enter estuaries in fall and overwinter, and move offshore into cooler, deeper water during the summer. • However, they may only move out of harbours and estuaries far enough to find cooler water at slightly greater depths (Bigelow and Schroeder 1953). • Smelt diets shift ontogenetically from consuming copepods and other plankton as larvae to large crustaceans, worms, and small fishes (silversides, mummichog, herring) as juveniles and adults (Scott and Scott 1988). • Smelt are prey to many larger species of fish, birds and seals.

[2] Individuals from all of these populations may occur on a seasonal basis within the Study Area (COSEWIC 2010).

Species	Overview
	Status and Use • Recreational fishery
Atlantic sturgeon ***(Acipenser oxyrinchus)***	**Typical Habitat** Preferred Temperature: Reported to spawn between 13.3-17.8°C (Borodin 1925 in Scott and Scott 1988) Preferred Depth: 56-110 m at sea **Biology and Ecology** • Anadromous • Restricted to the Atlantic coast of North America including the Gulf, the Atlantic sturgeon ranges from Hamilton Inlet, Labrador, to Florida. • A bottom-living species, entering freshwater rivers and estuaries to spawn. • Most of its life is spent in salt water. • Migrating mature sturgeon move in spring or early summer, arriving on breeding grounds in advance of spawning time. **Status and Use** • Maritimes population COSEWIC (Threatened)
Gaspereau/Alewife/ Blueback Herring **(*Alosa pseudoharengus* and *Alosa aestivalis*)**	**Typical Habitat** Preferred Temperature: 3-17°C Preferred Depth: at sea in depths up to 100 m (Stone *et al*.1992) **Biology and Ecology** • Anadromous herrings • Tend to move offshore in winter and inshore in summer (Stone and Jessop 1992), influenced by oceanographic features such as temperature and zooplankton abundance. • Migrate up rivers to breed during May-June predominantly in lakes or ponds and return to the sea afterwards. • Juveniles migrate to the sea during the late summer and autumn. • Feed on plankton, including ctenophores, copepods, amphipods, mysids and shrimp (Scott and Scott 1988, Munroe 2002b). • Preyed up at sea by a variety of predators including spiny dogfish, silver hake, salmon, cod and pollock (Munroe 2002b). • Eaten by seabirds and piscivorous fishes during spawning runs (Scott and Scott 1988). **Status and Use** • Commercial fishery
American eel **(*Anguilla rostrata*)**	**Typical Habitat** Preferred Temperature: 15.4 - 19.4°C Preferred Depth: 0-35 m **Biology and Ecology** • Catadromous • Found in freshwater streams, lakes, rivers and estuaries along the western North Atlantic (Jessop et al 2002) • Abundant in many parts of the Maritime Provinces, where it occurs in most freshwater streams and rivers (and their headwater lakes) having access to the sea. • During the freshwater phase of their life, eels move into streams, rivers, and muddy or silt-bottomed lakes. • The eel is unique to other fish in that it breeds at sea and the young move into fresh water where they feed and grow. • Larval eels at sea feed on plankton. Juvenile and adult eels in freshwater feed on

Species	Overview
	benthic invertebrates and small fishes • After a number of years in freshwater they return to the sea to spawn, and presumably die. **Status and Use** • Aboriginal fishery species in province • Recreational and Aboriginal fishery • COSEWIC (Threatened) status
Sea lamprey (*Petromyzon marinus*)	**Typical Habitat** Preferred Temperature: Preferred Depth: **Biology and Ecology** • Anadromous • A parasitic anadromous fish that spends its egg and larval life stages entirely in fresh water. • At transformation (the process by which the lamprey's body changes into that of a parasite), it moves out to sea for its parasitic life phase during which it lives on a host fish. • After one to two years at sea, it returns to fresh water as an adult to spawn and then die. • Because of the economic importance and the profound effects of the sea lamprey on fish communities, its life history has been studied intensely. **Status and Use** • No conservation status or fishery in region

3.2.7.4 Overview of Important Commercial Fish Species

Several marine fish species support important commercial fisheries in the Study Area, or have done so in the past. A brief overview of each of these species is provided in the following paragraphs.

Atlantic Cod

Atlantic cod (*Gadus morhua*) is a familiar bottom-dwelling fish species which has been a very important species commercially. They occur on both sides of the North Atlantic, with regionally unique stocks making up the larger populations. The Southern population, which encompassed the SEA Study Area has been designated as Endangered by COSEWIC, as this stock has declined by 64% in the last three generations and continues to decline (COSEWIC 2010). Southern Atlantic Cod occur throughout the SEA Study Area. The Cabot Strait is a significant mixing area for three Atlantic cod stocks (DFO 2011d): Southern Gulf of St. Lawrence - 4T plus 4Vn (November–April), Eastern Cape Breton - 4Vn resident, and Eastern Scotian Shelf - 4VsW. Juvenile cod are abundant in inshore areas (Gregory and Anderson 1997). Atlantic cod is also discussed in Subsection 3.2.11 on Species at Risk.

Haddock

Haddock (*Melanogrammus aeglefinus*) is a bottom-dwelling species which prefers hard, smooth sand and gravel bottoms. They have a marked seasonal depth distribution, preferring depths of 27 to 366 m and temperatures from 1 to 13°C in the winter, but moving to shallower and warmer waters (depths of 55 to 126 m) during the summer. There are seven populations of haddock in the northwest Atlantic: southwest Newfoundland, Grand Bank, St. Pierre Bank, Emerald Bank and eastern Gulf, Browns Bank – southwestern Nova Scotia, Georges Bank and Gulf of Maine – Bay of Fundy. Each of these populations are separated by deep channels and has differing spawning times and growth rates (Scott and Scott 1988). Kulka *et al.* (2003) showed that in recent years haddock are present in the Laurentian Channel and along the slope of the St. Pierre Bank during the spring only and were found further south in the fall. Haddock are primarily bottom-feeders. Adults consume mostly crustaceans, molluscs, echinoderms, annelids and other fishes. Haddock are preyed upon by harbour (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) (Scott and Scott 1988).

Pollock

Pollock (*Pollachius virens*) is a member of the Codfish family, but spends more of its time moving through the water column than its bottom-dwelling relatives (DFO 2009e). They are found on both sides of the North Atlantic, ranging from Davis Strait to North Carolina in the west (DFO 2009e). Pollock prefer depths between 110 to 181 m and water temperatures of 0°C to 10°C (Scott and Scott 1988; DFO 2006d). On the Scotian Shelf and in the Gulf of Maine, pollock are found at depths ranging from 35 to 380 m with bottom temperatures varying from 5 to 8°C (DFO 2009e). Offshore pollock aggregations are associated with hard bottom topographic features such as rises, ridges, or mounts (DFO 2009e). The life history of pollock in the NW Atlantic involves an offshore spawning and larval phase, recruitment to the coastal environment for a period of one to two years, followed by an offshore migration (DFO 2009e). Several spawning areas have been identified on the Scotian Shelf and spawning occurs from November through February (DFO 2009e). Juvenile pollock feed on crustaceans, especially small euphausiids and amphipods, although small fishes, especially herring and sand lance are also consumed (DFO 2009e). Food of adult pollock includes euphausiids, squid and fish such as herring, sand lance, and silver hake (DFO 2009e; Stone *et al.* 2009). Predators include Atlantic cod, white hake, and monkfish as well as grey and harbour seals (DFO 2009e). Populations of Pollock in NB, NS, and NL are considered a mid-priority species by COSEWIC, as of June 19, 2015.

White Hake

White Hake (*Uryphysis tenuis*) occurs in cold water over deep mud bottom on the continental shelf and upper continental slope. In Canadian waters it occurs from southern Labrador into the Strait of Belle Isle and throughout the Gulf of St Lawrence, around Newfoundland, Scotia Shelf, Bay of Fundy, Passamaquoddy Bay, and Georges Bank. It can be found in deep parts of the Laurentian and Fundian channels and on the continental slope off Nova Scotia. White Hake are mainly found at depths greater than 200 m. They feed heavily on fish, such as clupeids and gadoids, and less frequently, crustaceans (Scott and Scott 1988). The Atlantic and Northern Gulf of St. Lawrence population of White Hake was designated as Threatened by COSEWIC in 2013 and is listed as 2 (May Be At Risk) on the GSWSC list for the Atlantic Ocean (www.wildspecies.ca).

Witch flounder

Witch flounder (*Glyptocephalus cynoglossus*) is a deep water flatfish that occurs in the NW Atlantic from Hamilton Inlet in Labrador to Cape Hatteras. Relatively non-migratory, these flatfish are typically found offshore, in waters as deep as 1,589 m, but primarily in 185 to 400 m depth range (DFO 2008d). They appear to prefer mud or sand-mud substrates and water temperatures of 2 to 6°C (Scott and Scott 1988). Witch flounder are a slow growing, long-lived species which have been aged at >20 years old (Maddock-Parsons 2005). In the NW

Atlantic, spawning typically occurs over a prolonged period from March through September. The diet of witch flounder consists of benthic polychaetes and crustaceans, small fishes, molluscs and echinoderms (Scott and Scott 1988).

Greenland halibut

Greenland halibut (*Reinhardtius hippoglossoides*), also called turbot, is a deepwater flatfish that prefers water temperatures ranging from 0 to 4.5°C. In the northwest Atlantic, their range extends from Greenland to the Scotian Shelf, with and most catches occurring in areas with water depths >450 m. They occur to about 1600 m depth, with larger individuals occurring in deeper waters. Unlike most flatfishes, the Greenland halibut spends much of its time off the bottom, behaving more as a pelagic fish (Scott and Scott 1988). Greenland halibut is typically found in the channels of the Gulf of St. Lawrence and there are indications that the Gulf of St. Lawrence stock may spend its entire life within the Gulf (DFO 2005e in JW 2007). In winter, these fish migrate towards the entrance of the Gulf (Morin *et al.* 1996 in JW 2007). It is thought that some Greenland halibut spawn in the Laurentian Channel and Gulf of St. Lawrence during the winter (Scott and Scott 1988). The eggs are benthic, and upon hatching the young move up into the water column and remain at depths of 30 m until they grow to a length of about 70 mm. As they grow, the young halibut move downward in the water column and are transported by the currents (Scott and Scott 1988).

Redfish

Acadian redfish (*Sebastes fasciatus*) is a long-lived, late-maturing redfish species which is highly vulnerable to mortality from human activities (COSEWIC 2010). This species appears to have unpredictable recruitment, with strong year classes occurring only every 5-12 years. The abundance of mature Acadian redfish has declined by 99% over about two generations in in areas of highest historical abundance, though trends have been stable or increasing since the 1990s. Acadian Redfish was designated as Threatened by COSEWIC in 2010 and is listed as May Be at Risk (2) on the GSWSC list for the Atlantic Ocean (www.wildspecies.ca). Fisheries in parts of the range of this designatable unit (DU) are currently closed, but remain open in other areas. Commercial fishing and bycatch in the shrimp fishery the main threats to Acadian redfish. (COSEWIC 2010). This species is known to occur within the SEA Study Area.

Deepwater redfish (*S. mentalla*) is a long-lived redfish species which is highly vulnerable to mortality from human activities (COSEWIC 2010). The abundance of mature deepwater redfish has declined 98% since 1984, and this decline has not ceased. Like the Acadian redfish, this species appears to have unpredictable recruitment, with strong year-classes appearing only ever 5-12 years. Deepwater Redfish was designated as Threatened by COSEWIC in 2010 and is listed as 2 (May Be at Risk) on the GSWSC list for the Atlantic Ocean (www.wildspecies.ca). Commercial Fisheries in parts of the range of this designatable unit (DU) are currently closed, but remain open in Laurentian Channel. Commercial fishing and bycatch in the shrimp fishery are the main threats to Acadian redfish. (COSEWIC 2010). This species is known to occur within the SEA Study Area.

Monkfish

Monkfish or goosefish (*Lophius americanus*) is a bottom-dwelling sluggish fish which utilizes a variety of substrates. It occurs in the NW Atlantic from the Grand Banks and Northern Gulf of St Lawrence to North Carolina (DFO 2002). Monkfish are tolerant of temperatures of 0-21°C. This species moves into shallow waters of the banks in summer and migrate to deeper waters in winter. Spawning occurs from June to September in Canadian waters. They are capable of consuming prey almost as large as they are.

Atlantic Bluefin Tuna

Atlantic Bluefin Tuna (*Thynnus thynnus)* is a large predatory fish species which spawns in the Gulf of Mexico. Adults and large juveniles move northward to forage on smaller schooling fish species when Canadian waters warm in the summer and fall (COSEWIC 2011b). They are ranked as Endangered by COSEWIC and as 2 (May Be at Risk) on the GSWSC list for the Atlantic Ocean (www.wildspecies.ca). Despite large population decreases, Atlantic Bluefin Tuna are still fished commercially off Cape Breton Island and off Guysborough County (see Section 3.3.1 in summer and fall.

Atlantic Herring

Herring (*Clupea harengus harengus*) is a pelagic, schooling fish that usually occurs either in shallow inshore waters or in the upper 200 m of offshore waters. There are several separate herring populations in the northwest Atlantic, each with its own preferred spawning, feeding and wintering grounds. The time and location of spawning depends of the herring stock. Most stocks spawn in spring or fall (Scott and Scott 1988). Herring are demersal spawners, depositing their eggs on stable substrates in high energy environments with strong tidal currents. While spawning can occur on offshore banks at depths of 40 to 80 m, most herring stocks spawn in shallow coastal waters at depths of less than 20 m. In Nova Scotian waters, it appears that herring spawn in coastal waters only. The pelagic herring larval stage is much longer for the fall-spawned than spring-spawned herring, often lasting through the winter months. Larvae are very light sensitive, seeking deeper waters on bright days (Scott and Scott 1988).

Swordfish

Swordfish (*Xiphias gladius*) is a large migratory pelagic fish that is distributed worldwide. Individuals of this species typically occur in Canadian waters during the June to November period. Swordfish may be present in surface waters or as deep as 500 m, although their presence at surface tends to occur during darkness. These large pelagic fish do not reproduce within the SEA Study Area (Scott and Scott 1988). While in Canadian waters, swordfish feed on fish and invertebrate species such as mackerel, silver hake, redfish, herring and short-finned squid (Scott and Scott 1988). Recent DFO commercial fishery data indicate swordfish catches occur off eastern Cape Breton.

Smelt

Rainbow Smelt (*Osmerus mordax*), sometimes called American Smelt, is a small migratory pelagic fish that occurs in coastal waters (Scott and Scott 1988). They enter estuaries in fall and late winter. They prefer cooler temperatures and move into deeper waters in summer. Smelts spawn in spring (usually May in NS) in brooks and streams above the head of the tide. The eggs area heavy and sink to the bottom where they stick to the bottom (Scott and Scott 1988). The eggs hatch quickly and the larvae are carried downstream to brackish water shortly after hatching, where they feed on copepods and amphipods, mysids, shrimps, and marine works, graduating to small fish as they mature. Smelts are an important source of food for many larger species of fish and for some aquatic birds. At sea they are preyed up on by cod and salmon, brook trout and seals (Scott and Scott 1988). Within the SEA Study Area, most fishing for smelts occurs in estuaries.

Gaspereau

The term 'gaspereau' actually refers to two species of fish, which are closely related and very similar in appearance. Alewife (*Alosa pseudoharengus*) and blueback herring (*A. aestivalis*) are members of the herring family (Clupeidae) which spend most of their life at sea but swim up river to spawn in freshwater rivers and lakes in May in Nova Scotia. The young fish grow quickly in the freshwater environment and head to sea beginning in August. Gaspereau can spawn many times and fish as old as 20 years have been reported in NS. They usually swim near the sea surface in schools in coast waters and prey on plankton (Scott and Scott 1988). Light – sensitive, they migrate vertically to follow the daily migrations of plankton. Gaspereau support an important commercial fishery in Nova Scotia, with most fish currently being used as lobster bait.

Atlantic Mackerel

The Atlantic mackerel (*Scomber scombrus*) is a pelagic fish common to temperate waters of the open sea. It is one of the most active and migratory of fishes. Mackerel occupy inshore waters during spring and summer, and move to deep warm waters at the edge of the continental shelf for fall and winter (DFO 2008e). Two intense spawning areas occur in the NW Atlantic. During June and July, spawning predominately occurs in the southern Gulf of St. Lawrence. This spawning period is preceded by an extensive migration that begins early in the spring in the Gulf of Maine and Georges Bank Areas.

3.2.7.5 Regional Marine Fish Distributions

The habitats and environmental conditions in the Study Area are heterogeneous and as a result vary in their suitablity to various fish species. As indicated previously, the Study Area is composed of two general marine habitats, the Scotian Shelf area and a Portion of the deep Laurentian Channel. The shallower shelf areas, particularly the banks, are highly productive in the summer and serve as important spawning, nursery, and adult feeding grounds for both groundfish and pelagic fishes. The channels are occupied by deepwater species (*e.g.* redfish) and also serve as winter habitat for many species that occupy the shelf areas in summer (*e.g.* cod) (Dufour and Ouellet 2007).

Areas of elevated fish densities were defined using data collected during the 2004-2014 Scotian Shelf DFO RV Surveys and the 1997-2002 Laurentian Channel DFO RV surveys. While all species captured in the Laurentian Channel and Scotian Shelf regions are identified in Table 3-15, only a few species, selected on the basis of their current commercial and/or ecological importance, are mapped on the following pages. The Laurentian Channel data set is not plotted, due to its age and incompatibility (differences in gear types and survey methodologies) with the Scotian Shelf data.

Table 3-15. Most Abundant Finfish Species Caught in DFO RV Otter Trawl Surveys in the Scotian Shelf Portion of the SEA Study Area from 2004-2014

Common Name	Scientific Name	Number inside SEA Study Area	Avg #/tow Study area	Percent of Total Catch of Species	Commercial Use
Redfish	*Sebastes sp.*	67,411	239	19.1	Yes
Sand Lance	*Ammodytes dubius*	16,362	58	7.4	
American Plaice	*Hippoglossoides platessoides*	11,529	41	29.4	Yes
Atlantic Herring	*Clupea harengus*	8,753	31	12.4	Yes
Capelin	*Mallotus villosus*	8,007	28	74	Yes
Witch Flounder	*Glyptocephalus cynoglossus*	6,674	24	43.9	Yes
Shanny	*Lumpenus maculatus*	4,573	16	66.7	
Atlantic Cod	*Gadus morhua*	4,200	15	17.6	Yes
Greeenland Halibut	*Reinhardtius hippoglossoides*	2,507	8.9	50.39%	Yes
White Hake	*Urophycis tenuis*	2,502	9	57.19%	Yes
Snake blenny	*Lumpenus lumpretaeformi s*	764	3	65.4	
Pollock	*Pollachius virens*	709	2.5	8.2	Yes
Longfin Hake	*Urophycis chesteri*	445	1.5	30.9	Yes
Vahls Eelpout	*Lycodes vahlii*	415	1.5	27.2	
Striped Wolffish	*Anarhichas lupus*	412	1.5	61.5	

Table 3-16. Most Abundant Finfish Species Caught in DFO RV Surveys in the Laurentian Channel Portion of the SEA Study Area from 1997-2002

Common Name	Scientific Name	Number inside SEA Study Area	Avg #/tow Study area	Percent of Total Catch of Species	Commercial Use
Black Dogfish	*Centroscyllium fabricii*	28,567	154.	26	
Common Grenadier	*Nezumia bairdi*	10,022	54.2	9	
Witch Flounder	*Glyptocephalus cynoglossus*	3,873	20.9	35	Yes
Barracudina	*Paralepididae*	1,929	10.4	1.8	
Greeenland Halibut	*Reinhardtius hippoglossoides*	1,007	5.4	0.9	Yes
Threebeard Rockling	*Gaidropsarus ensis*	27	0.15	0.03	
Lanternfish	*Myctophidae*	1,127	6.1	1.03	
Dragonfish	*Stomias boa feroe*	37	0.2	0.03	
Viperfish	*Chauliodus sloani*	35	0.18	0.03	
Eelpout sp.	*Liparidae*	110	0.59	0.1	
Capelin	*Mallotus villosus*	1,796	9.70	1.6	Yes
Mackerel	*Scomber scombrus*	19	0.10	0.02	Yes
Hookear Sculpin	*Artediellus* sp.	69	0.37	0.06	
Deepwater Redfish	*Sebastes mentella*	41,032	221.8	37.6	Yes

Within the Study Area, redfish (*S. fasciatus* and *S. mentalla* combined), were most abundant north of Cape Breton Island and east of the St Anns Bank AOI (Figure 3-16). American plaice reachied its highest abundance east and south of northern Cape Breton Island (Figure 3-17). Atlantic cod were most abundant northeast of Cape Breton Island and along the Laurentian Slope (Figure 3-18). Greenland halibut reached its highest densities south and east of Cape Breton, and was abundant along the Laurentian Slope as well (Figure 3-19). Capelin were most abundant along the eastern Cape Breton coast (Figure 3-20). Sandlance were most abundant offshore, in the southern portion of the SEA Study Area (Figure 3-21). Atlantic Herring had small areas of high abundance along the southern and northern coasts of Cape Breton Island (Figure 3-22).

Figure 3-16 Distribution and Abundance of Redfish on the Scotian Shelf, as determined by DFO RV surveys from 2004-2014.

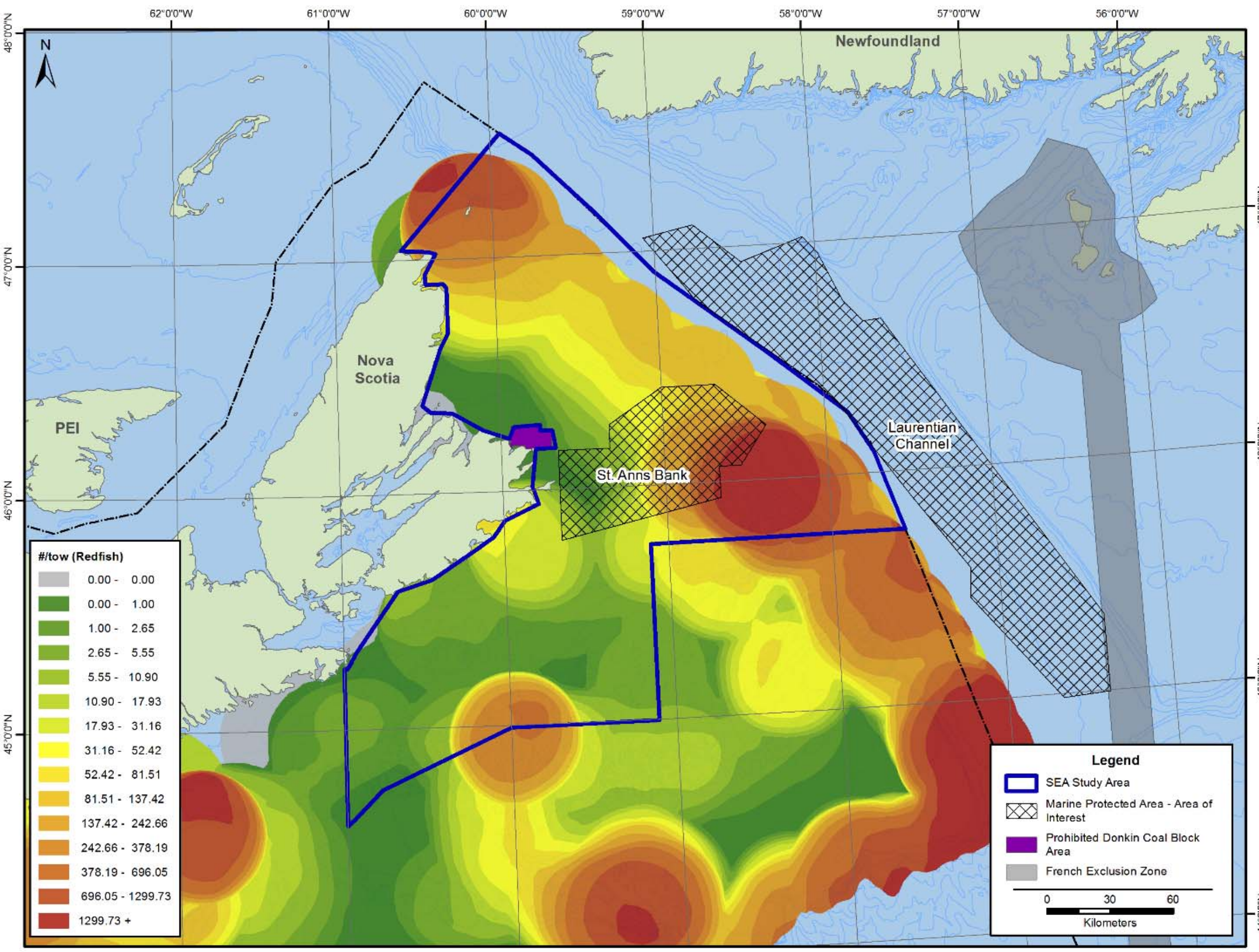


Figure 3-17 Distribution and Abundance of American Plaice on the Scotian Shelf, as determined by DFO RV surveys from 2004-2014.

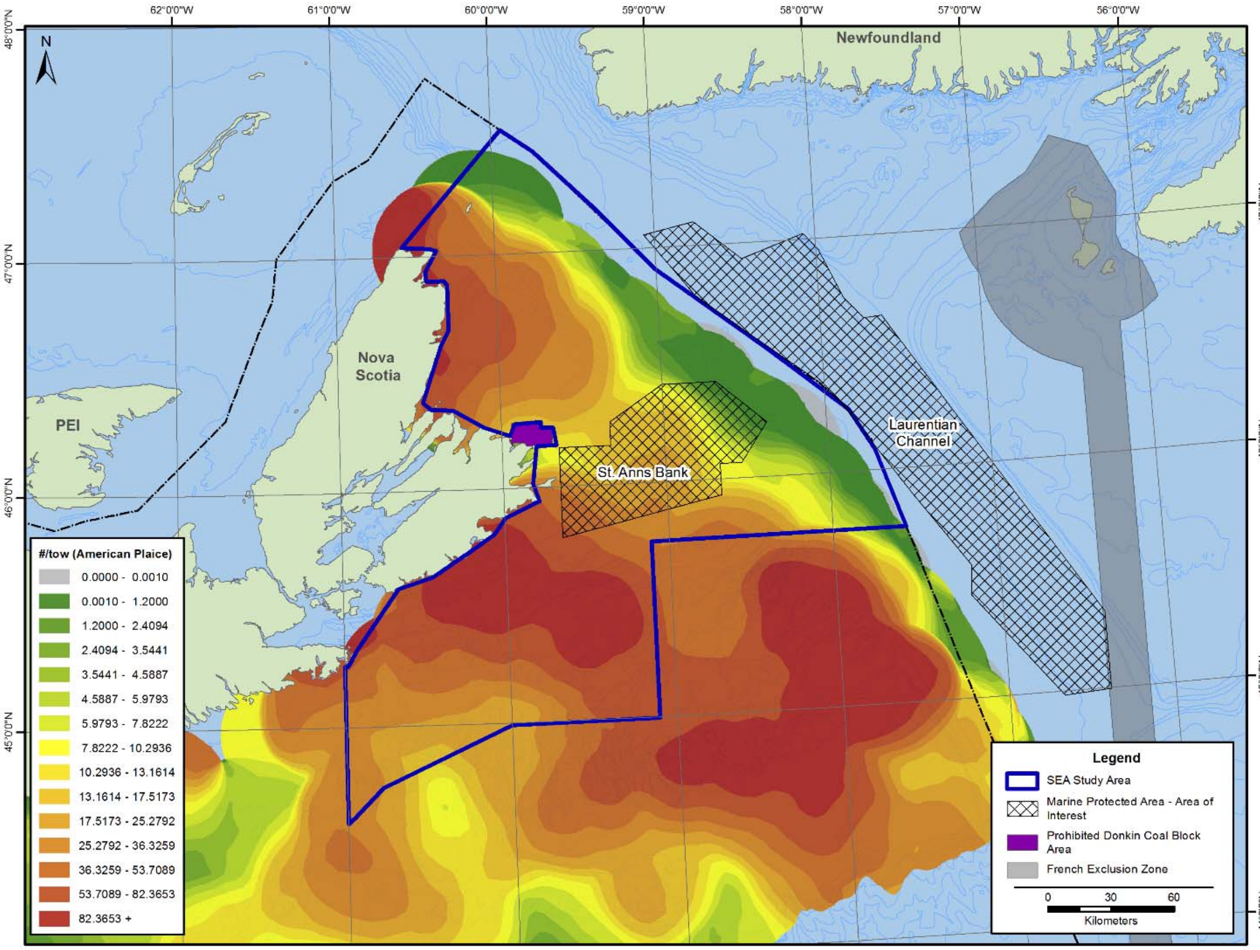


Figure 3-18 Distribution and Abundance of Atlantic Cod on the Scotian Shelf, as determined by DFO RV surveys from 2004-2014.

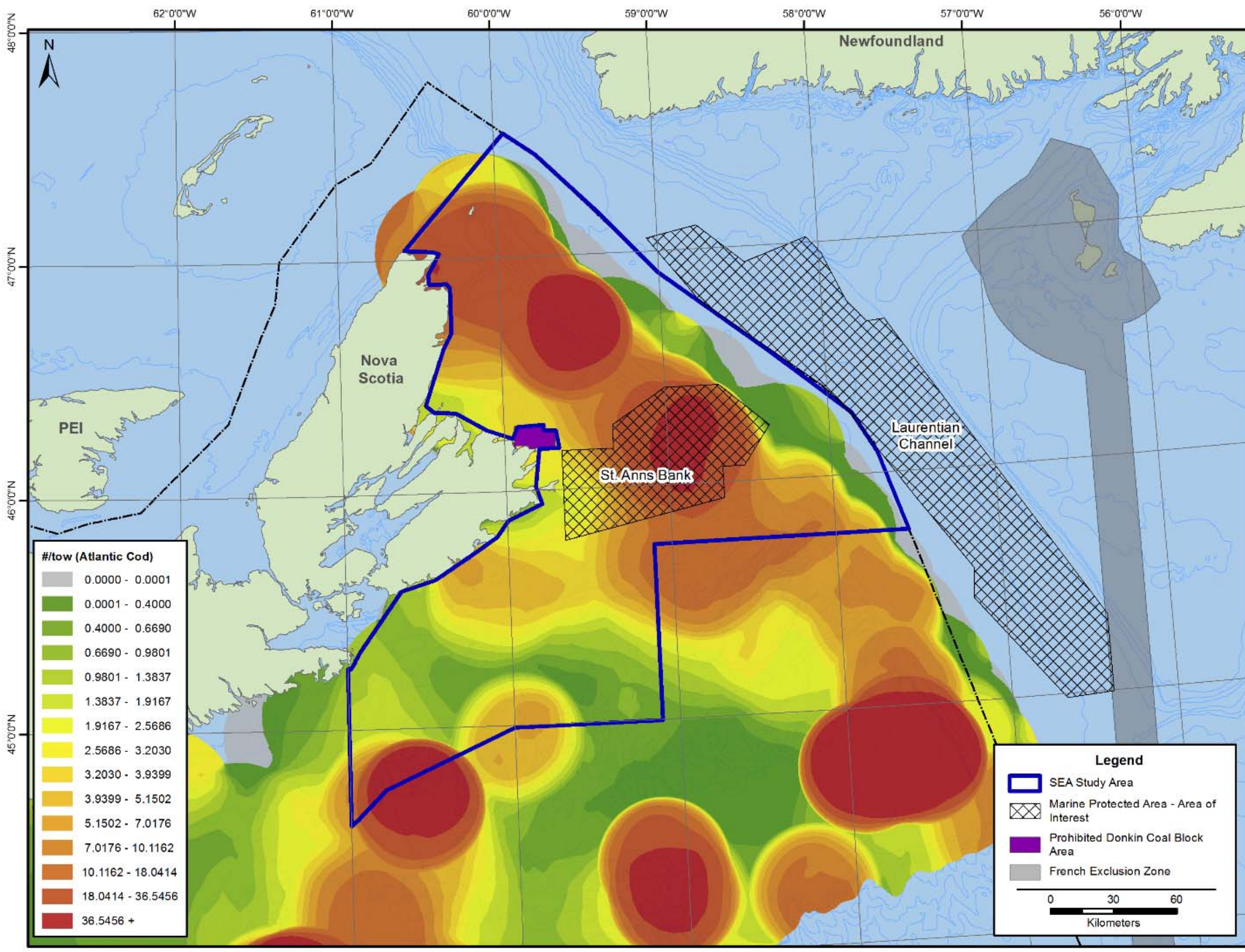


Figure 3-19 Distribution and Abundance of Greenland Halibut on the Scotian Shelf, as determined by DFO RV surveys from 2004-2014.

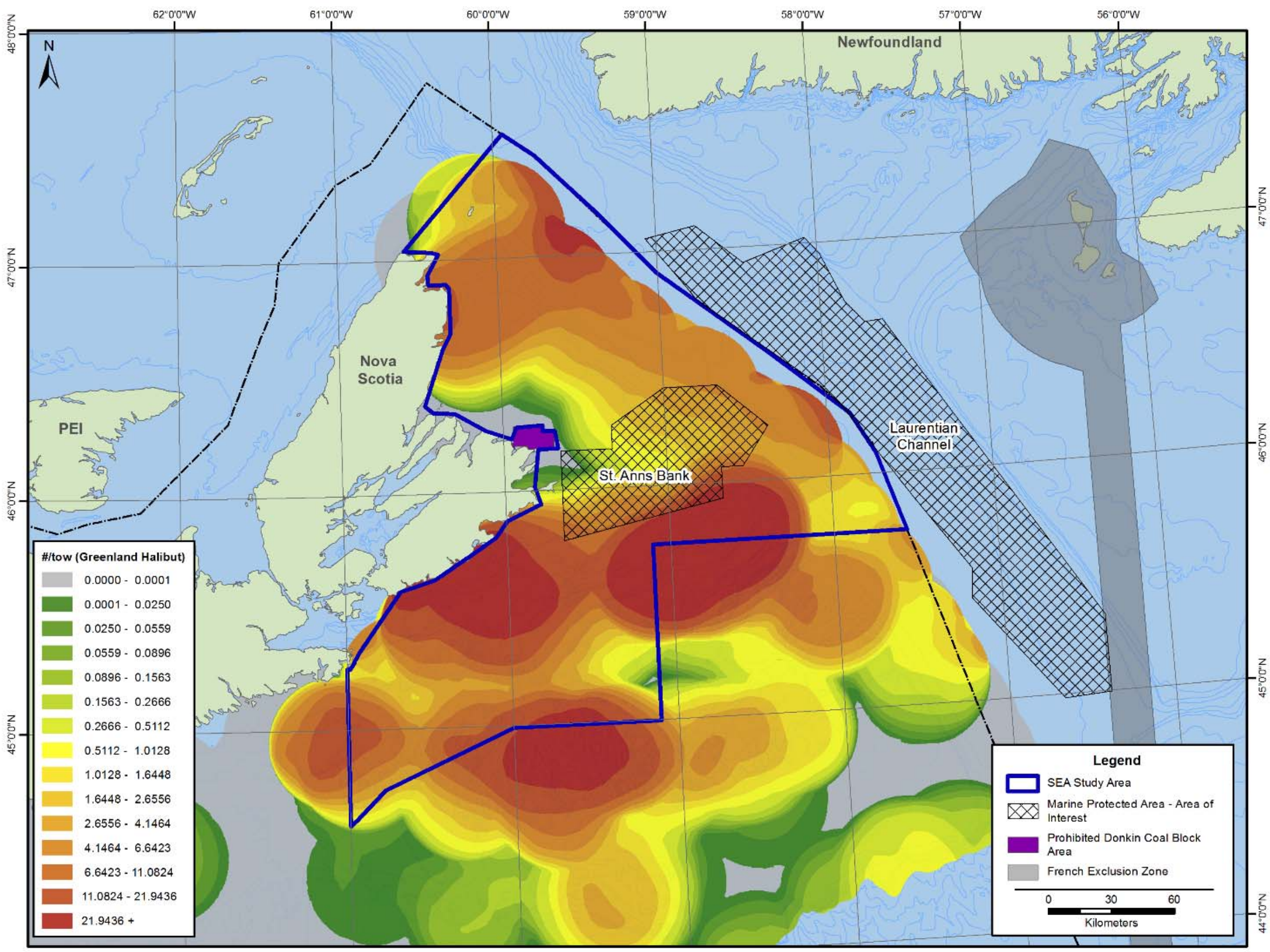


Figure 3-20 Distribution and Abundance of Capelin on the Scotian Shelf, as determined by DFO RV surveys

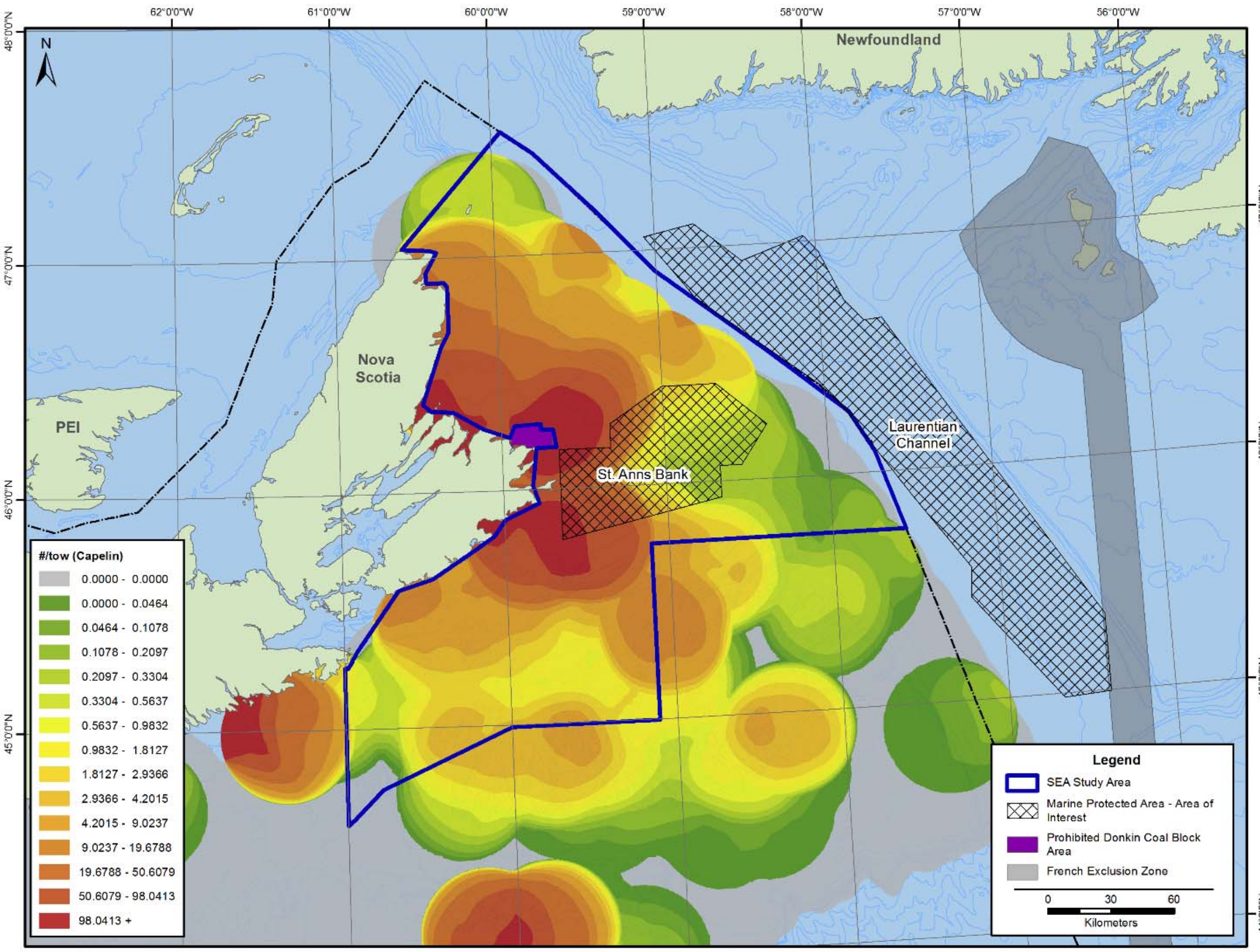


Figure 3-21 Distribution and Abundance of Sandlance on the Scotian Shelf, as determined by DFO RV surveys from 2004-2014.

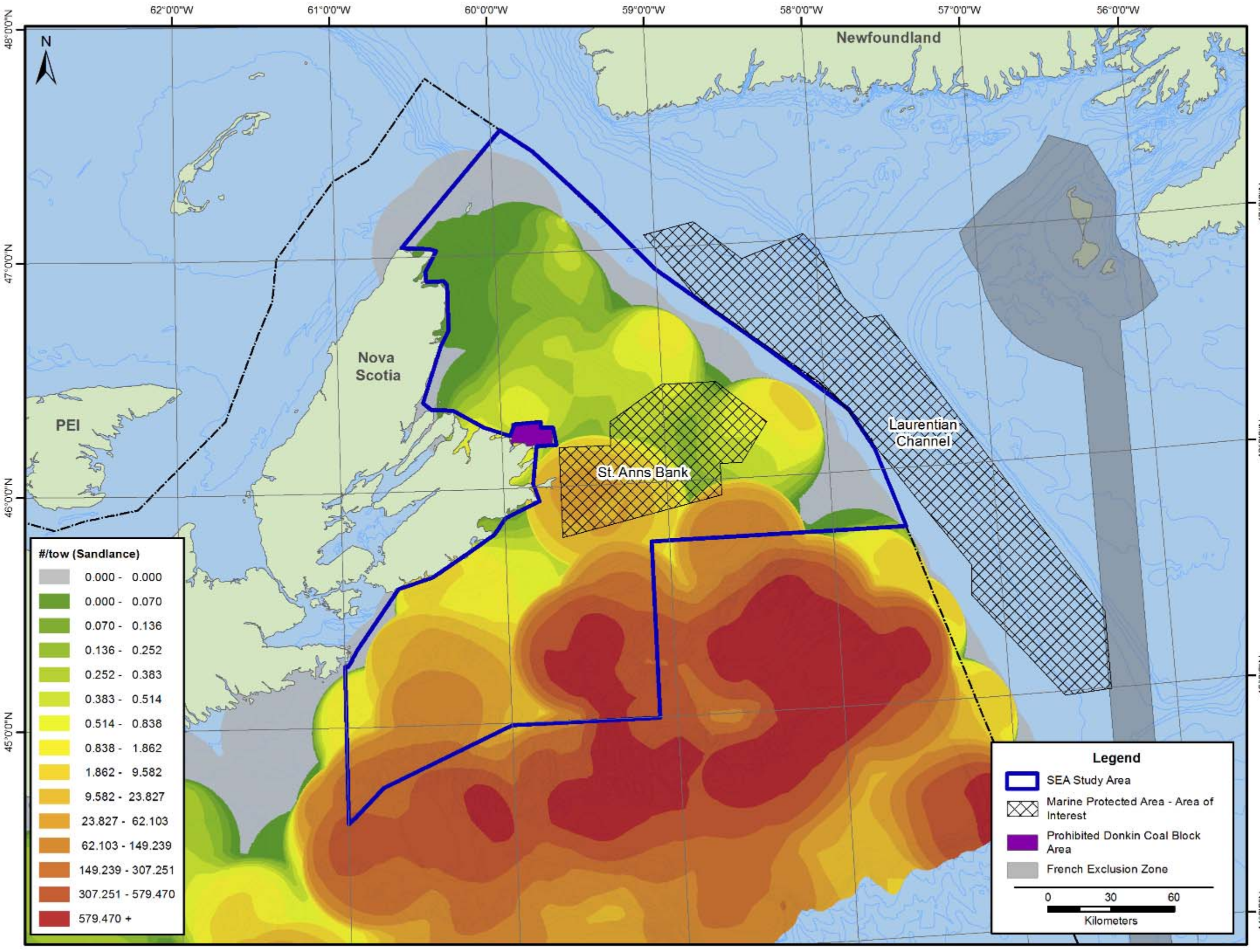
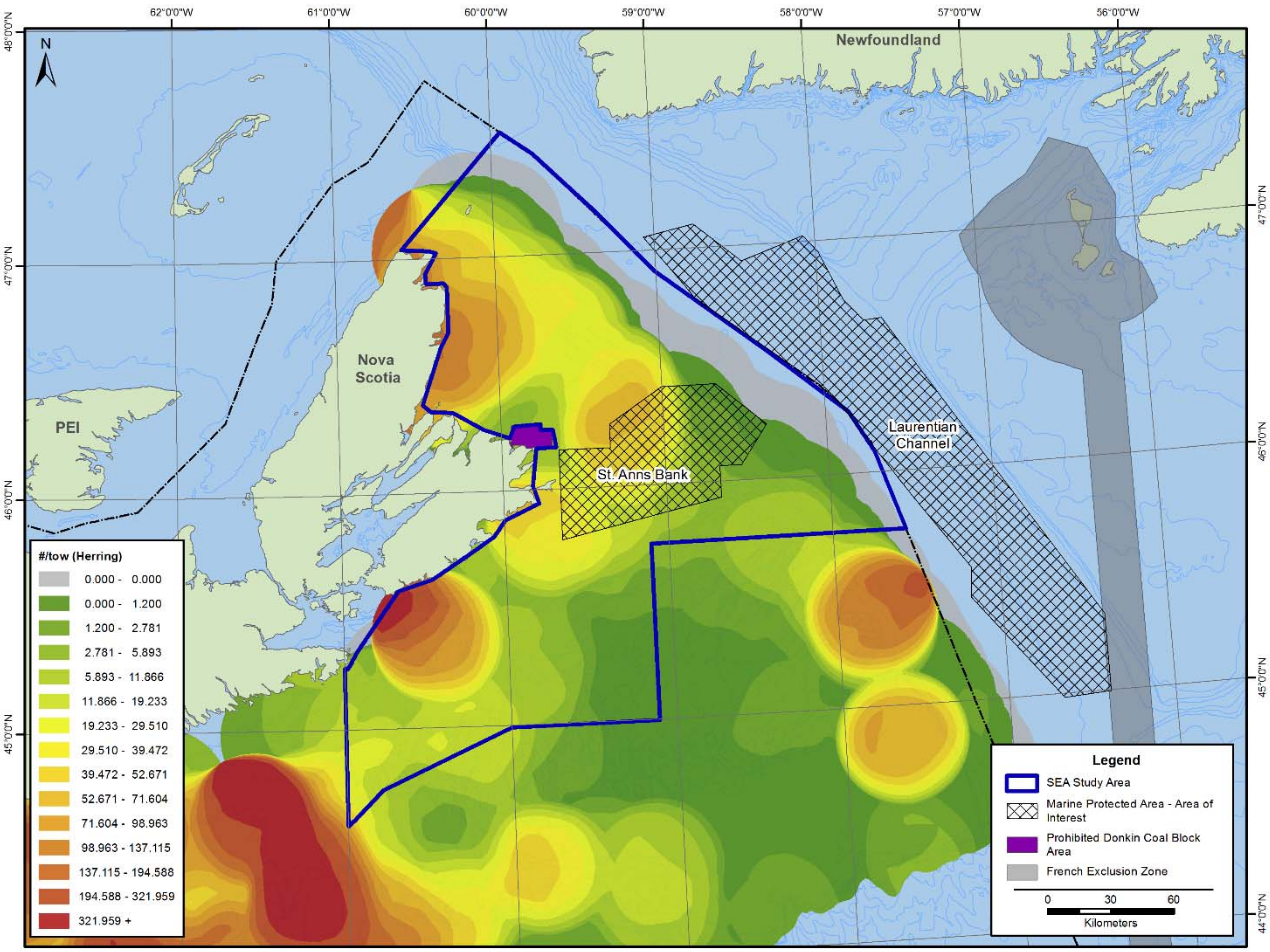


Figure 3-22 Distribution and Abundance of Atlantic Herring on the Scotian Shelf, as determined by DFO RV surveys from 2004-2014.



3.2.7.6 Fish Migration Patterns

In temperate latitudes, many fish species migrate at some point in their life history. Migration allows individuals to benefit from abundant resources, avoid unfavourable environmental conditions, and gather with other members of their species to spawn (Dingle and Drake 2007). Many species also migrate as juveniles from nursery habitats to adult habitats. As adults, many species undertake annual migrations to and from summer feeding, spawning, and overwintering grounds.

The Cabot Strait is a major route for migratory fish (D'Amours and Castonguay 1992, Campana *et al.* 1999, Comeau *et al.* 2002, Chadwick and Claytor 1989, DFO 2001 Bourassa et al. 2007.). The Gulf of St Lawrence, particularly the southern Gulf, contains important seasonal feeding grounds for a number of fish species. Many highly pelagic species which overwinter in more southern latitudes, such as Atlantic bluefin tuna and spiny dogfish, migrate into the Gulf of St Lawrence to take advantage of the warmer waters and increased food supply (Zwanenberg *et al.* 2006). Smaller pelagic such as Atlantic herring and Atlantic mackerel also migrate into the Gulf of St Lawrence, often in great numbers (Winters and Beckett 1978, D'Amours and Castonguay 1992, Grégoire and Lévesque 1994). It has been estimated that about 800 000 tons of mackerel enter Cabot Strait in late spring en route to their main spawning grounds in the southern Gulf of St Lawrence (Grégoire and Lévesque 1994) and leave mainly in October/November, as inferred from landings (Grégoire *et al.* 2009). Capelin also enter the Gulf of St Lawrence via the Cabot Strait, though they are not as predictable as mackerel. Pelagic shark species known to migrate into the Gulf of St Lawrence via the Cabot Strait include porbeagle, blue shark, basking shark, shortfin mako, and spiny dogfish (Zwanenberg *et al.* 2006).

Many demersal species also migrate in and out of the Gulf, through the SEA Study Area. These include:

- Atlantic cod which migrate from the Gulf to overwinter in the Sydney Bight;
- American plaice from the southwest Gulf (4T) migrate to the Sydney Bight/4Vn/Laurentian Channel area for the winter, and then return to the Gulf to spawn (Busby *et al.* 2007);
- Redfish undergo overwintering migrations from the Gulf (NAFO Zone 4T) to 4Vn in November and return to the Gulf in May (Morin *et al.* 1994; Gascon 2003);
- Witch flounder from 4T migrate into the Laurentian Channel each year; and
- Redfish undergo overwintering migrations from 4T to 4Vn in November and return to the Gulf in May (Morin *et al.* 1994; Gascon 2003).

Coastal regions also provide migratory routes for anadromous species; the adults of which pass through coastal areas to spawn in in freshwater rivers and lakes.

- Gaspereau are assumed to enter and exit the Gulf through Cabot Strait, exclusively along the north of Cape Breton Island (Rulifson and Dadswell 1987). Juveniles then move downstream and into estuaries of their home rivers in late summer or fall.
- Maturing eels also move seaward from their freshwater habitats in late summer and fall (Dufor and Oullet 2007).
- Atlantic salmon begin migrating to their spawning rivers in summer, and leave their natal rivers in spring (Scott and Scott 1988).
- Rainbow smelt enter estuaries in fall and late winter and spawn in brooks and streams above the head of the tide in spring (Scott and Scott 1988).

Many species migrate into shallow waters in summer, and return to deeper offshore waters for the winter months. Much of the Gulf is ice-covered in winter and this ice often extends out into the Cabot Strait (see description of winter ice condition in Section 3.1.5) and the seawater is near the freezing point throughout the water column. Many fish migrate out of the Gulf to avoid this. Others migrate into warmer deeper waters of the Laurentian Channel or along its slopes. Examples of species which exhibit this onshore/offshore migration behaviour include Atlantic herring, Atlantic cod, white hake, American plaice, witch flounder, and thorny skate. Some of these species stay in the Laurentian Channel, while others move further south, towards the entrance to the Laurentian Channel in the Cabot Strait (such as cod, herring, and redfish). Upon exiting the Gulf, most species travel north along the western coast of Cape Breton Island, and then turn south and enter the Cabot Strait (Dufor and Oullet 2007).

Many large pelagic species which overwinter in more southern latitudes migrate into and/or through the SEA Study to forage in the warmer months. Species include tunas (Atlantic Bluefin, yellowfin, bigeye, albacore), swordfish, sharks (white, porbeagle, blue, spiny dogfish, shortfin mako, basking) and sunfish.

While the fishing industry has developed in response to the distribution and behaviour of fish stocks, much is still unknown about the specific timing and extent of fish migratory patterns. The Ocean Tracking Network, an organization aiming to increase knowledge of the distribution and habitat preferences of many marine species, has a line of acoustic receivers extending from Cape North on the northern tip of Cape Breton Island to St. Paul's Island, and continuing across to Newfoundland. Species which have been fitted with acoustic tags and subsequently recorded passing through the Cabot Strait Line to date include Atlantic salmon, Atlantic cod, Atlantic sturgeon, porbeagle shark, American eel, blue shark, and Atlantic bluefin tuna (OTN 2015).

3.2.7.7 Summary of Some Key Spawning Times and Areas

A summary overview of some important spawning areas and times for key and select species in the SEA Study Area is provided in Table 3-17.

Table 3-17. Summary of Known Spawning (S) Times and Areas for Select Marine Fish Species, with a focus on the Eastern Scotian Shelf

Species	Month												Some Known Spawning Locations
	J	F	M	A	M	J	J	A	S	O	N	D	
American Plaice[1,2]					S								Eastern Scotian Shelf, Northern Scotian Shelf
Atlantic Cod (Northern)[1,3,4,5,]	S	S	S	S	S						S	S	Sable Island Bank Sydney Bight, Misaine Bank, St Anns Bank
Atlantic Mackerel[1]						S	S						Sable Island Bank
Atlantic Herring[6,7,8,]				S	S	S	S	S	S	S	S		Gulf of St Lawrence, Scotian Shelf, St Anns Basin , Sable Island Bank
Haddock[1,9]					S	S							Sydney Bight, Sable Island

Species	**Month**												**Some Known Spawning Locations**
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	
													Bank
Sandlance[10]	S	S	S								S	S	Banks on Scotian Shelf
Silver hake [6,12,3,1,]						S	S	S	S				Sable Island Bank, Middle Bank
White hake[1]							S						Scotian Shelf, Laurentian Channel
Winter Flounder [13]			S	S	S	S							Sable Island Bank
Witch Flounder[1,3]			S	S	S	S	S						Eastern Scotian Shelf, Sable Island Bank
Yellowtail Flounder	S	S	S	S	S	S	S	S	S	S	S	S	Sable Island Bank
Wolffishes [13]									S	S	S		Slope Region of Laurentian Channel
Redfish [14, 15]				S	S	S	S						Gulf of St. Lawrence
Greenland Halibut[16]	S	S	S								S	S	Laurentian Channel
White Hake[17]						S	S	S	S				Southern Gulf of St. Lawrence, Scotian Shelf

[1]Breeze *et al.* (2002), [2]Nevinsky and Serebryakov (1973),[3]Scott (1983), [4]Brander (1993), [5]Brander and Hurley (1992), [6]DFO (1980), [7]Haegele and Schweigert (1985), [8]Harris and Stephenson (1999), [9]Page and Frank (1989), [10]Davis *et al.* (1998), [11]DFO (1980), [11]Mobil Oil Canada Ltd. (1983), [13]Jonssen (1982) [14]Gascon (2003), Ollerhead *et al*. 2004).[15] St. Pierre and de Lafontaine (1995), [16]DFO (1984), [17]Markle *et al. (*1982).

3.2.8 Marine Birds

This section describes the overall presence, distribution and seasonal abundance of marine-associated bird species, including avian species at risk, in the SEA Study Area. For the purposes of this discussion, these avifauna are grouped into four categories: 1) seabirds, 2) coastal waterfowl (including loons and grebes), 3) shorebirds, and 4) landbird species, including passerines. Seabirds, coastal waterfowl and shorebirds are considered to be the most vulnerable to perturbation as they spend much of their life in the marine environment, although some landbird species may also be affected, particularly those that are associated with coastal habitats and those that migrate through the offshore study area.

The federal *Migratory Birds Convention Act* (MBCA) prohibits the disturbance or destruction of most migratory birds, as well as their nests and eggs, in Canada. The legislation and regulations of the Act, which is administered by Environment Canada, apply to all lands and waters in Canada. Environment Canada's website provides guidance on beneficial management practices and general avoidance information to reduce the risk of harm to migratory birds (as well as to avian species at risk) through incidental take (http://www.ec.gc.ca/paom-itmb). Species that are excluded from protection under the MBCA (*e.g.,* hawks, owls and game birds such as grouse and pheasant) are protected under the Nova Scotia *Wildlife Act* and its regulations.

Data on avian presence and abundance in and near the SEA Study Area were obtained from various sources. The Canadian Wildlife Service branch of Environment Canada (EC-CWS) provided information on seabird colonies off Eastern Newfoundland, as well as recent data on seasonal and spatial trends in seabird abundance from the Eastern Canadian Seabirds at Sea (ECSAS) program. Records from the Atlantic Canada Shorebird Survey (ACSS) and the Important Bird Areas (IBAs) of Canada programs provided further information on species presence and were used to identify avian "hotspots". Information on breeding distributions of bird species was obtained from the Maritimes Breeding Bird Atlas (MBBA 2015).

The Important Bird Area (IBA) program is coordinated by BirdLife International, and administered in Canada by the Canadian Nature Federation and Bird Studies Canada (IBA 2015). This program identifies areas of important habitat using internationally standardized criteria based on the presence of species at risk, species with restricted range, habitats holding representative species assemblages, or a congregation of a nationally and/or globally significant proportion of a species' population during one or more season. A total of 15 Important Bird Areas (IBAs) have been designated in and near the Study Area (see Table 3-37, Section 3.2.12). These areas are depicted on Figure 3-23.

A number of Ecological and Biologically Significant Areas (EBSAs) have been identified along the Atlantic coast of Nova Scotia, many for their important attributes related to birds and their habitats. The EBSAs are further discussed in Section 3.2.12 and many of the EBSAs that are of significance to birds are also designated as IBAs These areas are depicted in Figure 3-23.

Other designated sites that are important to migratory birds include federal Migratory Bird Sanctuaries (MBS) and provincially designated wilderness areas and nature reserves. Migratory Bird Sanctuaries are designated by Environment Canada and are protected by the *Migratory Bird Sanctuary Regulations* under the MBCA regarding the taking, injuring, destruction or molestation of migratory birds or their nests or eggs in the sanctuaries.

Hunting of migratory species not permitted in any Migratory Bird Sanctuary. There is one MBS in the area, the Big Glace Bay Lake MBS, which is also an IBA.

The Sydney Bight and Orpheus Graben area and the coast of eastern Nova Scotia provide important habitat to many species of birds at different times of year. In the summer, colonies of nesting seabirds can be found along the coast, while in the winter months, large numbers of eiders and other waterfowl inhabit coastal waters. During fall migration, it is thought that the Cabot Strait provides an important migratory corridor for birds nesting on the island of Newfoundland. In addition, there are many sites of provincial and regional significance in proximity to the SEA study area.

3.2.8.1 Seabirds

Seabirds are long-lived species with low fecundity, delayed recruitment and low rates of population growth, and are therefore particularly vulnerable to factors that affect adult survival. They are key indicators of ecosystem health, and are also socioeconomically important in tourism, most notably in the Bird Islands IBA. A variety of seabird species occur in the marine waters of the proposed Project area, including cormorants, gannets, phalaropes, gulls, terns, alcids, jaegers and skuas, fulmars, petrels and shearwaters; these groups are described Table 3-18. Seabirds occur year-round in offshore waters, and are present at colonies within the survey area throughout much of the year, with Black-legged Kittiwakes arriving as early as February; most species depart from the colonies by late September.

Figure 3-23. Locations of Important Birds Areas (IBAs) and Piping Plover Beaches in the SEA Study Area.

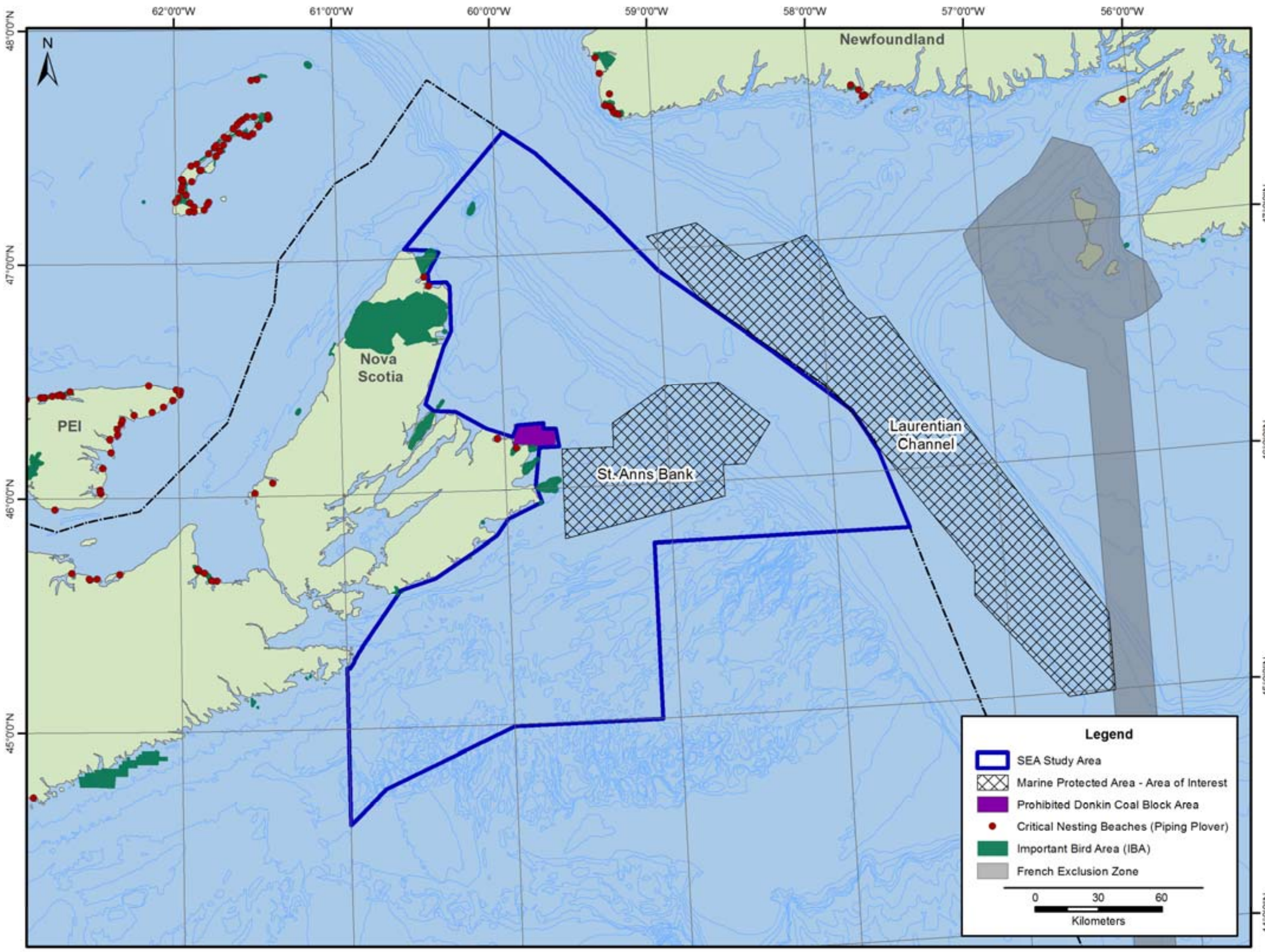


Table 3-18. Characteristics of Seabird Species in the SEA Study Area

Group	Details
Cormorants (*Phalacrocoracidae*)	**Species** Double-crested Cormorant, Great Cormorant **Status** Both species are secure in Canada. Populations of Double-crested have increased significantly since 1970 (Environment Canada 2011). **Typical Habitat** Nest on cliffs, artificial platforms, rocky ground, shrubs or trees Coastal; typically found in waters < 8 m deep. **Seasonal Movements** Arrive at colony in early spring. Double-crested migrates south in late fall, while Great are partial migrants with some individuals remaining within the breeding range year round. **Biology and Ecology** • Begins to breed at 2 or (typically) 3 years of age. Lays 1 to 7 eggs per clutch (mean = 4). Annual number of fledglings per breeding pair for populations in eastern Canada ranges from 0.98 - 2.35 for Double-crested and from 1.2 - 1.97 for Great (Hatch and Weseloh 1999; Hatch *et al.* 2000). • Double-crested has a wide breeding distribution in coastal areas throughout NS; Great is found mainly along the coast of eastern Cape Breton to the south and southwest coast (MBBA 2015). • Feed by pursuit diving typically to depths of 10 m or less, occasionally up to 35 m. • Diet includes a variety of small fish (typically < 20 cm) and invertebrates, predominantly benthic species.
Gannets (*Suliidae*)	**Species** Northern Gannet **Status** Secure in Canada. Steadily increasing population of 200,000 - 300,000 breeding adults (Environment Canada 2011). **Typical Habitat** Nest in dense colonies on cliff ledges, usually on islands, but occasionally inaccessible mainland cliffs. Typically found in continental shelf waters year-round. **Seasonal Movements** Adults arrive at colony in mid-March, followed a few weeks later by subadults. Juveniles migrate southward in September; adults and older immatures may travel north from the colonies to feed along the Labrador Coast before southward migration. The Laurentian Channel and St. Anns Bank are thought to provide an important migratory corridor for gannets breeding in the Gulf of St. Lawrence (Ford and Serdynska 2013). Winter range extends from the Gulf of Maine to Mexico. **Biology and Ecology** • Begins to breed between 4 and 7 years of age, and lays 1 egg per clutch. Mean annual number of fledglings per breeding pair for populations in eastern Canada is 0.81 (Mowbray 2002). • Northwest Atlantic breeding population is confined to six colonies in eastern Newfoundland and Québec (Mowbray 2002). • Feeds by plunge diving from a height of 10 - 40 metres above the surface, descending to depths of 15 m. Travels up to 180 km from breeding colony to forage, and flocks of up to 1000 may congregate over shoals of food fish. • Preys on shoaling fish (herring, mackerel and capelin), and invertebrates such as

Group	Details
	squid.
Phalaropes (*Scolopacidae*)	**Species** Red Phalarope, Red-necked Phalarope **Status** Red-necked Phalarope (COSEWIC: Special Concern) populations have decreased slightly; Red Phalarope population trends are unknown. Both species estimated to have a population of >1,000,000 in Canada (Environment Canada 2011). **Typical Habitat** Nest on the ground in Arctic tundra in short vegetation (sedges, mossy hummocks), typically close to fresh water. Winter offshore along ocean fronts, mostly in tropical and sub-tropical regions. **Seasonal Movements** Spend most of the year offshore, coming on land only during the summer months in the Arctic to breed. Congregate in areas such as upwellings, which are associated with higher prey densities. **Biology and Ecology** • Although taxonomically members of the shorebird family (*Scolopacidae*), phalaropes are pelagic outside of the breeding season and so are considered here as seabirds. • The western portion of the St. Anns Bank is considered likely to be an important migratory corridor for individuals entering and exiting the Gulf of St. Lawrence (Ford and Serdynska 2013). • Phalaropes display reverse sexual dimorphism, females being larger and more brightly coloured than males; as well, female departs shortly after egg-laying, leaving male as sole provider to the offspring. • Begins to breed in first year. Lays 4 eggs per clutch. Annual number of fledglings per breeding pair for populations highly variable and dependent on predator populations; for Red Phalarope, the average fledging success is approximately 10% in Canada (Rubega *et al.* 2000; Tracy *et al.* 2002). • Surface feeders. Phalaropes swim on the water surface in tight circles, churning prey upwards to within reach. • Diet includes zooplankton and small aquatic invertebrates
Gulls (*Laridae*)	**Species** Herring Gull, Iceland Gull, Glaucous Gull, Great Black-backed Gull, Ring-billed Gull, Bonaparte's Gull, Black-legged Kittiwake **Status** Most gull species considered secure in Canada; however, Glaucous are in decline (Environment Canada 2011). **Typical Habitat** Most gulls are ground nesters; Black-legged Kittiwakes nest on cliffs. Outside of the breeding season, most gull species can be found in coastal and offshore areas. Black-legged Kittiwakes are more pelagic than the larger gulls. **Seasonal Movements** Herring, Great Black-backed and Ring-billed Gulls and Black-legged Kittiwakes occur in temperate areas year-round. Bonaparte's, Iceland and Glaucous nest in the Arctic, occurring in the proposed Project area only outside the breeding season. **Biology and Ecology** • Begin to breed between 3 and 7 years of age, and lay 2 to 3 eggs per clutch. Mean

<table>
<tr><th>Group</th><th>Details</th></tr>
<tr><td></td><td>annual fledging success varies depending on food availability and predation; estimates range from about 50% for Black-legged Kittiwakes (Hatch et al. 2009) up to as high as 70% for Herring (Pierrotti and Good 1994).
• Herring and Great Black-backed Gull nest in numerous coastal locations along coastal NS. Within the province, most Black-legged Kittiwake colonies are in eastern Cape Breton. Ring-billed Gulls are thought to breed in a handful of locations in NS but are not known to nest in the SEA study area (MBBA 2015), while the other species do not breed in NS.
• Surface feeders.
• Feed on invertebrates (cephalopods and crustaceans) and fish, as well as offal. Larger species often prey on eggs, young, and occasionally adults of other seabird species.</td></tr>
<tr><td>Terns

(Sternidae)</td><td>Species Common Tern, Arctic Tern, Caspian Tern, Roseate Tern
Status Roseate Tern (COSEWIC, SARA and NSESA: Endangered). Populations of the other three species are considered stable in Canada. Estimated population of Common and Arctic Terns in Canada is between 100,000 and 200,000 individuals; Caspian Tern populations are somewhat smaller (Environment Canada 2011).
Typical Habitat Usually breed on islands, typically in areas with sand or low vegetation.
Occur in coastal and offshore waters outside the breeding season.
Seasonal Movements These four tern species breed in northern North America. Arctic Terns undertake long migrations to the waters off of Antarctica. Common and Caspian Terns winter in Central and South America.
Biology and Ecology
• Begins to breed between 2 and 4 years of age, and lays 1 to 3 eggs per clutch. Mean annual number of chicks fledged per pair varies between 0.59 and 2.0 in different studies (Hatch 2002; Nisbet 2002; Cuthbert and Wires 1999).
• Common and Arctic Terns are widely distributed in North America, and there are numerous colonies along the coast of eastern Nova Scotia. Roseate Terns do not nest in the Study Area, but the nearby Sable Island and Country Island Complex IBAs are important breeding sites for the species' Canadian population. Caspian Terns are not known to breed in Nova Scotia.
• Feed by surface feeding and pursuit plunging.
• Prey on fish and small crustaceans.</td></tr>
<tr><td>Alcids

(Alcidae)</td><td>Species Dovekie, Razorbill, Common Murre, Thick-billed Murre, Atlantic Puffin, Black Guillemot
Status Populations are considered secure, with many species showing slight increases in number in recent years (Environment Canada 2011; CWS Waterfowl Committee 2013).
Typical Habitat Breed on islands or mainland cliffs, in areas inaccessible to terrestrial predators.
Occur in offshore waters outside the breeding season.
Seasonal Movements In eastern North America, alcids breed from the high arctic to north of the Carolinas. The Dovekie is a largely arctic species occurring in the waters off of eastern Canada only in winter, while the other five</td></tr>
</table>

<table>
<tr><th>Group</th><th>Details</th></tr>
<tr><td></td><td>species may be found in the proposed Project area year round. They arrive at the colony in May to early June, and typically depart from the colony by late August. During breeding, they are most abundant in the waters near the colonies. In the winter months, murres tend to spend very little time in coastal waters (Hedd et al. 2011) while Black Guillemots tend to be more coastal, often found close to breeding colonies.
Biology and Ecology
Alcids are most vulnerable at sea in the winter months, when they spend the greatest proportion of their time on the water, and in fact they are rendered flightless for a period of several weeks during their winter moult (Gaston and Hipfner 2000).
For Razorbills and the two murre species, the chick departs the colony with the male parent; the two remain together for several weeks before the chick reaches independence.
Begins to breed between 2 and 5 years of age, and lays 1 egg per clutch (2 eggs for Black Guillemot). Mean annual number of chicks fledged per pair depends on factors such as food availability, weather and parental experience. Number of fledglings per breeding pair varies from 0.26 - 0.72 for Black Guillemot and from around 0.40 to 0.60 for Atlantic Puffins in eastern Newfoundland studies. Successful nest departures per breeding pair ranges from 0.65 - 0.75 for the Razorbill, from 0.35 - 0.85 for Common Murres (aalge subspecies), and 0.48 - 0.79 for Thick-billed Murres in the Atlantic (Ainley et al. 2002; Gaston and Hipfner 2000; Butler and Buckley 2002; Lowther et al. 2002; Lavers et al. 2009).
Black Guillemot nesting sites are widespread along the eastern coast of Nova Scotia. Razorbill and Atlantic Puffin nest in the Bird Islands IBA. Murres are not confirmed to breed in Nova Scotia.
Feed by pursuit diving.
Prey on small fish (capelin and sandlance) and some invertebrates such as copepods.</td></tr>
<tr><td>Jaegers and Skuas
(Stercorariidae)</td><td>Species: Pomarine Jaeger, Parasitic Jaeger, Long-tailed Jaeger, Great Skua, South Polar Skua
Status: All three jaeger species have an estimated population of 100,000 to 200,000 adults in Canada, but there is insufficient information to determine trends (Environment Canada 2011). Skuas do not breed in Canada; they are occasional visitors to offshore waters of the northwest Atlantic.
Typical Habitat: Jaegers breed in high Arctic tundra. South Polar Skuas nest along the Antarctic coast, and Great Skuas on coastal moors and rocky islands in Europe.
With the exception of nesting adults during the breeding season, jaegers and skuas are found in offshore waters.
Seasonal Movements: Non-breeders are found offshore year-round. Breeding adults return to the colonies in late May to early June, and typically leave in September.
Biology and Ecology
Begin to breed at 4 years of age, and typically lay 2 eggs per clutch. Mean annual number of fledglings per pair varies with factors such as parental experience and prey</td></tr>
</table>

Group	Details
	density; range is between approximately 0.5 - 1.5 (Wiley and Lee 1998, 1999, 2000). • Occasional visitors to the offshore SEA study area during the spring, summer and fall months; largely absent in the winter, with the exception of the Great Skua which is occasionally observed year-round. • Typically feed by kleptoparasitizing prey items from other seabirds, particularly outside of the breeding season.
Fulmars and Shearwaters (*Procellariidae*)	**Species** Northern Fulmar, Great Shearwater, Sooty Shearwater, Manx Shearwater, Cory's Shearwater **Status** Only the Northern Fulmar and Manx Shearwater breed in Canada. Fulmar populations are considered stable with 300,000 to 400,000 individuals in Canada (Environment Canada 2011). Only a small number of Manx Shearwaters (< 100 pairs) nest in Canada (Mallory *et al.* 2012). **Typical Habitat** Breed on offshore islands. Fulmars are cliff-nesters, while shearwaters generally nest in burrows. Occur in offshore waters outside the breeding season. **Seasonal Movements** Breeding individuals return to the colony in the spring, and depart in the fall; for Manx Shearwaters, they are present at the colony from mid-April to October, while for Northern Fulmar, colony attendance is from June to September (Lee and Haney 1996; Mallory *et al.* 2012). Outside the breeding season, they occur primarily along the continental shelf in temperate to cold water environments. The Laurentian Channel and St. Anns Bank provide important migratory corridor for fulmars and shearwaters that utilize the Gulf of St. Lawrence, and St. Anns Bank appears to be a valuable feeding area for some wintering fulmars (Ford and Serdynska 2013). **Biology and Ecology** • Shearwaters are known to be strongly attracted to artificial light sources (Weise *et al.* 2001). • Begins to breed between 5 and 8 years of age, and lays 1 egg per clutch. Mean annual number of chicks fledged per pair is approximately 0.55 for Northern Fulmar (Dunnet and Ollason 1978) and 0.69 for Manx Shearwater (Perrins *et al.* 1973). • Fulmars and shearwaters are not known to breed in Nova Scotia. Outside the breeding season, shearwaters and fulmars are wide-ranging at sea. • Shearwaters feed by pursuit plunging, while fulmars are surface feeders. • Prey on fish, offal and squid.

<table>
<tr><th>Group</th><th colspan="2">Details</th></tr>
<tr><td rowspan="5">Storm-petrels

(Hydrobatidae)</td><td>Species</td><td>Leach’s Storm-petrel, Wilson’s Storm-petrel.</td></tr>
<tr><td>Status</td><td>Leach’s population trends are unknown, but they are estimated to have a population of >10,000,000 in Canada (Environment Canada 2011), most in eastern Newfoundland. Wilson’s is an uncommon offshore visitor to Canada.</td></tr>
<tr><td>Typical Habitat</td><td>Nest in burrows on offshore islands.
Highly pelagic year-round; even breeding adults return to land only at night.</td></tr>
<tr><td>Seasonal Movements</td><td>Spend most of the year offshore, coming on land only to breed. Occur in higher numbers in areas such with higher prey densities. Leach’s Storm Petrels are very rare in winter months in the SEA Study Area, but otherwise common, while Wilson’s are uncommon spring and summer visitors.</td></tr>
<tr><td colspan="2">Biology and Ecology
Storm-petrels often follow ships and fishing boats, and are strongly attracted to artificial light sources.
Begin to breed at 5 years of age, and lay 1 egg per clutch. Annual average fledging success is approximately 48% in Canada (Huntington et al. 1996).
Leach’s Storm-petrels nest in a few locations in Nova Scotia, including the Scatarie Island, St. Paul Island and Country Island Complex IBAs (IBA 2015).
Surface feeders. Storm-petrels hover over the water’s surface, gleaning prey items.
Diet includes zooplankton and small crustaceans.</td></tr>
</table>

In 2006, EC-CWS initiated the ECSAS program (Gjerdrum *et al.* 2008; Fifield *et al.* 2009b). According to data from Fifield *et al.* (2009b), survey data indicate that the concentrations of seabirds is generally highest in the summer and winter months (May - August and November - February). In the fall months, however, the Cabot Strait hosts a particularly high density of kittiwakes, gannets, shearwaters, Dovekies and other alcid species (Fifield *et al.* 2009b). The seabird monitoring program is ongoing, and up-to-date information from the ECSAS program on the distribution and relative abundance of seabirds in the region has been provided (ECSAS 2015) and is summarized in Table 3-19 of this report.

Nesting sites for colonial seabirds and rare species also constitute particularly important areas and habitats. Table 3-20 summarizes the major nesting sites for gulls, terns, alcids and storm-petrels in eastern Nova Scotia from the Atlantic Canada Colonial Waterbird Database maintained by EC-CWS; these are also shown on Figure 3-24any of these colonies are also designated EBSAs and/or IBAs (Hastings *et al.* 2014, IBA 2015). As well, critical habitat beaches for Piping Plover in the SEA Study Area include North Harbour Beach and South Harbour Beach (near Aspy Bay), Big Glace Bay Lake, and Dominion Beach (Figure 3-23).

Table 3-19. Summary of ECSAS Data Provided by EC-CWS for the SEA Study Area and Surrounding Waters

Family	Common Name	Winter				Spring		Summer				Fall		Total
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	
Gaviidae		**2**				**2**		**30**				**7**		**41**
	Common Loon						2	1	18	3	3	4	2	33
	Red-throated Loon	2							4					6
	Unidentified Loons								1				1	2
Procellariidae		**477**				**848**		**4597**				**2867**		**8789**
	Northern Fulmar	262	112	33	36	47	764	169	258	178	172	72	237	2340
	Cory's Shearwater										46	2	22	70
	Great Shearwater	32	1					97	1229	502	1434	177	2316	5788
	Manx Shearwater								10	6	22	7	1	46
	Sooty Shearwater	1					35	238	133	61	29	4	17	518
	Unidentified Shearwaters						2	1	10	2		8	4	27
Hydrobatidae		**7**				**252**		**2226**				**392**		**2877**
	Wilson's Storm Petrel						17	32	130	68	300	91	9	647
	Leach's Storm-Petrel	6					109	122	163	201	674	182	22	1479
	Unidentified Storm-Petrels	1					126	69	195	165	107	69	19	751
Phalacrocoracidae		**2**				**26**		**66**				**11**		**105**
	Great Cormorant						6							6
	Double-crested Cormorant	1	1						1	16	48	10		77
	Unidentified Cormorants						20			1		1		22
Sulidae		**102**				**428**		**2384**				**1566**		**4480**
	Northern Gannet	91	11			6	422	117	921	292	1054	354	1212	4480

Family	Common Name	Winter				Spring		Summer				Fall		Total
Anatidae		**21**				**124**		**15**				**194**		**354**
	Common Eider	14				6	50		2		3	4	156	235
	Black Scoter	3					31						6	40
	Surf Scoter												4	4
	White-winged Scoter						1		3		3		7	14
	Red-breasted Merganser					2								2
	Harlequin Duck		2											2
	Lesser Scaup							1						1
	Long-tailed Duck												1	1
	Canada Goose						1							1
	Unidentified Ducks and Geese	2					33		3			6	10	54
Scolopacidae		**0**				**2**		**306**				**63**		**371**
	Red Phalarope							184		2	30	18	12	246
	Red-necked Phalarope										14	1	3	18
	Unidentified Phalaropes						2	49		9	18	11	18	107
Laridae - gulls		**958**				**1031**		**1015**				**872**		**3876**
	Black-legged Kittiwake	382	121	133	49	72	423	17	205	78	122	16	183	1801
	Herring Gull	87	11	2	10	27	350	98	53	68	132	185	197	1220
	Glaucous Gull	8		11		3	15	2			1		2	42
	Great Black-backed Gull	42	23	7	11	15	88	23	24	49	112	98	112	604
	Iceland Gull	7		3	6	2	2						2	22
	Ring-billed Gull	3					2		4	1	1			11
	Lesser Black-backed Gull	1												1
	Bonaparte's Gull										5			5
	Unidentified Gulls	23	2	13	3	12	20	2	1	17		31	46	170
Laridae - terns		**0**				**1**		**137**				**3**		**141**

Family	**Common Name**	**Winter**				**Spring**		**Summer**				**Fall**		**Total**
	Common Tern								4	10	42	1		57
	Arctic Tern							1	1		7	2		11
	Black Tern										1			1
	Unidentified Terns						1	40	4	7	20			72
Laridae - skuas and jaegers		**11**				**6**		**16**				**101**		**134**
	Pomarine Jaeger	2					5	8		1	3	3	52	74
	Parasitic Jaeger	7										2	11	20
	Long-tailed Jaeger												2	2
	Great Skua	2										1	4	7
	South Polar Skua							1	1				1	3
	Unidentified Jaeger and Skua						1	2				2	23	28
Alcidae		**3867**				**3688**		**1112**				**474**		**9141**
	Dovekie	1270	437	324	106	13	1206	115				1	313	3785
	Thick-billed Murre	84	44	8	349	129	729	89	13				2	1447
	Common Murre	20	4	4	4	13	160	22	488	20	4	1	7	747
	Razorbill	81	10	7	6	1	49	19	35	4	3	2	6	223
	Atlantic Puffin	30	1	10	7	1	136	10	22		19	11	35	282
	Black Guillemot					1	13		1	16	18	9	1	59
	Unidentified Alcids	253	204	193	411	98	1139	161	45	4	4	7	79	2598
Grand Total		**2717**	**984**	**748**	**998**	**448**	**5960**	**1690**	**3982**	**1781**	**4451**	**1393**	**5157**	**30309**

Table 3-20 Estimated Colony Sizes of Seabirds along Coastal Areas of the Study Area

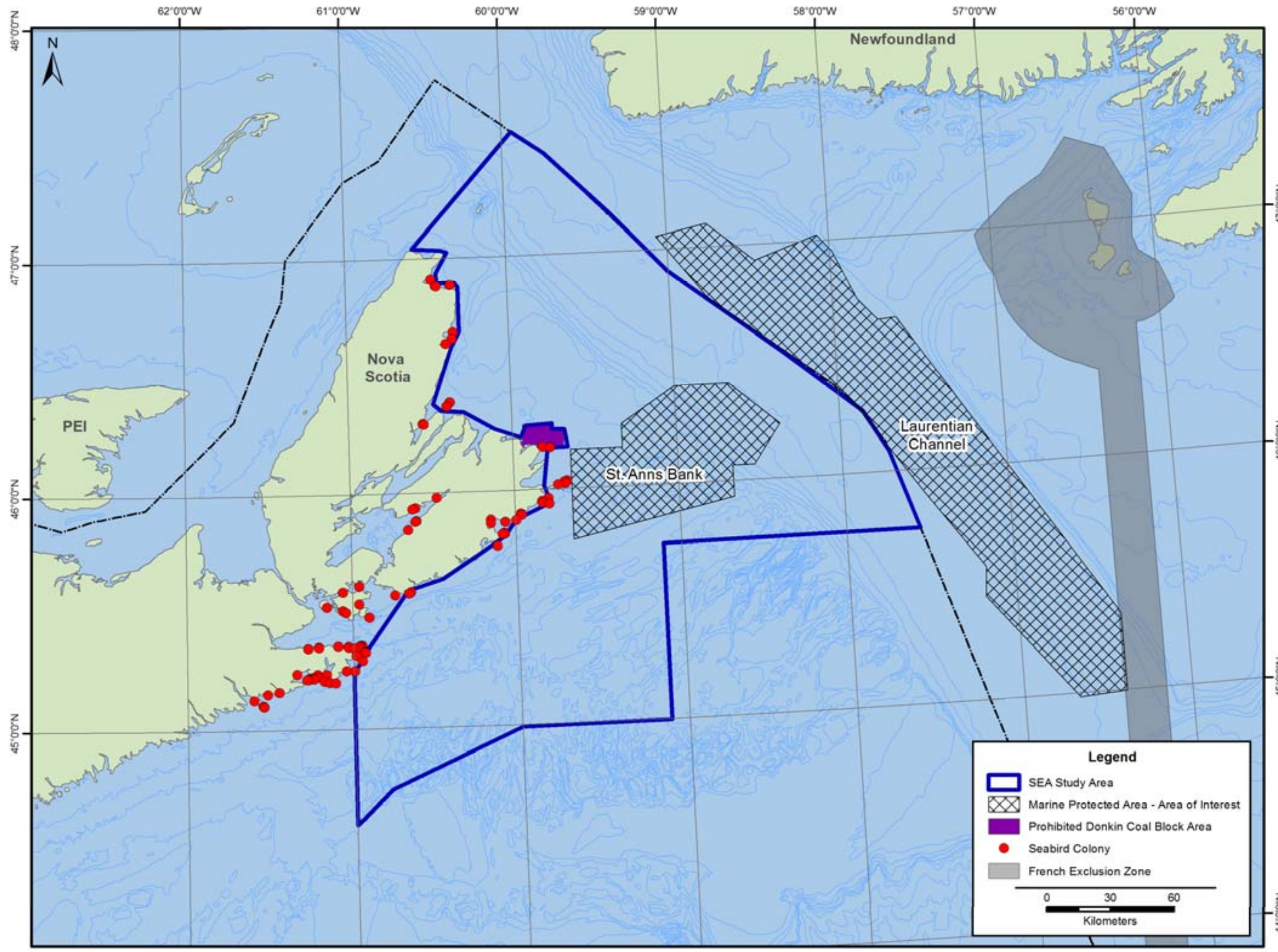
Colony Name	Great Black-backed Gull (individuals)	Herring Gull (individuals)	Black-legged Kittiwake (individuals)	Common and/or Arctic Tern (individuals)	Atlantic Puffin (individuals)	Razorbill (pairs)	Black Guillemot (pairs)	Leach's Storm-petrel (individuals)
Lead Island	85							
White Point Island, Aspy Bay	59	7	6					
small unnamed island, South Harbour				14				
small unnamed island, South Harbour				25				
Ingonish Island		70						
Steering Island		18						
south bar of Ingonish Beach				34				
Bird Islands, Ciboux	310	165	326		339	810	426	
Bird Islands, Hertford	240	120	315		213	764	387	
St. Anne's Beach				16				
St. Anne's Beach, opposite side of channel				2				
Wreck Point			87					
Flint Island	99	11						
Flint Island SW Rock #1	20	20						
Scatarie Island, Eastern Head			130					
Scatarie Island, Rock Point			6					3
Hay Island	160							
Scaterie Island, Northwest Cove								3
Cossitt Point, Bras D'Or				15				
Isle Aux Cannes	160							
Baleine, islet S of			280					
Baleine Head rock #1	6	13						

Colony Name	Great Black-backed Gull (individuals)	Herring Gull (individuals)	Black-legged Kittiwake (individuals)	Common and/or Arctic Tern (individuals)	Atlantic Puffin (individuals)	Razorbill (pairs)	Black Guillemot (pairs)	Leach's Storm-petrel (individuals)
Portnova Islands	20	20						
Christmas Island, East Bay Bras D'Or Lake				45				
Christmas Pond, east of		10						
Battery Island	38	13						
Green Island (Louisbourg)	50		20					
Sandspit, MacPhersons Pond, East Bay Bras D'Or Lake				34				
Irishvale				3				
Morrisons Cove	1							
White Point	1							
Kennington Rocks	3	3						
Harbour Rock	3							
Sandpsit at Irish Vale, East Bay Bras D'Or Lake				15				
Shallop Rock, off Cape Gabarus	16							
Green Island, off Cape Gabarus	120	80	106					
Joyces Rock, Cape Gabarus			80					
Guyon Island	60							
Quetique Island	28	112						
Berry Island	5	4						
East Basque Island	11							
South Basque Island	13							
Red Island	4							
Les Rochers	55							
Green Island (Janvrin Harbour)	56	84						
Crid Island, east	5							
Crid Island, west	7							

Colony Name	Great Black-backed Gull (individuals)	Herring Gull (individuals)	Black-legged Kittiwake (individuals)	Common and/or Arctic Tern (individuals)	Atlantic Puffin (individuals)	Razorbill (pairs)	Black Guillemot (pairs)	Leach's Storm-petrel (individuals)
Jerseyman Island rock #1	5	3						
Green Island	126	54						
Gunning Rocks, east	7	1						
Derabies Bar	12							
Fox Island	28	12						
Derabie Island	10							
Tickle Island	25							
Half Island		5						
Big Goosberry Island	15							
Half Island				12				
Pigeon Island	26							
Tickle Island				1				
Rook Island	50	6						
Davis Island				4				
Crow Island (DB)	5							
Frying Pan Shoal	38	9						
Cranberry Island				8				
small unnamed island, Spinney Gully				16				
Gull Island, Canso	2							
small unnamed island, Dover Bay				12				
Dover Bay, unnamed island south	3	2						
small unnamed island west of Forster Island, Tor Bay				16				
Hog Island Spit, Tor Bay				32				
Harbour Island		120						
Harbour Ledge	4							

Colony Name	**Great Black-backed Gull (individuals)**	**Herring Gull (individuals)**	**Black-legged Kittiwake (individuals)**	**Common and/or Arctic Tern (individuals)**	**Atlantic Puffin (individuals)**	**Razorbill (pairs)**	**Black Guillemot (pairs)**	**Leach's Storm-petrel (individuals)**
unnamed island Tor Bay				16				
Sugar Harbour Island, East	60							
Cooks Island	1							
Middle Sugar Harbour Island	18							
unnamed island beside Cook's Island				80				
Sugar Harbour Island, West	35							
Topstone Ledge	5							
Inner Gull Ledge				160				
Middle Gammon Island	10	2						
Millstone Island	5							
Shoal Point	23	8						
Thrumcap Island (CH)	8							
Harbour Island (CH)	60							
Frying Pan (CH)	19							
Country Island				950			560	23980

Figure 3-24 Locations of Known Seabird Colonies in the Vicinity of the SEA Study Area



3.2.8.2 Shorebirds

In Nova Scotia, shorebirds are most abundant during fall migration when many species move southward from their Arctic breeding grounds. While not typically found offshore, marine shoreline habitats such as sandy mudflats are utilized by foraging shorebirds. Table 3-21 presents information on the habits, habitats and key life history characteristics of shorebirds in the Study Area.

Table 3-21. Characteristics of Shorebirds in the Study Area

Group	Details
Shorebirds (Scolopacidae and Charadriidae)	**Species** Close to 30 species of shorebirds occur in the province for at least part of the year. Willet, Spotted Sandpiper, Greater Yellowlegs, Piping Plover and Killdeer nest in eastern Nova Scotia. Whimbrel, White-rumped Sandpiper, Greater Yellowlegs, Semipalmated Plover, Sanderling, American Golden-plover, Semipalmated Sandpiper and Black-bellied Plover are locally common during migration; other migrants include Dunlin, Hudsonian Godwit, Ruddy Turnstone, Least Sandpiper, Buff-breasted Sandpiper and Red Knot (*rufa* subspecies) (Environment Canada 2009). Purple Sandpiper feeds in rocky coastal areas in the winter months. **Status** Two species of shorebird are protected under federal and provincial legislation (*NSESA* and *SARA*: Endangered), the Red Knot *rufa* subspecies and Piping Plover. The Buff-breasted Sandpiper was assessed as Special Concern by COSEWIC. **Typical Habitat** Nest close to inland freshwater bodies, estuaries and tidal flats. Feed on tidal flats, coastal barrens, and rocky shorelines, and move to inland areas during high tide. **Seasonal Movements** Most shorebirds are long-distance migrants. Spring and fall migration routes differ; in Atlantic Canada, greater numbers of most species are seen during fall migration. According to data from the Atlantic Canada Shorebird Survey, important migration stopovers in eastern Nova Scotia include Point Michaud, Morien Bar and Big Glace Bay Lake (IBA 2015; Environment Canada 2009). In the winter months, from November to April, Purple Sandpipers are present along rocky shorelines and offshore ledges and islands in the area (IBA 2014; Environment Canada 2009). **Biology and Ecology** • Most species typically lay four eggs. Incubation lasts approximately three weeks. • Precocial young depart the nest within 24 hours of hatching, although they are unable to fully thermoregulate for the first few days. • Most shorebirds feed in tidal mudflats, probing sand with their long bills; other species such as Whimbrel feed on berries in coastal barrens, while still others feed on small invertebrates (*e.g.* molluscs) along rocky shorelines and offshore ledges and islands.

3.2.8.3 Waterfowl

Waterfowl, along with loons and grebes, spend much of their time on the water's surface, and while most species nest in freshwater environments, many are found in the offshore environment for at least part of the year such as during moulting or overwintering. Taxonomically, loons and grebes are not waterfowl; however, they have fairly similar life histories and are therefore considered together in this section. Broadly, waterfowl may be categorized as dabbling ducks (primarily inland breeders) and diving ducks. Table 3-22 presents information on the habits, habitats and key life history characteristics of waterfowl (including loons and grebes) in the Study Area.

Table 3-22. Characteristics of Waterfowl, including Loons and Grebes, in the Study Area

Group	Details
Shorebirds (Scolopacidae and Charadriidae)	**Species** Over 20 species of waterfowl occur in the province during at least part of the year. Common Loon, Pied-billed Grebe, Canada Goose and 13 duck species breed in the eastern part of the province (MBBA 2015). **Status** Two species of waterfowl are protected under federal legislation (SARA: Special Concern), the Harlequin Duck and Barrow's Goldeneye. The Harlequin Duck is also listed as Endangered under NSESA. Populations of inland-breeding duck species surveyed by CWS (American Black Duck, Mallard, Green-winged Teal and Ring-necked Duck) are considered stable in Eastern Canada (CWS Waterfowl Committee 2013). Population trends for sea ducks are relatively poorly known, as most breed in remote areas; however, available information suggests that populations are stable (CWS Waterfowl Committee 2013). **Typical Habitat** Most species nest on freshwater lakes and rivers; some (e.g. American Wigeon, Blue-winged Teal, Pied-billed Grebe, *etc.)* nest in estuaries. The colonial Common Eider breeds on coastal islands, including Scatarie Island. Many species winter in offshore waters, including scoters, mergansers, goldeneye and eiders. **Seasonal Movements** Many waterfowl species migrate south for the winter months, and in the fall, many species aggregate at staging and moulting areas. Other species, such as White-winged Scoters, Surf Scoters, Black Scoters, Long-tailed Ducks and Common Eiders, occur in large flocks ("rafts") in the offshore waters of eastern Nova Scotia from autumn to spring. Information provided by EC-CWS on wintering distributions of Common Eiders in 2012 in Nova Scotia show large coastal concentrations in eastern Cape Breton near the communities of Glace Bay, Louisbourg and Gabarus. The waters between Scatarie Island and Isle Madame also support large numbers of Common Eiders and other sea ducks in the winter months (Ford and Serdynska 2013; Hastings et al. 2014). **Biology and Ecology** • Clutch size for ducks typically 3-14; loons, grebes and sea ducks typically have lower

Group	Details
	reproductive rates compared with inland ducks (CWS Waterfowl Committee 2013). Age at first breeding 1-2 for most species, 2-3 for sea ducks (Sibley 2001). • Precocial young typically remain with female parent until near fledging. • The main foraging strategies of this group are dabbling (surface-feeding) and diving. • Dabbling ducks eat animals as juveniles and during breeding and pre-breeding, and plant material at other times. Sea ducks, loons and grebes feed on invertebrates, shellfish and fish year-round.

3.2.8.4 Other Marine-associated Avifauna

Landbirds, including passerines (songbirds), raptors and other taxa, breed throughout the province and while most do not regularly occur in the marine environment, some species frequently feed in coastal habitats (*e.g.* Bank Swallow, Savannah Sparrow, Short-eared Owl, Peregrine Falcon) and many fly long distances over water during migration. Nocturnal migrants such as most passerines are of particular concern, as they are attracted to artificial light sources at sea, particularly in foggy conditions. While the migration routes of birds between Newfoundland and the mainland is poorly understood, it is likely that the shortest overwater distance (i.e., from southwestern Newfoundland to northern Cape Breton Island) would be a preferred route; therefore, it is possible that the Study Area supports a large concentration of migrating birds in the fall months (J. Pulchan, EC-CWS, personal communication 2015).

3.2.9 Marine Mammals

For the purposes of this document, the term marine mammals refers to Cetaceans (whales, dolphins and porpoises) and Pinnipeds (seals), all of which occur in the Study Area. Many marine mammal species have historically supported hunting activities, and some, like seals, continue to do so today in Atlantic Canada to some extent. To a greater degree, however, marine mammals are now the focus of a growing tourism industry in the form of whale-watching, particularly in northern Cape Breton.

The Laurentian Channel is an important migratory route for many marine mammal species, as it connects the Scotian Shelf to the Gulf of St Lawrence. The Cabot Strait is an important migratory corridors for whales, particularly between Cape North and St. Paul Island. Both Blue Whales (Endangered – SARA) and Fin Whales (Special Concern – SARA) are known to migrate through the Cabot Strait (Hastings *et al.* 2014). St Anns Bank AOI likely encompasses an important migration route for baleen whales, including blue whales, fin whales, and right whales, travelling through the Cabot Strait to and from the Gulf of St. Lawrence (Ford and Serdynstra 2013). Aspy Bay, on the northern tip of Cape Breton Island is also a known feeding and breeding area for whales. (Hastings *et al.* 2014). Most whale species present likely only use this area on a seasonal basis, though it is possible that some species, such as pilot whales, may use the St Ann's Bank area throughout the year (AOI). Several of these areas have been identified as coastal or offshore Ecologically and Biologically Significant Areas (Hastings *et al.* 2014, DFO 2014), and are discussed in detail in Section 3.2.12.

DFO maintains a database of marine mammal sightings, and data form this source is used to plot known whale distributions within the Study Area. DFO stresses, however, that this data is not a complete record of all whale sightings. Aerial surveys of marine megafauna conducted in Atlantic Canada by DFO in 2007 resulted in detection of 23 marine mammal species on the Scotian Shelf and around Cape Breton (not included the Gulf of St Lawrence) (Lawson and Gosselin 2009). Of these species, 18 cetaceans and three seals are expected to occur within the Study Area. This includes Mysticetes or baleen whales, Odonocetes (dolphins and porpoises) and Pinnipeds (seals and walrus). Each of these groups are discussed in the following subsections.

Several of the marine mammal species present are considered to be of special conservation concern. Further details on marine mammal Species of Special Status, such as Species at Risk and Species of Conservation Concern, are provided in Section 3.2.11.

3.2.9.1 Mysticetes

Six species of the cetacean suborder Mysticetes (the baleen whales), have been reported in the waters of the eastern Scotian Shelf. The baleen whale typically reach very large sizes and have plates of baleen along their jaws instead of teeth. These baleen plates serve to strain tiny food organisms out of the huge volumes of seawater processed by these whales as they feed. Baleen whales are often solitary or may occur in small groups called pods. The following Table 3-23 summarizes key life history and habitat information for the six species of baleen whales (North Atlantic Right, Fin, Humpback, Blue, Sei, and Minke) that occur in the Study Area. Recorded locations, as listed in DFO's Marine Mammal Database, are depicted on Figure 3-25.

Table 3-23. Characteristics of Baleen Whales Occurring Regularly in the Study Area

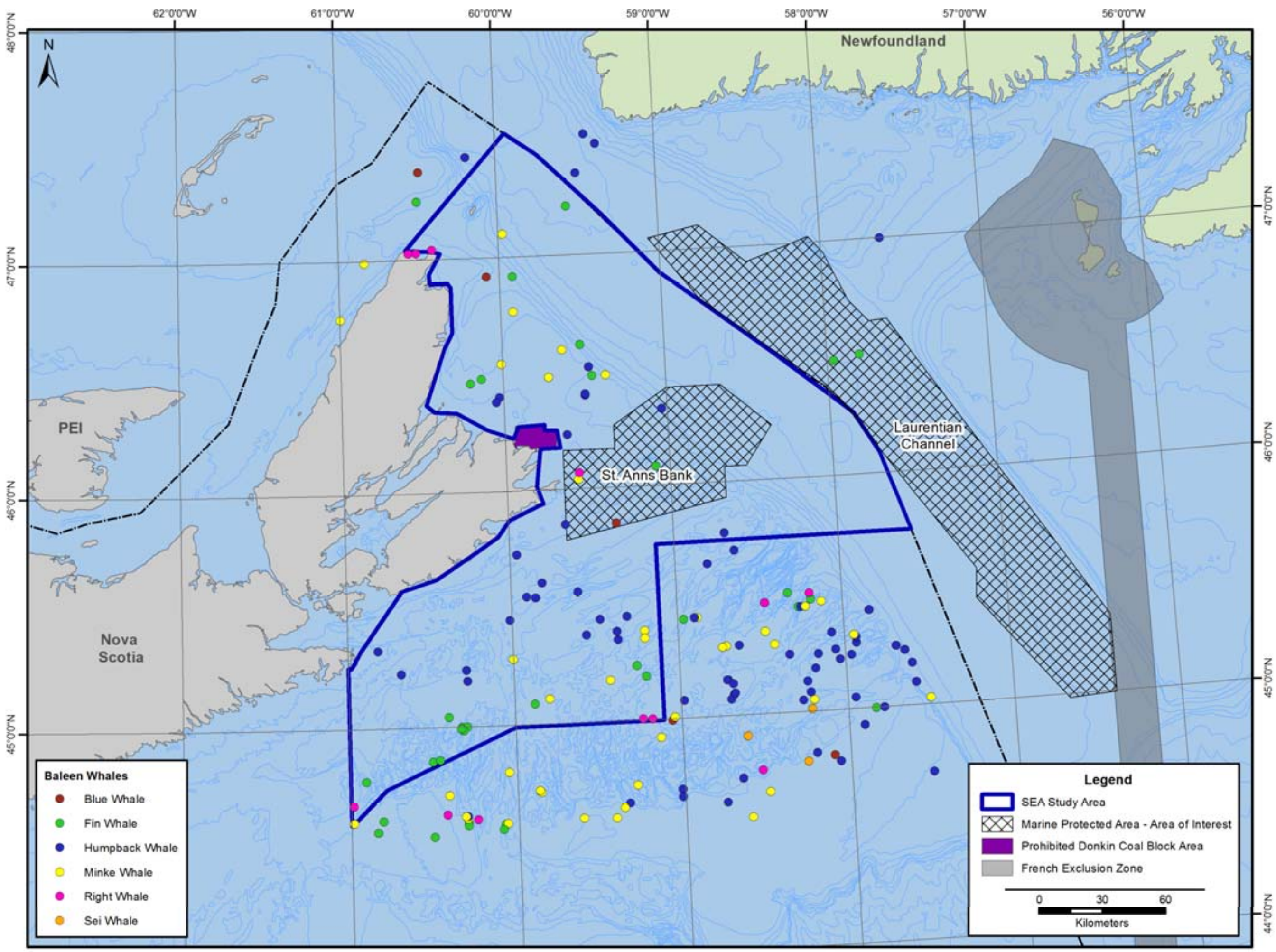
Species	Overview
Humpback Whale (*Megaptera novaengliae*)	**Population** Western North Atlantic **Status** Not At Risk (COSEWIC); Special Concern (*SARA* Schedule 3). Relatively common in the study area; abundance estimate on Scotian Shelf and in the Gulf of St. Lawrence is 653 individuals (95 percent confidence limits: 385-1032), based on 2007 surveys. Estimate is considered by the authors to be preliminary, as it has not been corrected for perception biases (Lawson and Gosselin 2009). **Habitat and Distribution** Usually found in coastal waters, but also may occur in offshore habitats (Baird 2003). Wide-ranging species found in all oceans (Reilly *et al.* 2008a) **Seasonal Movements** Highly migratory; individuals from the Gulf of St Lawrence and Gulf of Maine-Scotian Shelf feeding stocks breed, calve in the Dominican Republic, Puerto Rico and the Virgin Islands (Katona and Beard 1990; IWC 2002). Calving occurs between January and April. **Biology and Ecology** • Usually observed singly or in groups of 2-3; during breeding and feeding, groups of up to 15 individuals seen.

Species	Overview
	• Sexual maturity at 9 years of age, on average. Gestation approximately 12 months, and inter-calving interval is 2 years (Baird 2003). • Feed on krill and small schooling fishes such as capelin (Reilly *et al.* 2008a). • Often feed cooperatively, using specialized feeding techniques such as bubble net feeding (Reilly *et al.* 2008a).
Blue Whale (*Balaenoptera musculus*)	**Population** Atlantic **Status** Endangered (SARA Schedule 1 and COSEWIC). The population size in Canadian waters is unknown, but based on data from a 2007 DFO survey in Atlantic Canadian waters, is believed to be fewer than 250 mature individuals (Lawson and Gosselin 2009; COSEWIC 2012). **Habitat and Distribution** Found in both coastal and pelagic waters; frequently at continental shelf edge where food production is high (Schoenherr 1991). Wide-ranging species found in all oceans except the Arctic (Reilly *et al.* 2008b). Ecologically and Biologically Significant Areas utilized by this species include the Cabot Strait and Apsy Bay EBSAs (Section 3.2.1.2.3). **Seasonal Movements** In the summer, distribution in the western Atlantic extends in the west from the Scotian Shelf to the Davis Strait; they are found off the coast of Cape Breton during spring and fall (Hastings *et al.* 2014). Migration patterns are poorly understood, but variable and apparently related to food availability (Reilly *et al.* 2008b). Mating and calving occurs between late fall to mid-winter (Yochem and Leatherwood 1985). **Biology and Ecology** • Usually observed singly or in small groups. • Sexual maturity at 5 - 15 years of age. Gestation approximately 10 - 11 months, and inter-calving interval is 2 - 3 years (Yochem and Leatherwood 1985). • Feed almost exclusively on krill (Reilly *et al.* 2008b).
Fin Whale (*Balaenoptera physalus*)	**Population** Atlantic **Status** Special Concern (SARA Schedule 1 and COSEWIC). Relatively common in the study area, particularly in summer; abundance estimate in Scotian Shelf and Gulf of St Lawrence is 462 individuals (95 percent confidence limits: 270 - 791) based on 2007 surveys. Estimate is considered by the authors to be preliminary, as it has not been corrected for perception biases (Lawson and Gosselin 2009). **Habitat and Distribution** Generally found at the coastal shelf edge and further offshore (COSEWIC 2005). World-wide distribution, with higher abundance in temperate and polar latitudes compared with tropical waters (Reeves *et al.* 2002) Ecologically and Biologically Significant Areas utilized by this species include the Cabot Strait and Apsy Bay EBSAs (Section 3.2.1.2.3).

Species	Overview
	Seasonal Movements Migration habitats are not well understood. Conception and calving takes place in the winter, and is thought to occur in low latitudes. Summer distribution is typically in areas with high prey concentration. **Biology and Ecology** • Usually observed singly or in pairs; groups of up to 20 individuals seen on feeding grounds. • Sexual maturity at 6 - 7 years of age for females, 7 – 8 for males. Gestation approximately 12 months, and inter-calving interval averages 2.7 years (COSEWIC 2005). • Feed on krill and small schooling fishes such as capelin (Kenney 2001).
Sei Whale (*Balaenoptera borealis*)	**Population** Atlantic **Status** Data Deficient (COSEWIC). Uncommon in the study area (Lawson and Gosselin 2009). **Habitat and Distribution** Usually found in offshore waters, and associated with shelf edge in the northwest Atlantic (Hain *et al.* 1985). World-wide distribution, but generally found at temperate latitudes (Perry *et al.* 1999) **Seasonal Movements** In the Northwest Atlantic, sei whales migrate north along the continental slope in July-August, and return south in September to November for breeding and calving (Mitchell and Chapman 1977). **Biology and Ecology** • Sexual maturity at 5 - 15 years of age, on average. Gestation 10.5 - 12 months, and inter-calving interval is 2 - 3 years (COSEWIC 2003). • Feed on copepods, krill and small fish (Reilly *et al.* 2008c).
Common Minke Whale (*Balaenoptera acutorostrata*)	**Population** North Atlantic (*acutorostrata* subspecies) **Status** Not At Risk (COSEWIC). Relatively common in the study area; abundance estimate in Scotian Shelf and Gulf of St Lawrence is 1,927 individuals (95 percent confidence limits: 1196-2799) based on 2007 surveys. Estimate is considered by the authors to be preliminary, as it has not been corrected for perception biases (Lawson and Gosselin 2009). **Habitat and Distribution** Occurs in both coastal and offshore waters. Worldwide distribution, although they are only rarely seen in the tropics (ACS 2006). **Seasonal Movements** In the northwest Atlantic, common in the waters off New Jersey to Baffin Island during spring and summer. Very little information on winter distribution, but it is possible that some individuals remain within the summer range year-round (Reilly *et al.* 2008d).

Species	Overview
	Biology and Ecology • Usually observed singly, but may be seen in groups of 2 – 6. Where food is concentrated (generally in polar regions), larger aggregations occur. • Sexual maturity at 7 - 8 years of age. Gestation approximately 10 - 11 months, and inter-calving interval is 2 years (ACS 2006). • Feed on small schooling fishes such as capelin and sandlance, as well as copepods and krill (ACS 2006).
North Atlantic Right Whale (*Eubalaena glacialis*)	**Population** Western North Atlantic **Status** Endangered (SARA Schedule 1 and COSEWIC). The western North Atlantic population is estimated at about 322 animals (IWC 2001). Only rarely sighted in the proposed Project area; none were observed during aerial surveys conducted in 2007 Scotian Shelf and Gulf of St Lawrence (Lawson and Gosselin 2009), but are occasionally sighted by whale tour operators in northern Cape Breton. **Habitat and Distribution** Usually found in waters 100 – 200 m deep with surface temperatures between 8 and 15°C (Kenney 2001). The species was formerly distributed throughout the North Atlantic; however, it appears to be extinct in the eastern North Atlantic (Reilly *et al.* 2012). **Seasonal Movements** Known to aggregate in five seasonal habitat areas along the east coast of North America. Within their range, distribution can shift dramatically with prey distribution and abundance. Calving takes place in the winter in the waters off of Georgia south to Florida; winter distribution of males and non-calving females is poorly known, but they are thought to be scattered along the waters off the eastern US as far north as Cape Cod Bay (Winn *et al.* 1986). **Biology and Ecology** • Sexual maturity at approximately 10 years of age. Gestation unknown, but may be > 12 months, and inter-calving interval averages 3.7 years (COSEWIC 2003). • Feed on plankton, primarily copepods (Kenney 2001).

Figure 3-25 Sightings of Baleen Whales Recorded by DFO in the Study Area



3.2.9.2 Odontocetes

The cetacean suborder Odontoceti includes the toothed whales, which includes dolphins and porpoises. Instead of baleen, these whales have true teeth which they use to capture fish and squid. Six species of larger toothed whales, five dolphins and one porpoise have been reported by DFO in the waters of the Study Area. The following Table 3-24 summarizes key life history and habitat information for the toothed whales, dolphins and porpoises known to occur in the Study Area. Recorded locations of larger toothed whales, as listed in DFO's Marine Mammal Database, are depicted in Figure 3-26, while smaller toothed whales, such as dolphins and porpoises are plotted separately on Figure 3-27.

Table 3-24. Characteristics of Larger Toothed Whales Occurring Regularly in the Study Area

Species	Overview
Sperm Whale (*Physeter macrocephalus*)	**Population** Western North Atlantic **Status** Not At Risk (COSEWIC). Uncommon in the study area; just 2 groups totaling 11 individuals were observed in 2007 DFO surveys (Lawson and Gosselin 2009). However, the western North Atlantic population appears healthy, with reasonably high population density and reproduction (NMFS 2000) **Habitat and Distribution** Generally a deep-water species (> 1000 m), but has been sighted in coastal waters. Worldwide distribution, though most abundant in tropical and temperate waters > 15°C (Rice 1989). **Seasonal Movements** Adult females and juveniles generally found in tropical and subtropical waters year-round; adult males often found in higher latitudes outside of the breeding season (Rice 1989). **Biology and Ecology** • Males usually observed singly. • Sexual maturity at 7 - 13 years of age for females; somewhat later for males. • Gestation approximately 14 - 16 months, and inter-calving interval is 3 - 6 years (Shirihai and Jarrett 2006). Feed primarily on deep-water squid (Shirihai and Jarrett 2006).
Northern Bottlenose Whale (*Hyperoodon ampullatus*)	**Population** Scotian Shelf **Status** Scotian Shelf population: Endangered (SARA Schedule 1). The Scotian Shelf population, though apparently stable, is estimated at only 164 individuals (COSEWIC 2011). **Habitat and Distribution** Found in deep waters, typically 800 m to 1500 m. Distribution is restricted to the North Atlantic ocean; in western North Atlantic, they are found from Baffin Island to New England (Taylor *et al.* 2008a). **Seasonal Movements**

Species	Overview
	The Scotian Shelf population is believed to be non-migratory. **Biology and Ecology** • May be found in groups of up to 20 individuals. • Females reach reproductive age at 8 - 13 years, males at 7 – 9. Gestation approximately 12 months, and inter-calving interval is 2 years (Benjaminsen and Christensen 1979). • Feed on deep-water squid, some fish and invertebrates; usually feed at or near the sea bed (Hooker and Baird 1999).
Killer Whale (*Orcinus orca*)	**Population** Northwest Atlantic/Eastern Arctic **Status** Special Concern (COSEWIC). The population size is estimated at < 1000 individuals (COSEWIC 2008). **Habitat and Distribution** Occur in nearshore and pelagic environments, and tolerate a broad range of temperatures. Found in all oceans, although they tend to be concentrated in areas of high productivity (Forney and Wade 2006). **Seasonal Movements** Not known to be reliably migratory (Higdon 2007). Small numbers observed year-round in the proposed Project area (Lein *et al.* 1988; Lawson and Gosselin 2009). **Biology and Ecology** • Usually observed in matrilineal groups of a few up to tens of individuals. • Sexual maturity at 14 - 15 years of age for females, and 13 years for males. Gestation approximately 16 - 17 months, and inter-calving interval is 5 years Calving peaks from fall to spring (Olesiuk *et al.* 2005). • Prey on a diverse variety of items including marine mammals, seabirds, fish and squid, and have been known to use cooperative tactics to herd prey (Taylor *et al.* 2013).
Long-finned Pilot Whale (*Globicephala melas*)	**Population** Atlantic Ocean **Status** Not At Risk (COSEWIC). Abundance in western North Atlantic is estimated at 31,000 individuals (Waring *et al.* 2006) **Habitat and Distribution** Typically found in deep water with steep bottom topography in temperate to subpolar latitudes (Kingsley and Reeves 1998). In the northern hemisphere they are found only in the North Atlantic; circum-Antarctic distribution south of the equator (Taylor *et al.* 2008c). **Seasonal Movements** Occur in high densities over the continental slope in winter and spring months in the western North Atlantic; in summer and autumn, they move off the shelf (Taylor *et al.* 2008c). Considered to be abundant in northern Cape Breton in the summer months. **Biology and Ecology** • Very social, occurring in pods of 20 to 90 individuals. Pods are known to strand en masse (ACS 2006).

Species	Overview
	• Sexual maturity at 6 - 7 years of age. Gestation approximately 12 - 15 months, and inter-calving interval is 3 - 5 years (ACS 2006). • Feed on cephalopods and fish (Taylor *et al.* 2008c).
Beluga Whale (*Delphinaptera leucas*)	**Population** St. Lawrence Estuary (1 of 7 populations in Canada) **Status** Threatened (SARA Schedule 1), Endangered (COSEWIC). Abundance of St Lawrence Estuary population is estimated at 952 individuals, and the numbers are believed to be stable or increasing (Gosselin *et al.* 2001). As they seldom range far from the St. Lawrence Estuary, belugas are likely to be quite rare in the Study Area. **Habitat and Distribution** Generally limited to seasonally ice-covered Arctic and sub-Arctic waters. The St. Lawrence population represents the southern limit of its distribution worldwide (Lesage and Kingsley 1998) **Seasonal Movements** Typically found in coastal waters (ACS 2006). In the summer, St. Lawrence population is concentrated in comparatively warm and shallow waters near the outlet of the Saguenay River to calve; in the winter months, they disperse from estuarine habitats, regularly occurring as far downstream as the western end of Anticosti Island (COSEWIC 2004). **Biology and Ecology** • Adult male beluga whales can reach approximately 5.5m in length, females smaller. • Distinct from other whales in that they are white or cream coloured. • Does not have a dorsal fin. • St. Lawrence population is considerably less migratory than some high-Arctic populations (Jefferson *et al.* 2013). May aggregate in large numbers in spring (COSEWIC 2004). • •Sexual maturity at 4 - 7 years of age for females, 6 - 7 for males (COSEWIC 2004). Gestation approximately 14 months, and inter-calving interval is about 3 years (ACS 2006, COSEWIC 2004). • Feed on a variety of prey items including small squid, crabs, clams, shrimp, sandworms, and various kinds of fish, typically at depths to about 20 m, although they do occasionally dive deeper (ACS 2006).
Cuvier's Beaked Whale (*Ziphius cavirostris)*	**Population** Atlantic Ocean **Status** COSEWIC = Not at Risk (1990). Pelagic species only found rarely in Canadian waters; no significant threats identified. **Habitat and Distribution** The most widely distributed of all the beaked whales, is pelagic, and prefers water deeper than 1,000 m. Occurs in deep, offshore waters from the tropics to the cool temperate seas **Seasonal Movements** Migratory patterns poorly known **Biology and Ecology**

Species	Overview
	• The body of Cuvier's beaked whale is robust and cigar-shaped, similar to beaked whales • Can be difficult to identify at sea • Dorsal fin is curved, small and located two-thirds of the body length behind the head. • Reaches about 5–7 m in length and weighs 2,500 kg. • There is no significant size difference between sexes. • Feeds on several species of squid, and deep-sea fish. Known to dive up to 2,992 meters below the ocean surface and spend over two hours underwater before resurfacing, the deepest and the longest dives ever documented for any mammal. • Similar to other beaked whales, this species may be sensitive to noise.

At least two additional species of large toothed whale have been reported to occur in the area, though little information is available. True's beaked whale (*Mesoplodon mirus*) is a temperate-water species that has been reported from Cape Breton Island, Nova Scotia, to the Bahamas (Leatherwood and Reeves 1983) but is said to rarely occur in Canadian waters (Houston 1989). The last COSEWIC assessment (1989) of this species ranked it as Not at Risk (COSEWIC 1989a). Another beaked whale, Blainsville's Beaked Whale (*Mesoplodon densirostris*) is also said to occur off NS, Leatherwood and Reeves 1983). The last COSEWIC assessment (1989) of this species ranked it as Not at Risk (COSEWIC 1989b). DFO has no records for either of these species in the vicinity of the Study Area.

Table 3-25. Characteristics of Dolphin and Porpoises Occurring Regularly in the Study Area

Species	Overview
Atlantic/Common Bottlenose Dolphin (*Tursiops truncatus*)	**Population** Atlantic Ocean **Status** Not At Risk (COSEWIC). Likely uncommon in the study area, as they tend to frequent more tropical waters. None were observed in 2007 DFO aerial surveys (Lawson and Gosselin 2009). **Habitat and Distribution** Primarily coastal, but also found in inshore, shelf and offshore areas. Worldwide distribution in temperate and tropical waters; seldom found north of 45° latitude (Hammond *et al.* 2012a). **Seasonal Movements** Many populations non-migratory; however, near the extremes of the species' range, they do undertake migration (Hammond *et al.* 2012a); unlikely to occur in the study area outside the summer months. **Biology and Ecology** • Usually seen in large groups, often mixed with other cetaceans, including large whales and other dolphin species (Hammond *et al.* 2012a). • Dolphins generally reach sexual maturity at 3 - 4 years, and gestation is from 10 - 14 months (ACS 2006).

Species	Overview
	• Feed primarily on fish and squid (Hammond *et al.* 2012a).
Short-beaked/ Common Dolphin (*Delphinus delphis*)	**Population** Atlantic Ocean **Status** Not At Risk (COSEWIC). Abundant in the study area; abundance estimate in Scotian Shelf and Gulf of St. Lawrence is 53,049 individuals (95 percent confidence limits: 34,865-80,717) based on 2007 surveys. Estimate is considered by the authors to be preliminary, as it has not been corrected for perception biases (Lawson and Gosselin 2009). **Habitat and Distribution** Occurs in nearshore and offshore waters in tropical to cool temperate latitudes in the Atlantic and Pacific (Hammond *et al.* 2008a). In the northwest Atlantic, most abundant south of George's Bank (Reeves *et al.* 1999). **Seasonal Movements** Will move to follow aggregations of prey. **Biology and Ecology** • Often observed in groups of 50 - 200 individuals (Reeves *et al.* 1999). • Dolphins generally reach sexual maturity at 3 - 4 years, and gestation is from 10 - 14 months (ACS 2006). • Feed on small schooling fishes and squid (Hammond *et al.* 2008a).
Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)	**Population** Atlantic Ocean **Status** Not At Risk (COSEWIC). Common in the study area; abundance estimate in Scotian Shelf and Gulf of St. Lawrence is 4,289 individuals (95 percent confidence limits: 1,713-10,741) based on 2007 surveys. Estimate is considered by the authors to be preliminary, as it has not been corrected for perception biases (Lawson and Gosselin 2009). **Habitat and Distribution** Occurs along the continental shelf and slope, as well as offshore, in cold temperate to subpolar latitudes in the North Atlantic (Hammond *et al.* 2008b). **Seasonal Movements** Not migratory. **Biology and Ecology** • Often associate with other cetaceans, including baleen whales, pilot whales and other dolphin species (Hammond *et al.* 2008b). • Dolphins generally reach sexual maturity at 3 - 4 years, and gestation is from 10 - 14 months (ACS 2006). • Feed on small schooling fishes, shrimp and squid (Hammond *et al.* 2008b).
White-beaked Dolphin (*Lagenorhynchus albirostris*)	**Population** Atlantic Ocean **Status** Not At Risk (COSEWIC). No abundance estimate available for the Scotian Shelf and Gulf of St. Lawrence. **Habitat and Distribution** Typically found in coastal and continental shelf areas in relatively shallow (< 200 m)

Species	Overview
	waters in cool temperate to subpolar regions of the North Atlantic (Reeves *et al.* 1999; Hammond *et al.* 2012b). **Seasonal Movements** Non-migratory; will move to follow aggregations of prey. **Biology and Ecology** • Associate with other cetaceans, including large whales and other dolphin species (Reeves *et al.* 1999). • Dolphins generally reach sexual maturity at 3 - 4 years, and gestation is from 10 - 14 months (ACS 2006). • Feed on small schooling fish, squid and crustaceans (Hammond *et al.* 2012b).
Atlantic spotted dolphin (*Stenella frontalis*)	**Population** Atlantic Ocean **Status** Infrequent in Canada, not assessed by COSEWIC. Taxonomy somewhat uncertain (LeDuc *et al.* 1999). Abundance has not been estimated for the mid- and eastern Atlantic **Habitat and Distribution** Endemic to the temperate and tropical areas of the Atlantic Ocean, found mostly in the Gulf Stream. **Seasonal Movements** Poorly known. Sometimes enters very shallow water adjacent to the beach seasonally, perhaps in pursuit of migratory fish (Perrin *et al.* 1987) **Biology and Ecology** • Feeds on a wide variety of pelagic fishes and squids, as well as benthic invertebrates (Perrin *et al.* 1994) • Dark gray back, lighter sides, and a white belly. Older members of the species have a very distinctive spotted coloration all over their bodies. • Reach over 2 m in length and 140 kg • Very social species • A fast swimmer and keen bow-rider, prone to acrobatic aerial displays
Harbour Porpoise (*Phocoena phocoena*)	**Population** Atlantic Ocean **Status** Special Concern (COSEWIC); Threatened (SARA Schedule 2). Fairly common in the study area; abundance estimate in Scotian Shelf and Gulf of St. Lawrence is 3,667 individuals (95 percent confidence limits: 1,565-6,566) based on 2007 surveys. Estimate is considered by the authors to be preliminary, as it has not been corrected for perception biases (Lawson and Gosselin 2009). **Habitat and Distribution** Occurs in cold temperate to sub-polar waters in the northern hemisphere, usually in coastal shelf waters in shallow bays and estuaries < 200 m in depth, although occasionally offshore (Hammond *et al.* 2008d). **Seasonal Movements** During summer harbour porpoises are found throughout the Gulf of St. Lawrence. It is suspected that they are migratory and that most of them move out of the Gulf in winter to avoid ice entrapment (COSEWIC 2006).

Species	Overview
	Biology and Ecology • Usually observed in groups of 1 - 3 individuals, often including at least one calf (COSEWIC 2006). • Reach sexual maturity at 3 - 4 years, and gestation is 10 - 11 months (ACS 2006). Intercalving interval of 1 - 2 years (COSEWIC 2006; ACS 2006). • Feed on small schooling fishes and cephalopods (Hammond *et al.* 2008d).

Figure 3-26 Sightings of Large Toothed Whales Recorded by DFO in the Study Area

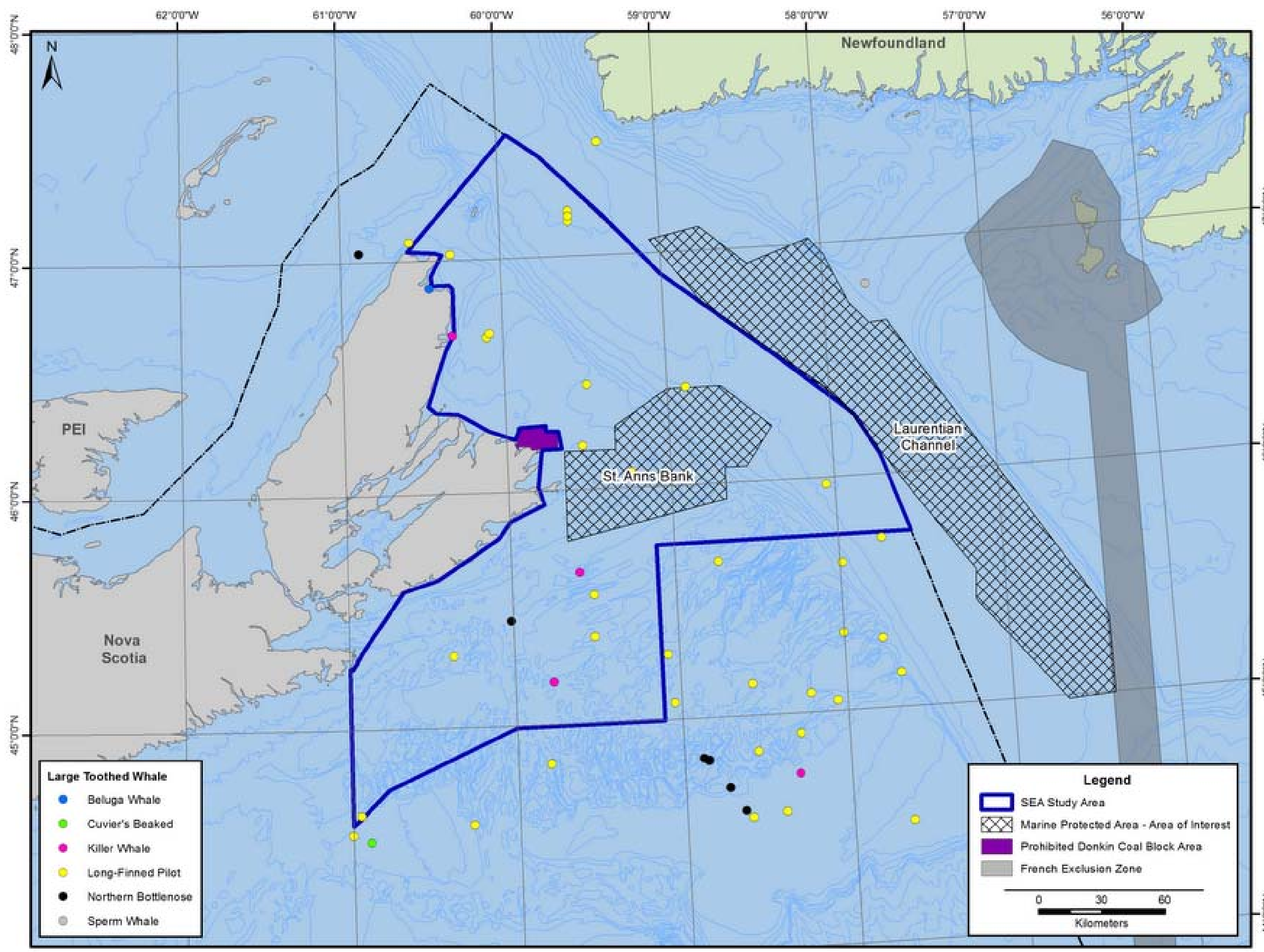
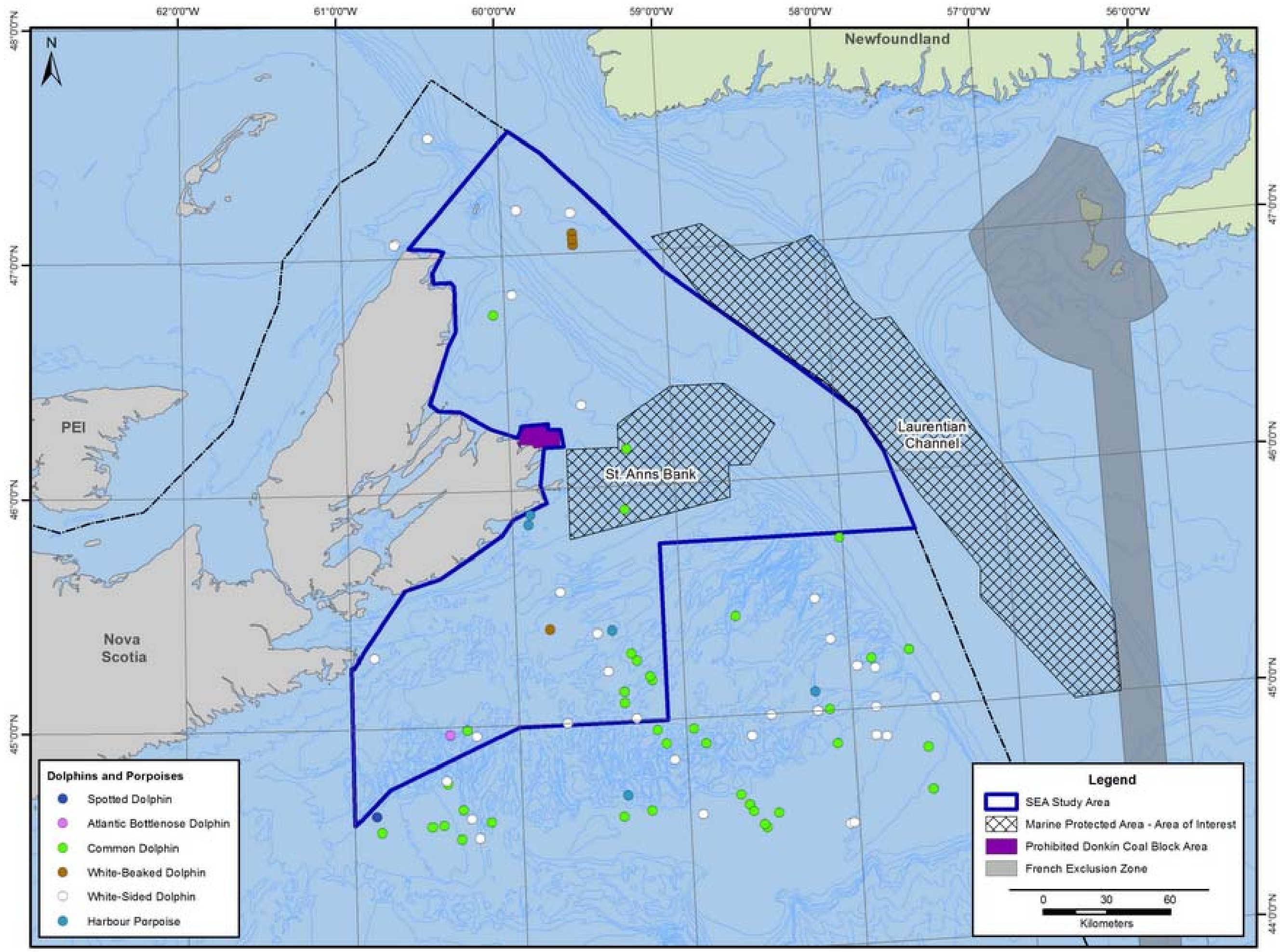


Figure 3-27 Sightings of Dolphins, Porpoises Recorded by DFO in the Study Area



3.2.9.3 Pinnipeds

The Pinnipeds include the true seals (Phocidae), the eared seals (Otariidae), and the walrus (Odobenidae). Only the true seals currently occur on the eastern Scotian Shelf, though walrus have historically occurred in the waters off Nova Scotia. Two seal species, the harbour and grey seals, are known to occur regularly in the proposed Project area. Harp, hooded and ringed seals are also occasionally reported from the northeastern Scotian Shelf but are not usually observed in waters further south than Sable Island (DFO 2011b). Table 3-26 presents a summary of key characteristics of these five species. Bearded seals are typically Arctic dwellers, but they may occasionally occur in the study area in the winter months. They are not discussed in Table 3-26.

All five of the species in Table 3-26 may forage in the Study Area at some point throughout the year. Only two species, however, are known to breed within the vicinity of the Study Area. The world's largest breeding colony of grey seals occurs on Sable Island. This population has grown significantly in recent decades but the rate of growth has recently slowed (DFO 2009). Another grey seal colony occurs on Hay Island, near Scaterie Island. It is estimated that about 3,000 pups are born there annually (DFO 2011b). Some seal hunting also occurs in this area in late winter. A small and declining population of harbor seals also give birth on Sable Island from mid-May to mid-June (Bowen *et al.* 2003, DFO 2011b). Ringed, harp and hooded seals may also occasionally occur on Sable Island, but do not breed there.

Table 3-26. Characteristic of Pinnipeds (Seals) Occurring in the Study Area

Species	Overview
Grey Seal (*Halichoerus grypus*)	**Population** West Atlantic (*grypus*) subspecies **Status** Not At Risk (COSEWIC). Populations apparently secure, numbering approximately 250,000 in the western Atlantic, divided between two herds, one in the Gulf of St Lawrence and the other at Sable Island (DFO 2006). Sable Island is home to the world's largest breeding colony of grey seals (DFO 2009) **Habitat and Distribution** Occurs in cold temperate to sub-Arctic regions of the North Atlantic, over the continental shelf; in the west Atlantic, ranges from the Gulf of Maine to southern Labrador (Thompson and Härkönen 2008b). **Seasonal Movements** Not long-distance migrants, but will forage hundreds of kilometres from haul-out sites (Thompson and Härkönen 2008b). Pupping peaks in January in the Gulf of St. Lawrence and Sable Island colonies, and moulting occurs in the spring. Most abundant in the study area in the summer months, although they occur year round (Lesage *et al.* 2007; Stenson 1994). Tagging indicates that grey seals from the Gulf of St. Lawrence also forage in the Study Area, as part of their large foraging areas.

Species	Overview
	Biology and Ecology • Females give birth between late December and early February on Sable Island (DFO 2011b) • Pups may be born on land or pack ice, and are nursed for 15 - 18 days (Thompson and Härkönen 2008b). • Feeds primarily on fish; in Canada, Atlantic cod, herring and capelin are the main species taken (Thompson and Härkönen 2008b).
Harbour Seal (*Phoca vitulina*)	**Population** Western Atlantic (*concolor*) subspecies **Status** Not At Risk (COSEWIC 2007). Populations have been stable and likely increasing since the 1980s. **Habitat and Distribution** Very widespread distribution; occurs in temperate to polar latitudes in the northern hemisphere in coastal waters, bays, rivers, estuaries and intertidal areas (Thompson and Härkönen 2008a). **Seasonal Movements** Generally considered non-migratory (Thompson and Härkönen 2008a). Likely present in the study area year-round (Lesage *et al.* 2007) **Biology and Ecology** • Gregarious at haul-out areas, but at sea, most often seen alone or in small groups (Thompson and Härkönen 2008a). • Reach sexual maturity at 3 - 4 years, and gestation is 10.5 - 11 months (Thompson and Härkönen 2008a). • Generalist feeders, taking a wide variety of fish, cephalopods and crustaceans from surface, mid-water, and benthic habitats (Olesiuk *et al.* 1990).
Harp Seal (*Pagophilus groenlandicus*)	**Population** Western North Atlantic (*groenlandicus*) subspecies **Status** Populations are considered secure; it is the most abundant pinniped in the northern hemisphere, and numbers are increasing (Kovacs 2008a). The Northwest Atlantic stock is estimated at 5,900,000 (DFO 2005). **Habitat and Distribution** Widespread in pack ice in coastal and offshore waters of the North Atlantic and adjacent Arctic Ocean (Kovacs 2008a) **Seasonal Movements** Summer in the Canadian Arctic and Greenland, migrating to the Gulf of St. Lawrence in December - January and returning north in April - May after breeding. **Biology and Ecology** • Highly social, travelling and foraging in groups (Kovacs 2008a). • Reach sexual maturity at 4 - 8 years, and gestation is 11.5 months. Pups are born on pack ice and nursed for approximately 12 days (Kovacs 2008a).

<table>
<tr><th>Species</th><th>Overview</th></tr>
<tr><td></td><td>Feed on a wide variety of fish and invertebrates (Kovacs 2008a; Hammill and Stenson 2000).</td></tr>
<tr><td>Hooded Seal

(Cystophora cristata)</td><td>Population
East coast Canada breeding stock
Status
Not At Risk (COSEWIC). In the northwest Atlantic, populations are stable or increasing slightly (Kovacs 2008b).
Habitat and Distribution
Occurs in high latitudes in the North Atlantic and into the Arctic Ocean. Associated with pack ice during breeding and over much of the year, but also spend significant periods of time at sea without hauling out (Lavigne and Kovacs 1988, Kovacs 2008b).
Seasonal Movements
A highly migratory species, hooded seals congregate at one of four major pupping areas in mid-March, where they remain for approximately 2.5 weeks (Kovacs 2008b); individuals in the study area pup near the Magdalen Islands. Individuals again congregate in August for moulting. Following the moulting period, seals disperse throughout the North Atlantic (Kovacs 2008b).
Biology and Ecology
Adult males have peculiar inflatable bladder on their heads and in their nostrils, used in mating displays
Form loose aggregations during breeding and moulting, but otherwise believed to be solitary (Kovacs 2008b).
Pups are born on pack ice and nursed for just 4 days (Kovacs 2008; Bowen et al. 1985).
Feed on a wide variety of fish and invertebrates throughout the water column (Kovacs 2008b).
Generally a solitary species, except during breeding and moulting seasons</td></tr>
<tr><td>Ringed Seal

(Phoca hispida)</td><td>Population
Atlantic
Status
COSEWIC - Not at Risk (1989)
Habitat and Distribution
They prefer to rest on ice floes and will move farther north for denser ice. Most abundant and wide-ranging ice seal in the northern hemisphere.
Seasonal Movements
In the summer, ringed seals feed on polar cod along edge of the sea-ice
Biology and Ecology
Relatively small seal, rarely greater than 1.5 m in length,
Distinctive patterning of dark spots surrounded by light grey rings gives it its name adult size can reach 175 cm and 140 kg
Females give birth to a single pup on ice floes or shorefast ice in March or April after a 9-month gestation period.
Pups are weaned after one month and build up a thick layer of blubber
Eat a wide variety of small fish and invertebrates, prey of choice includes mysids,</td></tr>
</table>

Species	Overview
	shrimp, arctic cod, and herring. • Can dive to 45 m to reach prey

Sable Island was once also home to a breeding population of Atlantic Walrus, which were last seen in the late 1800s. They are now listed as Extirpated in Atlantic Canada under the *Species at Risk Act*.

3.2.10 Sea Turtles

Sea turtles are marine reptiles that are found in all but the polar regions of the world's oceans. All seven species of sea turtles are considered endangered globally, with fisheries bycatch, hunting, contamination and beach development all considered major threats. Three species of sea turtles, summarized in Table 3-27 are or may be found in the waters of the Study Area. A fourth species, the Green Turtle, (*Chelonia mydas*) was recently reported on the Scotian Shelf (James *et al.* 2004). It is expected to occur very infrequently, if at all, in the Study Area, and so is not included in Table 3-27. Locations of sea turtle records reported by DFO are depicted on Figure 3-28.

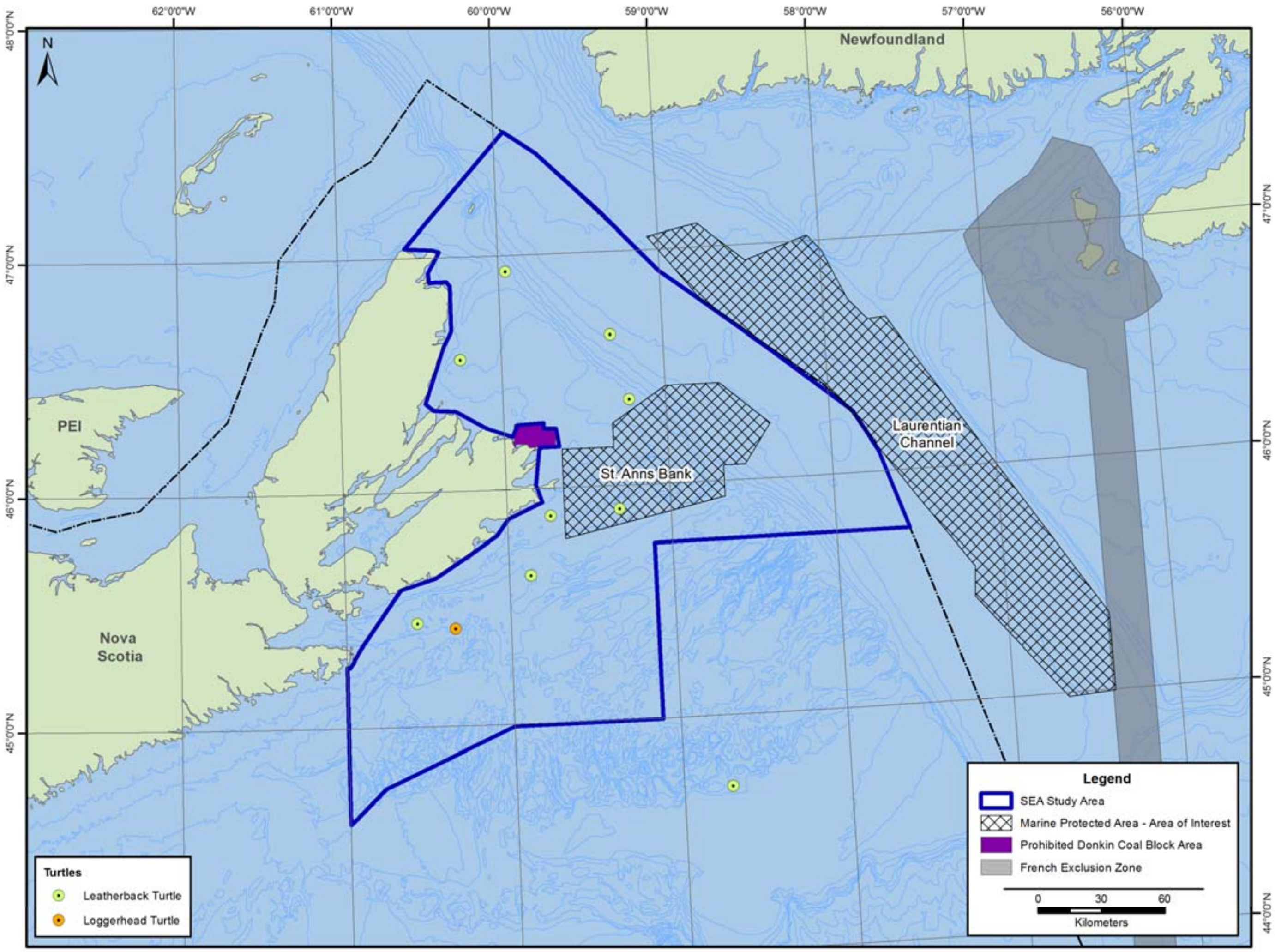
Table 3-27.Characteristics of Sea Turtle Species in the Study Area

Species	Overview
Leatherback Sea Turtle (*Dermochelys coriacea*)	**Population** Atlantic **Status** Endangered (*SARA* Schedule 1). Populations in the northwest Atlantic are increasing (Wallace 2013), and estimates in the North Atlantic range from 34,000 - 94,000 individuals (COSEWIC 2012). **Habitat and Distribution** Occur in tropical to sub-polar regions in the Atlantic, Pacific and Indian oceans. They are predominantly pelagic, typically inhabiting coastal shelf waters to a depth of <200m (COSEWIC 2012). Ecologically and Biologically Significant Areas utilized by this species include the Cabot Strait, Western Sydney Bight, St Anns Bank and Laurentian Channel EBSAs (Section 3.2.1.2.3). **Seasonal Movements** Most widely distributed and largest of all marine turtles, and undertakes annual migrations to Atlantic Canadian waters to forage. Undertakes extensive migrations between different feeding areas at different seasons, and to and from nesting areas in the tropics (James *et al.*2007, Wallace 2013). Some undertake annual migrations to Atlantic Canadian waters to forage and are present from April to December and most numerous from July to September (Heaslip *et al.*2012). The southeastern Gulf of St. Lawrence and waters off eastern Cape Breton Island, including Sydney Bight, the Cabot Strait, portions of the Magdalen Shallows and adjacent portions of the Laurentian Channel have been identified as one of three primary areas of

Species	Overview
	important habitat identified in Atlantic Canada particularly in the summer and fall (DFO 2012). **Biology and Ecology** • Females produce 3 -10 clutches of 60 - 90 eggs per season, with an inter-migration interval of 2 or more years between reproductive seasons (Wallace 2013) • Feed primarily on gelatinous organisms such as lion's mane jellyfish (*Cyanea capillata*), and moon jellyfish (*Aurelia aurita*), salps, and siphonophores, prey that are seasonally abundant in temperate shelf and slope waters off eastern Canada (COSEWIC 2012, Heaslip *et al.*2012).
Loggerhead Sea Turtle (*Caretta caretta*)	**Population** Atlantic **Status** Endangered (COSEWIC 2010). No population estimate available; they are believed to be the most abundant marine turtle in Canadian waters (COSEWIC 2010), but are less commonly observed than Leatherbacks in the study area. **Habitat and Distribution** Occurs in temperate to tropical regions of the Atlantic, Pacific and Indian Oceans. Nest on ocean beaches; outside of nesting, they inhabit the oceanic and near-shore zones of temperate and tropical waters (COSEWIC 2010). In the waters off Atlantic Canada, they are generally associated with the warmer waters of the Gulf Stream. Immature loggerhead turtles occur regularly at the edge of the Scotian Shelf and on the slope, preferring relatively warm waters (above 20 °C) (Brazner and McMillan 2008). **Seasonal Movements** Nests in tropical to sub-tropical regions, and undertake extensive lateral migrations between different feeding areas at different seasons, as well as north-south migrations to and from nesting areas in the tropics. In Atlantic Canadian waters, they are most abundant in the spring, summer and fall (Canadian Sea Turtle Sighting Database, cited in COSEWIC 2010). **Biology and Ecology** • Lay 3 - 4 clutches of over 100 eggs per season, with an interval of 2 - 3 years between breeding seasons (Miller 1997). • Feeds on crustaceans, molluscs and jellyfish (COSEWIC 2010).
Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)	**Population** Atlantic **Status** Not assessed by COSEWIC due to infrequency of occurrence in Canadian waters. Critically endangered globally; however, populations are showing signs of recovery in the last 50 years (Marine Turtle Specialist Group 1996). **Habitat and Distribution** Extremely restricted breeding range in the Atlantic coast of Mexico and Texas. Outside the nesting season, occurs offshore in the Northwest Atlantic in tropical and temperate waters, usually as far north as New Jersey (Marine Turtle Specialist Group 1996); however, juveniles occasionally wander further north and may occur in the Study Area. **Seasonal Movements**

Species	Overview
	Nesting occurs from April to July, after which females return to the offshore environment. Individuals forage in coastal areas along coastal United States, more northerly feeders moving to more favourable overwintering sites south of Cape Hatteras in late fall (NMFS *et al.* 2010). **Biology and Ecology** • Lay 2 - 3 clutches of over 100 eggs per season, with an interval of 1 - 3 years between breeding seasons (Marine Turtle Specialist Group 1996). • Feeds on crustaceans, fish, molluscs and jellyfish (Marine Turtle Specialist Group 1996).

Figure 3-28 Sightings of Sea Turtles Recorded by DFO in the Study Area



There are no estimates of the population size in Canada; however, adult leatherbacks are a regular part of the eastern Scotian Shelf marine fauna in the summer and fall (DFO 2012). They are much more abundant seasonally within the Study Area than the depicted DFO data would suggest Leatherback turtles are known to use the area east of Cape Breton heavily during the summer months, including the Laurentian Channel (DFO 2011, 2012). In fact, the presence of leatherback turtles in this area was one of the reasons the St Ann's Bank and the Laurentian Channel have been selected as Areas of Interest for consideration as potential Marine Protected Areas. This region is also part of a migratory corridor for leatherbacks, which are known to frequent areas along the tip of the Gaspé Peninsula, near the Magdalen Islands and along the north shore of the Gulf of St. Lawrence. DFO (2012) has identified the southeastern Gulf of St. Lawrence and waters off eastern Cape Breton Island, including Sydney Bight, the Cabot Strait, portions of the Magdalen Shallows and adjacent portions of the Laurentian Channel as one of three primary areas of important habitats for leatherback turtles in Atlantic Canada.

Although there are no estimates available for the density of loggerhead turtles in the Study Area, they are likely to be rare; loggerheads are less common than leatherbacks elsewhere in eastern Canadian waters (Breeze *et al.*2002) and tend to stay offshore (Brazner and MacMillan 2008). The number of Kemp's ridley turtles that visit the Study Area is unknown, but this species is likely to be extremely rare in the Study Area. Green turtles have only recently been reported from the Scotian Shelf, and are considered to be even less likely to occur in the Study Area.

Four Ecologically and Biologically Significant Areas (discussed further in Section 3.2.1.2.3) within the Study Area have been designated as such due in part to the importance of these areas to leatherback turtles. The Cabot Strait EBSA and the Sydney Bight EBSA are both part of the Gulf of St. Lawrence important habitat area for Leatherbacks discussed earlier. The Laurentian Channel and the St Anns Bank, as discussed above, are also located along an important migratory route for leatherbacks in Atlantic Canada. O'Boyle (2012) discussed potential threats to leatherback sea turtles from fisheries activities in the Canadian Atlantic.

3.2.11 Species of Special Status

A number of species of Species at Risk and Species of Conservation Concern occur in the Study Area. These include marine fish species with varying degrees of formal protection under provincial and/or federal legislation, as well as other species which are considered to potentially be of conservation concern and/or regionally rare.

The Canadian *Species at Risk Act* (*SARA*) provides protection to species at the national level to prevent extinction and extirpation, facilitate the recovery of endangered and threatened species, and to promote the management of other species to prevent them from becoming at risk in the future. Designations under the *Act* follow the recommendations and advice provided by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), an independent body which assesses current population statuses and trends of species occurring in Canada.

There are currently various Schedules associated with the SARA. Species that have formal protection are listed on Schedule 1, which includes the following potential designations:

- *Extirpated*: A species that no longer exists in the wild in Canada, but exists elsewhere;
- *Endangered*: A species that is facing imminent extirpation or extinction;
- *Threatened*: A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction; and
- *Special Concern*: A species that has characteristics which make it particularly sensitive to human activities or natural events.

Schedule 1 of *SARA* is the official federal list of Species at Risk in Canada. Once a species is listed, steps are taken to protect and recover a listed species, including the development of a recovery strategy. These recovery strategies must be developed within one year for species designated as endangered, and within two years for threatened or extirpated species. These recovery strategies aim to define conservation goals and objectives, identify critical habitat, and describe the research and management activities required. Critical habitat under the *SARA* is defined as habitat that is required for the species' survival or recovery.

Species listed as Endangered, Threatened, or Vulnerable under the *Nova Scotia Endangered Species Act* (*NSESA*) are also considered to be SAR. The *NSESA* provides protection for indigenous species, sub-species and populations considered to be endangered, threatened, or vulnerable within the province. These potential designations under the legislation are defined as follows:

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

Since the latest amendment to the list of protected species in July 2015, there are 60 species, subspecies, and populations listed as SAR under the *NSESA*. Of these species, 28 are listed as endangered, nine as threatened, and 15 as vulnerable. (The remaining 8 are considered Extirpated from NS or Extinct). These designations are based on recommendations from the NS Endangered Species Working Group, an independent committee of scientists who determine the status of species, subspecies and significant populations considered to be at risk of extinction or extirpation. The evaluation processes of both are independent, open and transparent, and based on the best available information on the biological status of species including scientific, community and traditional knowledge. The NSESA does not cover marine species, but does assess birds and anadromous fishes which may occur in the marine environment off Nova Scotia.

Other organizations apply their own criteria to species considered threatened by human activity. These include species which are ranked in the General Status of Wild Species in Canada for Nova Scotia and the Atlantic Ocean (CESCC 2010) as 1 (At-Risk), 2 (May Be At Risk) or 3 (Vulnerable). Such species are often referred to as Species of Conservation Concern (SOCC), not SAR, since they May Be at Risk but are not yet legally protected federally or provincially. In addition to species that are listed under the provincial and/or federal legislation, there is also often a degree of interest around species that are considered to be regionally rare, even though these are not necessarily provided with formal, legal protection. Although the designation of a species by COSEWIC or other such organizations, for example, does not in itself constitute such legal protection, they do provide a general indication of species that may be considered rare, and thus, of some degree of potential conservation interest

Species at Risk and Species of Conservation Concern are discussed for each relevant group in the following subsections.

3.2.11.1 Fish Species at Risk and Species of Conservation Concern

Within the Study Area, Fish Species at Risk and Species of Conservation Concern include both fully marine and anadromous species. These species are discussed in the following subsection.

3.2.11.1.1 Marine Fish Species at Risk

A total of 25 species of marine or anadromous fish species are listed by federal (SARA/COSEWIC) or provincial (NSESA) governments as being of conservation concern (Table 3-28). Of these, only four are considered to be Species at Risk, *i.e.* are legally protected species. Some of these species are still common but populations are much reduced from their abundance levels prior to the groundfish collapse of the early 1990s (*e.g.* American plaice, Atlantic cod, redfish). Others, such as various tuna and shark species, were likely never abundant in the Study Area. The four marine fish species that have formal designation and protection under *SARA* include three species of wolffish (family *Anarhichadidae*) and the white shark (Table 3-28). A brief description of each species is provided below.

Table 3-28. Fish Species of Conservation Concern Listed under SARA/COSEWIC, and/or the NSESA which are Known to or May Occur within the Study Area

Species			Status / Designation [1,2]			Population
Common Name	**Scientific Name**	**Family**	**NSESA**	**SARA**	**COSEWIC**	
Acadian redfish	*Sebastes fasciatus*	Scombridae			T	Atlantic
American eel	*Anguilla rostrata*	Anarhichadidae			T	Atlantic
American plaice	*Hippoglossoides platessoides*	Macrouridae			T	Atlantic
Atlantic bluefin tuna	*Thunnus thynnus*	Salmonidae			E	Atlantic
Atlantic cod	*Gadus morhua*	Gadidae			E	Southern Atlantic
Atlantic salmon	*Salmo salar*	Salmonidae			E / SC	Eastern Cape Breton (E), Southern Nova Scotia Uplands(E), Gaspe/Southern Gulf of St. Lawrence Population (SC)[2]
Atlantic sturgeon	*Accipenser oxurhinchos*				T	NS/ Atlantic
Atlantic wolffish	*Anarhichas lupus*	Anarhichadidae		SC	SC	Atlantic
Basking shark	*Cetorhinus maximus*	Cetorhinidae			SC	Atlantic
Blue shark	*Prionace glauca*	Anguillidae			SC	Atlantic
Cusk	*Brosme*	Gadidae			E	Atlantic
Deepwater redfish	*Sebastes mentella*	Sebastidae			T	Atlantic
Northern wolffish	*Anarhichas denticulatus*	Anarhichadidae		T	T	Atlantic
Porbeagle	*Lamna nasus*	Lamnidae			E	Atlantic
Roughhead grenadier	*Macrourus berglax*	Macrouridae			E	Atlantic
Roundnose grenadier	*Coryphaenoides rupestris*	Macrouridae			E	Atlantic
Shortfin mako	*Isurus oxyrinchus*	Lamnidae			T	Atlantic
Smooth skate	*Malacoraja senta*	Rajidae			E	Atlantic
Spiny dogfish	*Squalus acanthias*	Squalidae			SC	Atlantic
Spotted wolffish	*Anarhichas minor*	Anarhichadidae		T	T	Atlantic

Species			Status / Designation [1,2]			Population
Common Name	**Scientific Name**	**Family**	**NSESA**	**SARA**	**COSEWIC**	
Thorny skate	*Amblyraja radiata*	Rajidae			SC	Atlantic
White Hake-	*Urophysis tenuis*	Lotidae			T	Atlantic and Northern Gulf of St. Lawrence population
White shark	*Carcharodon carcharias*			E	E	Atlantic
Winter skate	*Leucoraja ocellata*	Rajidae			T	Atlantic

[1] E= Endangered, T= Threatened, SC= Special Concern

[2]Atlantic Salmon from the Inner Bay of Fundy (Endangered) and Anticosti Island (Endangered) populations may also occur in the Study Area, but expected to represent a small portion of the Atlantic Salmon present. Atlantic Salmon from the Southwest Newfoundland population are also expected to occur, but are considered to be Not At Risk (COSEWIC 2010).

Wolffishes

Three species of wolffish occurring within the Study Area are listed under *SARA.* These are the Northern Wolfish, Spotted Wolffish and Striped Wolffish. Wolffish are large, slow-growing and long-lived nest-building fish that are experiencing population declines in the Study Area which are thought to be associated with bycatch mortality and habitat alteration by trawling gear (COSEWIC 2012a,b,c). Northern wolffish (95 percent decline) and spotted wolffish (90 percent decline) have both been listed as Threatened by *SARA*, while the striped wolffish has been listed as being of Special Concern. A recovery strategy and management plan have been developed for the three wolffish species (DFO 2013a) to increase population levels and distributions. Proposed measures include mitigating human impacts, identifying and protecting critical habitats, improving knowledge of the species' biology and life history, and implementing education programs (DFO 2013a).

Northern wolfish appear to occur in deeper water (300 – 1,200 m), than are spotted wolffish (100 – 800 m) and Striped wolffish (50 – 450 m) (DFO 2013a). Northern wolffish are reported more frequently from sand, shell, or pebble habitats (reviewed in DFO 2013a), while striped (Kulka *et al.* 2004) and spotted (Baker *et al.* 2012) wolffish appear to prefer rocky substrates.

DFO RV survey data for Striped wolffish are shown in Figure 3-29. Most Striped Wolfish were encountered in the vicinity of the proposed St Anns Bank Area of Interest, with other areas of higher abundance off northern Cape Breton and in the offshore southeast of the Island. Northern and Spotted Wolffish were also encountered within the Study Area. The locations were sparsely and widely distributed around the Study Area (Figure 3-30).

Figure 3-29 Abundance of Striped Wolffish within the Study Area, based on DFO RV surveys (2004-2014)

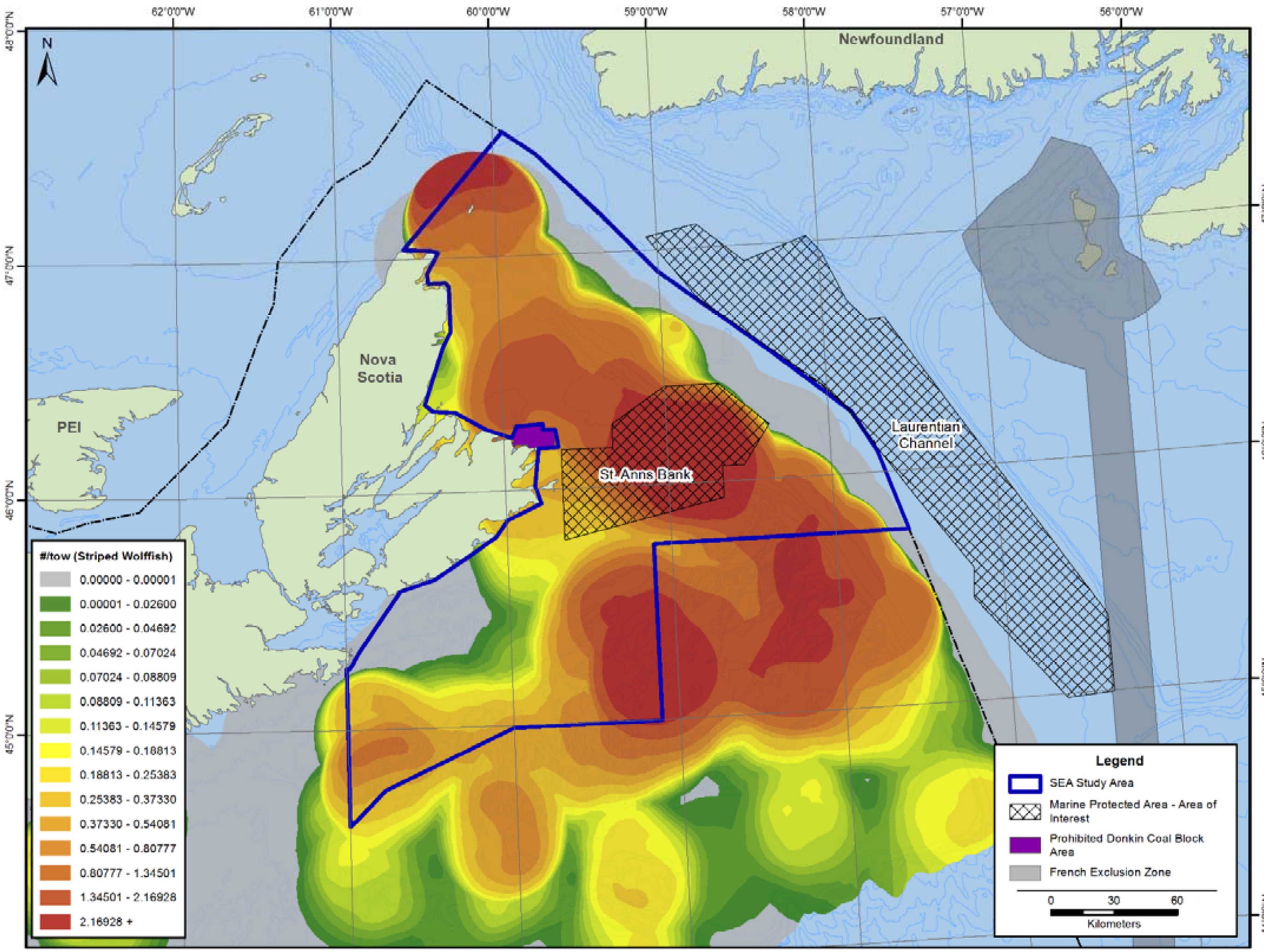
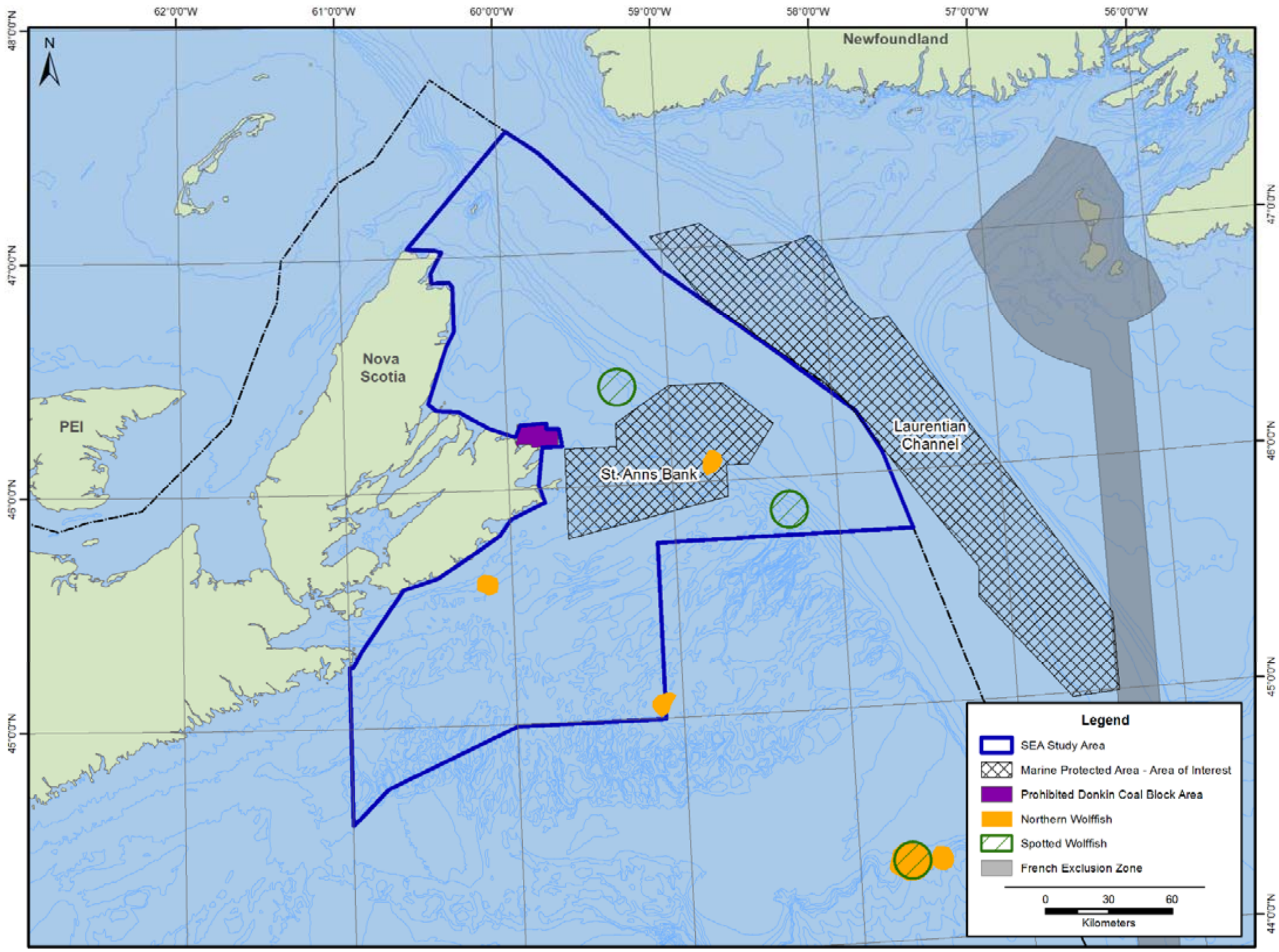


Figure 3-30 Areas of Northern and Spotted Wolffish Occurrence within the Study Area, based on DFO RV surveys (2004-2014)



White Shark

The white shark was assessed in 2006 as being endangered under Schedule 1 of SARA as its numbers have declined by about 80 percent over 14 years in areas of the northwest Atlantic Ocean outside of Canadian waters. The poor understanding of the species' biology (DFO 2006a), particularly in Canadian waters where it is less common (only 32 records over 132 years for Atlantic Canada; COSEWIC 2006a), has resulted in an inability to define critical habitat for this species. Canadian Atlantic waters are considered to represent the northernmost fringe of this species'' range. They have been reported on the eastern Scotian Shelf and in the Gulf of St Lawrence, though sightings are infrequent. White sharks are also thought to be responsible for several attacks on seals on Sable Island (Lucas and Natanson 2010).

The white shark was designated in 2006 (COSEWIC 2006) as being Endangered under Schedule 1 of *SARA*, and this assessment has not been updated. The greatest threat to white sharks, (by-catch in the American long line fishery) does not occur in Canadian waters (DFO 2006a).

3.2.11.1.2 Other Fish Species of Conservation Concern

In addition to the Federal and Provincial legal protection ranking systems, species are also ranked by the Canadian Endangered Species Conservation Council (CESCC) (www.wildspecies.ca). While most of the species ranked are not currently legally protected in Canada (some are listed in the previous section), they are of conservation concern and could receive such protection in the future. Nova Scotia ranks, as determined by the CESCC, are provided in Table 3-29.

Table 3-29. Marine and Anadromous Fish Species of Conservation Concern listed by the Canadian Endangered Species Conservation Council.

Species			Rank (NS and/or Atlantic)	Population
Common Name	**Scientific Name**	**Family**		
Anarhichas denticulatus	Northern Wolffish	Anarhichadidae	At Risk	Atlantic
Anarhichas minor	Spotted Wolffish	Anarhichadidae	At Risk	Atlantic
Carcharodon carcharias	White Shark	Lamnidae	At Risk	Atlantic
Isurus oxyrinchus	Shortfin Mako	Lamnidae	At Risk	Atlantic
Morone saxatilis	Striped Bass	Moronidae	At Risk, At Risk	NS, Atlantic
Coregonus huntsmani	Atlantic Whitefish	Salmonidae	At Risk, At Risk	NS, Atlantic
Lamna nasus	Porbeagle	Lamnidae	At Risk	Atlantic
Brosme	Cusk	Lotidae	At Risk	Atlantic
Coryphaenoides rupestris	Roundnose Grenadier	Macrouridae	May Be At Risk	Atlantic
Macrourus berglax	Roughead Grenadier	Macrouridae	May Be At Risk	Atlantic

Species			Rank (NS and/or	Population
Hippoglossoides platessoides	American Plaice	Pleuronectidae	May Be At Risk	Atlantic
Hippoglossus	Atlantic Halibut	Pleuronectidae	May Be At Risk	Atlantic
Amblyraja radiata	Thorny Skate	Rajidae	May Be At Risk	Atlantic
Sebastes mentella	Deepwater Redfish	Scorpaenidae	May Be At Risk	Atlantic
Sebastes norvegicus	Golden Redfish	Scorpaenidae	May Be At Risk	Atlantic
Cetorhinus maximus	Basking Shark	Cetorhinidae	May Be At Risk	Atlantic
Urophycis tenuis	White Hake	Phycidae	May Be At Risk	Atlantic
Thunnus thynnus	Bluefin Tuna	Scombridae	May Be At Risk	Atlantic
Sebastes fasciatus	Acadian Redfish	Scorpaenidae	May Be At Risk	Atlantic
Anarhichas lupus	Atlantic Wolffish	Anarhichadidae	Sensitive	Atlantic
Gadus morhua	Atlantic Cod	Gadidae	Sensitive	Atlantic
Nezumia bairdii	Marlin-Spike Grenadier	Macrouridae	Sensitive	Atlantic
Antimora rostrata	Blue Hake	Moridae	Sensitive	Atlantic
Glyptocephalus cynoglossus	Witch Flounder	Pleuronectidae	Sensitive	Atlantic
Lycodes vahlii	Vahl's/Checker Eelpout	Zoarcidae	Sensitive	Atlantic
Urophycis chesteri	Longfin Hake	Phycidae	Sensitive	Atlantic
Zoarces americanus	Ocean Pout	Zoarcidae	Sensitive	Atlantic
Thunnus alalunga	Albacore	Scombridae	Sensitive	Atlantic
Squalus acanthias	Spiny Dogfish	Squalidae	Sensitive	Atlantic
Alopias vulpinus	Thresher Shark	Alopiidae	Sensitive	Atlantic
Prionace glauca	Blue Shark	Carcharhinidae	Sensitive	Atlantic
Acipenser oxyrinchus	Atlantic Sturgeon	Acipenseridae	May Be At Risk, Sensitive	NS, Atlantic
Acipenser brevirostrum	Shortnose Sturgeon	Acipenseridae	Sensitive	Atlantic
Pollachius virens	Pollock	Gadidae	Sensitive	Atlantic
Makaira nigricans	Blue Marlin	Istiophoridae	Sensitive	Atlantic
Tetrapturus albidus	White Marlin	Istiophoridae	Sensitive	Atlantic
Lophius americanus	Monkfish	Lophiidae	Sensitive	Atlantic
Urophycis chuss	Red Hake	Phycidae	Sensitive	Atlantic
Dipturus laevis	Barndoor Skate	Rajidae	Sensitive	Atlantic
Leucoraja ocellata	Winter Skate	Rajidae	Sensitive	Atlantic
Malacoraja senta	Smooth Skate	Rajidae	Sensitive	Atlantic
Thunnus albacares	Yellowfin Tuna	Scombridae	Sensitive	Atlantic
Thunnus obesus	Bigeye Tuna	Scombridae	Sensitive	Atlantic

3.2.11.2 Bird Species at Risk and Species of Conservation Concern

A number of bird Species at Risk and Species of Conservation Concern occur in the province and in the waters offshore. Some of these species have the potential for negative interactions with projects within the Study Area for at least some part of the year; these species are addressed in Section 5.2.1 Species that do not inhabit the offshore environment, or those that only migrate over the ocean in the daytime (and are therefore unlikely to be affected by attraction to artificial marine lighting), are considered unlikely to be affected by offshore oil and gas exploration or development activities and so were not assessed. The Rusty Blackbird breeds throughout the province and may migrate over the offshore area, but as a diurnal migrant (Avery 2013). Other diurnal migrant Species at Risk or Species of Conservation Concern that occur in the province but are not considered here include the Chimney Swift (Cink and Collins 2002) and Barn Swallow (Brown and Bomberger Brown 1999).

One additional marine-associated avian Species at Risk in Eastern Canada is not considered likely to occur in the Study Area: the Eskimo Curlew, which once bred in large numbers in the Arctic and passed through eastern Canada on its migration to the South American wintering grounds in the fall. The species' numbers have declined sharply, and there have been no confirmed sightings of the Eskimo Curlew since 1963; therefore, the species is considered to possibly be extinct (COSEWIC 2009).

Table 3-30. Avian Species at Risk that are Known to or May Occur within the Study Area

Species	Provincial Status	Federal Status		Habitat and Distribution in Eastern Nova Scotia	Potential Presence in SEA Study Area
		SARA Listing	COSEWIC Assessment		
Barrow's Goldeneye	No status	Special Concern Schedule 1	Special Concern	• Breeds in high elevation lakes north of St. Lawrence Estuary and Gulf of St. Lawrence. • Moults and winters in small numbers off the coast of Eastern Canada. • Often seen in groups with Common Goldeneye. • Small numbers have regularly been reported wintering in Sydney Harbour.	Barrow's Goldeneye are found in eastern Cape Breton during the winter months. They are known to congregate in relatively small geographic areas in important shipping corridors, and therefore considered to be particularly vulnerable to being affected by accidental spills (NLDEC 2013).
Harlequin Duck	Endangered	Special Concern Schedule 1	Special Concern	• Breeds in fast-flowing streams in northern Canada, and congregate in moulting sites in the late summer to fall. • In eastern Nova Scotia, winter along rocky coastlines, subtidal ledges, and exposed headlands.	Though they breed inland, Harlequin Ducks occur in the coastal marine environment, including the waters off eastern Cape Breton, throughout the fall and winter months.
Piping Plover (*Melodus* subspecies)	Endangered	Endangered Schedule 1	Endangered	• Nests on sand and gravel beaches on the ground, above the normal high water mark. • Few breeding locations identified in the study area, one near Glace Bay and the other near Dingwall.	During the nesting season, Piping Plovers are found on sandy beaches along the coast. Piping Plovers are unlikely to be affected by typical project activities, although accidental spills near breeding habitat could potentially be harmful.
Red Knot (*rufa* subspecies)	Endangered	Endangered Schedule 1	Endangered	• Found on open sandy inlets, coastal mudflats, sand flats, salt marshes, sandy estuaries and areas with rotting kelp deposits during fall migration (NLDEC 2013). • Though considered to be common transients by the NSDNR, numbers of Red Knots have declined sharply in recent years. • In eastern Nova Scotia, small numbers are seen at	During fall migration, the species can be found in small numbers along the coast. They are unlikely to be affected by typical project activities, but accidental spills near migration stopovers could potentially be harmful.

Species	Provincial Status	Federal Status		Habitat and Distribution in Eastern Nova Scotia	Potential Presence in SEA Study Area
		SARA Listing	COSEWIC Assessment		
				Morien Bar and in southern Cape Breton in the late summer.	
Buff-breasted Sandpiper	No status	No status	Special Concern	• Arctic breeders; during fall migration, considered to be a rare migrant in Atlantic Canada (COSEWIC 2012). • Considered to be uncommon transients in Nova Scotia (COSEWIC 2012), Buff-breasted Sandpipers have been observed at the Sydney Airport and Morien Bar, as well as on Scatarie Island.	During fall migration, the species can be found in small numbers along the coast. They are unlikely to be affected by typical project activities, but accidental spills near migration stopovers could potentially be harmful.
Roseate Tern	Endangered	Endangered Schedule 1	Endangered	• Breeds in a handful of areas in Southern Nova Scotia and the Northeastern United States, and winters further south (Gochfeld *et al.* 1998). • Nesting colonies in the vicinity of the Study Area include Sable Island and the Country Island Complex IBA.	Potentially present in small numbers in coastal and nearshore areas of the study area during the summer months.
Peregrine Falcon	Vulnerable	Special Concern Schedule 1	Special Concern	• Migrates along the coast during the fall, often preying on concentrations of migrating shorebirds. • Within the Maritimes, breeding is largely restricted to coastal sites along the Bay of Fundy.	Present in small numbers in coastal areas within the study area during fall migration.
Bank Swallow	No status	No status	Threatened	• Colonial, nesting in burrows constructed in banks. • Diurnal migrants (Garrison 1999). • Within the province, widespread breeding distribution, primarily in coastal areas.	Bank Swallow colonies are often found in banks created through coastal erosion and so may be located in close proximity to the marine environment during the breeding season.
Olive-sided Flycatcher	Threatened	Threatened Schedule 1	Threatened	• Found in boreal forest habitat, particularly open areas such as wetlands with tall trees and snags. • Migrates to south and central America to overwinter (Altman and Sallabanks 2012).	An inland species, and so unlikely to be affected by offshore activities at most times of year. During fall migration, like other nocturnal migrants, there is

Species	Provincial Status	Federal Status		Habitat and Distribution in Eastern Nova Scotia	Potential Presence in SEA Study Area
		SARA Listing	COSEWIC Assessment		
				• Widespread breeders in eastern Nova Scotia.	potential for individuals to be attracted to or disoriented by artificial light sources on the water such as ship lighting.
Eastern Wood-pewee	Vulnerable	No status	Special Concern	• Found primarily in deciduous and mixed forests. • Widespread breeding distribution in Nova Scotia, mainly in inland areas.	An inland species, and so unlikely to be affected by offshore activities at most times of year. During fall migration, like other nocturnal migrants, there is potential for individuals to be attracted to or disoriented by artificial light sources on the water such as ship lighting.
Bicknell's Thrush	Vulnerable	Threatened Schedule 1	Threatened	• Breed at high elevation, dense and stunted fir and spruce forests on rocky peaks. Favour a wet, cool, windy climate that increases with elevation. • Within Nova Scotia, nests solely in northern Cape Breton.	An inland species, and so unlikely to be affected by offshore activities at most times of year. During fall migration, like other nocturnal migrants, there is potential for individuals to be attracted to or disoriented by artificial light sources on the water such as ship lighting.
Canada Warbler	Endangered	Threatened Schedule 1	Threatened	• Most abundant in moist, mixed forests with a well-developed understory, dense nest site cover, often near open water. • Widespread breeding distribution in Nova Scotia.	An inland species, and so unlikely to be affected by offshore activities at most times of year. During fall migration, like other nocturnal migrants, there is potential for individuals to be attracted to or disoriented by artificial light sources on the water such as ship lighting.
"Ipswich" Savannah Sparrow (princeps ssp.)	No status	Special Concern Schedule 1	Special Concern	• Found in heath-dominated terrain in dense marram grass on coastal dunes and upper beaches; prefer outer dune beaches with good grass coverage. • While there are no MBBA records for the species, they are known to breed almost exclusively on Sable	An inland species, and so unlikely to be affected by offshore activities at most times of year. During fall migration, like other nocturnal migrants, there is potential for individuals to be attracted

Species	Provincial Status	Federal Status		Habitat and Distribution in Eastern Nova Scotia	Potential Presence in SEA Study Area
		SARA Listing	COSEWIC Assessment		
				Island.	to or disoriented by artificial light sources on the water such as ship lighting.
Bobolink	Vulnerable	No Status	Threatened	• Nests in agricultural and natural grasslands, and migrates to South America in the fall (Martin and Gavin 1995). • Breeding distribution is widespread in the Maritimes.	An inland species, and so unlikely to be affected by offshore activities at most times of year. During fall migration, like other nocturnal migrants, there is potential for individuals to be attracted to or disoriented by artificial light sources on the water such as ship lighting.
Short-eared Owl	No status	Special Concern Schedule 1	Special Concern	• Typically nests in coastal barrens and grasslands, and suitable habitat occurs in parts of eastern Nova Scotia. • Possible breeding observed near Louisbourg and St. Ann’s.	Present in coastal areas, primarily during the summer months.

3.2.11.2.1 Other Bird Species of Conservation Concern

The following Table 3-31 lists bird Species of Special Status occurring in the Study Area which are ranked as Vulnerable or lower by the Canadian Endangered Species Conservation Council.

Table 3-31. Bird Species listed as At-Risk, May Be at Risk or Vulnerable by the Canadian Endangered Species Conservation Council

Species			
Common name	**Scientific name**	**Family**	**CESCC-NS Rank[1]**
Piping Plover	*Charadrius melodus*	Charadriidae	At-Risk
Red Knot	*Calidris canutus*	Scolopacidae	At-Risk
Olive-sided Flycatcher	*Contopus cooperi*	Tyrannidae	At-Risk
Common Nighthawk	*Chordeiles minor*	Caprimulgidae	At-Risk
Bobolink	*Dolichonyx oryzivorus*	Icteridae	Vulnerable
Willet	*Tringa semipalmata*	Scolopacidae	May Be At Risk
Great Cormorant	*Phalacrocorax carbo*	Phalacrocoracidae	Vulnerable
Barrow's Goldeneye	*Bucephala islandica*	Anatidae	At-Risk
Killdeer	*Charadrius vociferus*	Charadriidae	Vulnerable
Blue-winged Teal	*Anas discors*	Anatidae	May Be At Risk
Peregrine Falcon	*Falco peregrinus*	Falconidae	Vulnerable
Arctic Tern	*Sterna paradisaea*	Laridae	May Be At Risk
Common Tern	*Sterna hirundo*	Laridae	Vulnerable
Harlequin Duck	*Histrionicus histrionicus*	Anatidae	At-Risk
Rusty Blackbird	*Euphagus carolinus*	Icteridae	May Be At Risk
Short-eared Owl	*Asio flammeus*	Strigidae	May Be At Risk
Barn Swallow	*Hirundo rustica*	Hirundinidae	Vulnerable
Bay-breasted Warbler	*Dendroica castanea*	Parulidae	Vulnerable
Black-backed Woodpecker	*Picoides arcticus*	Picidae	Vulnerable
Spotted Sandpiper	*Actitis macularius*	Scolopacidae	Vulnerable
Wilson's Snipe	*Gallinago delicata*	Scolopacidae	Vulnerable
Tennessee Warbler	*Vermivora peregrina*	Parulidae	Vulnerable
Bank Swallow	*Riparia riparia*	Hirundinidae	May Be At Risk
Pine Grosbeak	*Pinicola enucleator*	Fringillidae	May Be At Risk
Northern Pintail	*Anas acuta*	Anatidae	May Be At Risk
Common Loon	*Gavia immer*	Gaviidae	May Be At Risk
Northern Shoveler	*Anas clypeata*	Anatidae	May Be At Risk
American Golden-Plover	*Pluvialis dominica*	Charadriidae	Vulnerable
Red-necked Phalarope	*Phalaropus lobatus*	Scolopacidae	Vulnerable
Semipalmated Sandpiper	*Calidris pusilla*	Scolopacidae	Vulnerable
Purple Sandpiper	*Calidris maritima*	Scolopacidae	Vulnerable
American Bittern	*Botaurus lentiginosus*	Ardeidae	Vulnerable

Species			
Common name	**Scientific name**	**Family**	**CESCC-NS Rank**[1]
Cape May Warbler	*Dendroica tigrina*	Parulidae	Vulnerable
Gray Jay	*Perisoreus canadensis*	Corvidae	Vulnerable
Blackpoll Warbler	*Dendroica striata*	Parulidae	Vulnerable
Wilson's Warbler	*Wilsonia pusilla*	Parulidae	Vulnerable
Greater Yellowlegs	*Tringa melanoleuca*	Scolopacidae	Vulnerable
Pine Siskin	*Spinus pinus*	Fringillidae	Vulnerable
Tree Swallow	*Tachycineta bicolor*	Hirundinidae	Vulnerable
Ruby-crowned Kinglet	*Regulus calendula*	Regulidae	Vulnerable
Golden-crowned Kinglet	*Regulus satrapa*	Regulidae	Vulnerable
Yellow-bellied Flycatcher	*Empidonax flaviventris*	Tyrannidae	Vulnerable
Boreal Chickadee	*Poecile hudsonicus*	Paridae	Vulnerable
Black-legged Kittiwake	*Rissa tridactyla*	Laridae	Vulnerable
Razorbill	*Alca torda*	Alcidae	Vulnerable
Atlantic Puffin	*Fratercula arctica*	Alcidae	Vulnerable
Red Phalarope	*Phalaropus fulicarius*	Scolopacidae	Vulnerable
Whimbrel	*Numenius phaeopus*	Scolopacidae	Vulnerable
Canada Warbler	*Wilsonia canadensis*	Parulidae	At-Risk
Eastern Kingbird	*Tyrannus tyrannus*	Tyrannidae	Vulnerable
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Cardinalidae	Vulnerable
Gadwall	*Anas strepera*	Anatidae	May Be At Risk
Gray Catbird	*Dumetella carolinensis*	Mimidae	May Be At Risk
Pied-billed Grebe	*Podilymbus podiceps*	Podicipedidae	3
Vesper Sparrow	*Pooecetes gramineus*	Emberizidae	May Be At Risk
Cliff Swallow	*Petrochelidon pyrrhonota*	Hirundinidae	May Be At Risk
Baltimore Oriole	*Icterus galbula*	Icteridae	May Be At Risk
Long-eared Owl	*Asio otus*	Strigidae	May Be At Risk
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Cuculidae	May Be At Risk
Brant	*Branta bernicla*	Anatidae	Vulnerable
Hudsonian Godwit	*Limosa haemastica*	Scolopacidae	Vulnerable
Eastern Wood-Pewee	*Contopus virens*	Tyrannidae	Vulnerable
Turkey Vulture	*Cathartes aura*	Cathartidae	Vulnerable
Great Crested Flycatcher	*Myiarchus crinitus*	Tyrannidae	May Be At Risk
Roseate Tern	*Sterna dougallii*	Laridae	At-Risk
Chimney Swift	*Chaetura pelagica*	Apodidae	At-Risk
Purple Martin	*Progne subis*	Hirundinidae	May Be At Risk
Black Tern	*Chlidonias niger*	Laridae	May Be At Risk
Black-crowned Night-Heron	*Nycticorax nycticorax*	Ardeidae	May Be At Risk
Eastern Meadowlark	*Sturnella magna*	Icteridae	Vulnerable
Eastern Phoebe	*Sayornis phoebe*	Tyrannidae	Vulnerable

Species			
Common name	**Scientific name**	**Family**	**CESCC-NS Rank**[1]
Eastern Bluebird	*Sialia sialis*	Turdidae	Vulnerable
Whip-poor-will	*Caprimulgus vociferus*	Caprimulgidae	At-Risk
Bicknell's Thrush	*Catharus bicknelli*	Turdidae	At-Risk
Willow Flycatcher	*Empidonax traillii*	Tyrannidae	Vulnerable

[1]Canadian Endangered Species Conservation Council (CESCC). Wild Species: The General Status of Species in Canada. National General Status Working Group (www.wildspecies.ca).

3.2.11.3 Marine Mammal Species at Risk and Species of Conservation Concern

3.2.11.3.1 Marine Mammal Species at Risk

A total of five federally listed marine mammal Species at Risk (blue whale-Atlantic population, North Atlantic right whale, northern bottlenose whale-Scotian Shelf population, fin whale-Atlantic population and harbour porpoise-Northwest Atlantic population) are known to occur in the Study Area (Table 3-32). Additional species that may occur in the Study Area include the killer whale (Northwest Atlantic and Eastern Arctic populations), and Sowerby's Beaked whale (Atlantic Ocean), species which are listed by COSEWIC but not under *SARA* (Table 3-32).

Table 3-32. Marine Mammal Species of Special Status that are Known to or May Occur within the Proposed Project Area

Species	Federal Status		CESCC Status (Atlantic Ocean)	Habitat and Distribution	Potential Presence in Project Area
	SARA Listing	COSEWIC Assessment			
Blue Whale - Atlantic Population	Endangered Schedule 1	Endangered	At Risk	• Coastal and pelagic waters; frequently at shelf edge where food production is high (Schoenherr 1991). • Found in all oceans except the Arctic (Reilly et al 2008b). • No critical habitat has been identified for the species.	Present in small numbers throughout the year; most common in the winter and early spring.
Fin Whale - Atlantic Population	Special Concern Schedule 1	Special Concern	Sensitive	• Coastal shelf edge and offshore (COSEWIC 2005). • World-wide distribution; most abundant in temperate and polar latitudes (Reeves et al. 2002) • Summer distribution is typically in areas with high prey concentration (e.g., the Grand Banks).	Present year-round, but likely most common in the summer months.
North Atlantic Right Whale	Endangered Schedule 1	Endangered	At Risk	• Usually found in waters 100 – 200 m deep with surface temperatures between 8 and 15°C (Kenney 2001). • Distribution shifts with prey	Likely to be very rare visitors to the area, primarily in the summer months.

Species	Federal Status		CESCC Status (Atlantic Ocean)	Habitat and Distribution	Potential Presence in Project Area
	SARA Listing	COSEWIC Assessment			
				distribution and abundance. • Aggregate in five seasonal habitat areas along the east coast of North America, including two in Canada: the lower Bay of Fundy and Roseway Basin on the Scotian Shelf. These two areas have been designated as critical habitat for the species (Brown et al 2009).	
Northern Bottlenose Whale, Scotian Shelf population	Endangered Schedule 1 (Scotian Shelf population)	Endangered	Sensitive	• Deep-diving species found in waters 800 - 1500 m deep. • In western North Atlantic, occur from Baffin Island to New England (Taylor et al 2008). • Scotian Shelf population apparently non-migratory. Three marine canyons, all along the Scotian Shelf, have been identified as critical habitat for this population (DFO 2010).	May be present in small numbers in the area year round; most sightings have been in the spring and summer.
Sowerby's Beaked Whale	Special Concern Schedule 1	Special Concern	Sensitive	• Deep-diving species found at continental edges and slopes in depths of 550 - 1500 m or more. • Seasonal movements unknown. • Found in cold North Atlantic waters, from Massachusetts to Labrador (Taylor et al 2008).	May be present year round in deep water habitats.
Killer Whale	none	Special Concern	Sensitive	• Nearshore and pelagic environments. • Cosmopolitan distribution, concentrated in areas of high productivity (Forney and Wade 2006).	Small numbers have been observed in the area at all times of year.
Harbour Porpoise	none	Special Concern	Sensitive	• Coastal shelf, bays and estuaries; occasionally offshore (Hammond et al 2008). • Found in cold waters throughout the northern hemisphere (Hammond et al 2008). • Seasonal movements poorly known.	Fairly common in the study area, possibly present year round.
Beluga	Threatened Schedule 1	Threatened	At Risk	• Generally limited to seasonally ice-covered Arctic and sub-Arctic waters. • The endangered St. Lawrence population represents the southern limit of its distribution worldwide Lesage and Kingsley (1998.	Occurs infrequently in the Study Area, usually as roaming individuals from the St Lawrence Estuary population

No pinniped Species at Risk occur in the vicinity of the Study Area. Locations of whale, dolphin, and porpoise Species at Risk are depicted in Section 3.2.9 Marine Mammals.

3.2.11.4 Sea Turtle Species of Special Status

A single listed sea turtle Species at Risk (Leatherback-Atlantic population) is known to occur in the Study Area (Table 3-33). One additional species that may occur in the Study Area, the loggerhead sea turtle (Atlantic Ocean population), is listed by COSEWIC but not under *SARA* (Table 3-33). Two other sea turtle species, the Kemp's Ridley and the Green Sea Turtle, are not federally listed and have not been assessed by COSEWIC, but are each considered to be globally endangered. These last two species occur very rarely, if at all, in the Study Area.

Table 3-33. Sea Turtle Species of Special Status that are Known to or May Occur within the Proposed Project Area

Species	Federal Status		Habitat and Distribution	Potential Presence in Project Area
	SARA Listing	COSEWIC Assessment		
Leatherback Sea Turtle	Endangered Schedule 1	none	• Typically found in coastal shelf waters with depths of < 200 m. • Range from tropical to sub-polar regions in the Atlantic, Pacific and Indian oceans (COSEWIC 2012). • Undertake extensive migrations between feeding areas and to tropical nesting areas (Wallace 2013). • Critical habitat has not yet been identified. • Three high-use feeding areas are known (DFO 2012b): o 1) waters east and southeast of Georges Bank, including the Northeast Channel near the southwestern boundary of the Canadian Exclusive Economic Zone; o 2) the southeastern Gulf of St. Lawrence and waters off eastern Cape Breton Island, including Sydney Bight, the Cabot Strait, portions of the Magdalen Shallows and adjacent portions of the Laurentian Channel; and o 3) waters south and east of the Burin Peninsula, Newfoundland, including parts of Placentia Bay.	Occur with some regularity in the study area, mainly in summer and fall months
Loggerhead Sea Turtle	none	Endangered	• Found in oceanic and near-shore zones of temperate and tropical Atlantic, Pacific and Indian Oceans. (COSEWIC 2010). • Nest on beaches in subtropical and tropical climates. • In Atlantic Canada, most abundant in spring to fall, and generally associated with the Gulf Stream.	Uncommon; most frequently observed in the spring to summer months.

3.2.12 Protected and Special Areas

In Canada, unique or sensitive environments may be designated as protected through federal, territorial or provincial legislation, with areas sometimes also protected and/or managed by municipal or Aboriginal governments. These special places may be set aside to protect important or sensitive species and habitats, as representative natural areas, for cultural or historical reasons, and/or for human use and enjoyment.

This section describes various types of existing and proposed protected and identified sensitive areas in and surrounding the Study Area, beginning with marine and coastal protected and special areas followed by protected land areas. The descriptions presented are based on data obtained from Fisheries and Oceans Canada, Parks Canada, Environment Canada, the Province of Nova Scotia as well as other sources.

3.2.12.1 Management of Marine Protected and Special Areas in Canada

The government of Canada has economic, social and ecological interests in protecting marine and coastal area of the country. Various pieces of legislation are used to conserve Canada's marine ecosystems to ensure their sustainability as an economic resource, a food source and the principal industry of a number of communities. The Fisheries Act, the Oceans Act, the National Marine Conservation Areas Act, the Species at Risk Act and the Canadian Environmental Assessment Act are used to manage marine environments and to reduce the effects of human activities upon them. The following sections discuss Canada's management framework and specific measures used to provide protection in marine and coastal areas.

3.2.12.2 Bioregions and Large Ocean Management Areas

Canada's Oceans Strategy (2002) outlines the federal government's commitment to marine conservation through integrated management. Fisheries and Oceans Canada (DFO) has defined 13 bioregions as the ecological base for ocean management decisions. Eastern Canada is encompassed by three bioregions: The Gulf, the Scotian Shelf and Newfoundland and Labrador Shelves. Within these bioregions, DFO has identified five priority large ocean management areas (LOMA) that exhibits important living and non-living marine resources, areas of high biological diversity and productivity as well as increasing development pressures and competition for ocean space and resources. Conservation strategies in these areas involve an integrated planning approach from all levels of government, Aboriginal groups, industry organizations, environmental and community groups and academia (DFO 2002 [Canada's Ocean Strategy]; DFO 2005 [Canada's Oceans Plan]).

The Study Area borders on two LOMAs: Gulf of St. Lawrence and Eastern Scotian Shelf. The Gulf of St. Lawrence Integrated Management Plan aims to manage human activities among multiple user groups while conserving sustainable ocean resources (DFO 2013 [Gulf of St. Lawrence Integrated Management Plan]). The Eastern Scotian Shelf Integrated Management Initiative is developing a long-term strategic plan for integrated, ecosystem-based and adaptive ocean management (DFO 2014 [Eastern Scotian Shelf Integrated Management Initiative]). DFO has also identified smaller scale integrated Coastal Management Areas (CMAs) and local committees are working to develop capacity for dealing with local and regional issues. The Government of Nova

Scotia and other stakeholders have developed a Draft Coastal Strategy for Nova Scotia (PNS 2011 [Coastal Management in Nova Scotia]).

3.2.12.3 Ecologically and Biologically Significant Areas

Along with protected areas established through legislation, DFO has also defined Ecologically and Biologically Significant Areas (EBSAs) within LOMAs (Figure 3-31). This was achieved by ranking candidate areas using criteria of fitness consequence, aggregations, uniqueness, naturalness and resilience. A number of coastal (Hastings *et al.* 2014), and offshore (DFO 2014 [Offshore Ecologically and Biologically Significant Areas in the Scotian Shelf Bioregion]) EBSAs are located entirely or partially within the Study Area, as summarized in Table 3-34 and Table 3-35. Benthic EBSAs were discussed in Section 3.2.6.

Table 3-34 Coastal ESBAs within the Study Area, with discussion of Uniqueness, Aggregation and Fitness Consequence Characteristics (From Hastings *et al.* 2014).

Coastal EBSAs (Number on Map)	Uniqueness	Aggregation	Fitness consequences
Cabot Strait (between Cape North and St. Paul Island) (39)	• The scale of the migrations through Cabot Strait is unparalleled in Canada. • The long distance between the mainland and St. Paul Island is rare in Nova Scotia. • St. Paul is a potentially unique island ecosystem.	• Important summer habitat for Atlantic Cod (Endangered – COSEWIC), American Plaice (Threatened – COSEWIC), redfish (Endangered/Threatened – COSEWIC), Atlantic Wolffish (Special Concern – SARA), White Hake (Threatened – COSEWIC) and Witch Flounder. • Area of high finfish species richness compared to the rest of the Scotian Shelf. • Significant at-sea aggregations of shallow-diving coastal piscivorous birds (*e.g.* loon and grebe spp., cormorant spp.), shallow-diving piscivore/generalists (*e.g.* large gull spp., skua and jaeger spp., Black-legged Kittiwake, tern spp.), pursuit-diving piscivores (*e.g.* Razorbill, Atlantic Puffin, murre spp.), pursuit-diving planktivores (*e.g.* Dovekie), shallow pursuit generalists (*e.g.* shearwaters), surface-seizing planktivores (*e.g.* Wilson's Storm-petrel, phalarope spp.), plunge-diving piscivores (*e.g.* Northern Gannet), and ship-following generalists (*e.g.* Northern Fulmar). • *Nationally significant* numbers of	• Larval American Plaice (Threatened – COSEWIC), Atlantic Cod (Endangered – COSEWIC), redfish (Endangered/Threatened – COSEWIC), and Atlantic Mackerel observed in the area. • Mackerel eggs observed in the area. • Part of the Gulf of St. Lawrence important habitat area for Leatherback Turtle (Endangered – SARA). • Important cetacean migratory corridor. • Blue Whale (Endangered – SARA) and Fin Whale (Special Concern – SARA) migrate through Cabot Strait. • Potentially significant Leach's Storm-petrel colony on St. Paul Island. • **Ecologically Significant Species and Community Properties =Type 1 (Species with a crucial trophodynamic role):** Atlantic Cod, Atlantic Wolffish. • Designated Areas: IBA NS032 St. Paul Island

Coastal EBSAs (Number on Map)	Uniqueness	Aggregation	Fitness consequences
		Bicknell's Thrush on St. Paul Island.	
Western Sydney Bight (36)	• Unique bathymetric feature (The Gutter).	• Important summer habitat for Atlantic Cod (Endangered – COSEWIC), American Plaice (Threatened – COSEWIC), Smooth Skate (Special Concern – COSEWIC), Thorny Skate (Special Concern – COSEWIC), White Hake (Threatened – COSEWIC), Atlantic Herring, and Witch Flounder. • Area of high finfish species richness compared to the rest of the Scotian Shelf. • Significant at-sea aggregations of shallow-diving coastal piscivores (*e.g.* loon and grebe spp., cormorant spp.), shallow-diving piscivore/generalists (*e.g.* large gull spp., tern spp., skua and jaeger spp., Black-legged Kittiwake), pursuit-diving piscivores (*e.g.* Razorbill, Atlantic Puffin, murre spp.), pursuit-diving planktivores (*e.g.* Dovekie), shallow pursuit generalists (*e.g.* shearwaters), surface-seizing planktivores (*e.g.* Wilson's Storm-petrel) and plunge-diving piscivores (*e.g.* Northern Gannet).	• Larval American Plaice (Threatened – COSEWIC), Atlantic Cod (Endangered – COSEWIC), redfish (Endangered/Threatened – COSEWIC), Atlantic Herring, Atlantic Mackerel, and Longhorn Sculpin observed in the area. • Part of the Gulf of St. Lawrence important habitat area for Leatherback Turtle (Endangered – SARA). • **Ecologically Significant Species and Community Properties =Type 1 (Species with a crucial trophodynamic role):** Atlantic Herring, Atlantic Cod.
Aspy Bay (38)		• Cape North hosts globally significant numbers of Bicknell's Thrush (Threatened – SARA). • Significant at-sea aggregations of shallow-diving coastal piscivores (*e.g.* loon and grebe spp., cormorant spp.), shallow-diving piscivore/generalists (*e.g.* large gull spp., skua and jaeger spp., Black-legged Kittiwake, tern spp.), pursuit-diving piscivores (*e.g.* Razorbill, Atlantic Puffin, murre spp.), pursuit-diving planktivores (*e.g.* Dovekie), shallow pursuit generalists (*e.g.* shearwaters), surface-seizing planktivores (*e.g.* Wilson's Storm-petrel), plunge-diving piscivores (*e.g.* Northern Gannet), and ship-	• Significant Great Blue Heron colony. • Overwintering aggregation of Atlantic Herring. • Breeding and feeding area for whales. • North Harbour Beach and South Harbour Beach are Piping Plover critical habitat (Endangered – SARA). • North Aspy River is an important spawning river for Atlantic Salmon (Endangered – COSEWIC). (Lagoon ecosystems are known to provide important juvenile fish habitat) • Resilience: Lagoons are innately vulnerable to human disturbance

Coastal EBSAs (Number on Map)	Uniqueness	Aggregation	Fitness consequences
		following generalists (*e.g.* Northern Fulmar). • Significant areas of salt marsh in lagoon areas. • Significant areas of eelgrass in lagoon areas. • (Lagoons are known to be one of the most highly productive ecosystems on the planet)	and environmental variability. • **Ecologically Significant Species and Community Properties =Type 1 (Species with a crucial trophodynamic role):** Atlantic Herring. • Protected Areas: o Lily Pond Beach o South Harbour Beach o South Harbour Beach Piping Plover Critical Habitat o Middle Harbour Beach o North Harbour Beach o North Harbour Beach Piping Plover Critical Habitat o Cabot's Landing Provincial Park • Designated Areas o IBA NS030 Cape North • Conservation easements/ENGO lands/joint venture lands o Yellow Head
Ingonish Bays (37)		• Significant aggregations of merganser spp.	• The Ingonish River and Clyburn Brook watersheds, both draining into the Ingonish Bays, support spawning Atlantic Salmon (Endangered – COSEWIC). • Breeding and feeding area for whales. • Globally significant numbers of nesting Great Cormorant on Ingonish Island. • Significant colonies of Great Black-backed Gull and Herring Gull. • Protected Areas: o Cape Breton Highlands National Park o North Bay Beach o Ingonish Lighthouse National Historic Site • Designated Areas: o IBA NS055 Ingonish Island o IBA NS056 Cape Breton Highlands National Park
Bird Islands (35)	• Highest	• High concentration (relative to the	• Nursery area for Atlantic Cod

Coastal EBSAs (Number on Map)	Uniqueness	Aggregation	Fitness consequences
	concentrations of Black-legged Kittiwake, Razorbill, and Atlantic Puffin in Nova Scotia - all provincially rare species.	rest of Sydney Bight) of Winter Skate (Threatened – COSEWIC). • High concentrations (relative to the rest of Sydney Bight) of Common Starfish, Rock Crab, scallop, Winter Flounder, Shorthorn Sculpin, Longhorn Sculpin. • High diversity of marine birds in high abundances.	(Endangered – COSEWIC) and White Hake (Threatened – COSEWIC). • Overwintering area for the Bras d'Or Lakes population of Atlantic Herring. • Possible overwintering area for American Lobster. • Largest known colony of Great Cormorant in North America (globally significant numbers of nesting birds). • Significant colonies of Razorbill, Herring Gull, Great Black-backed Gull, and tern spp. • Roosting and feeding area for the Bald Eagle. • **Ecologically Significant Species and Community Properties** o Type 1 (Species with a crucial trophodynamic role): Atlantic Herring Atlantic Cod American Lobster. o Type 4 (Species posing a threat to ecosystem structure): Grey Seal. • Protected Areas: o Bird Islands Wildlife Management Area • DESIGNATED AREAS: o IBA NS001 Bird Islands o Site of Ecological Significance (Bird Islands) • Conservation easements/ENGO lands/joint venture lands o Hertford Island
Indian Bay-Lingan Bay (34)		• Significant aggregations of American Black Duck, merganser spp., scaup spp., and goldeneye spp. • Significant at-sea aggregations of shallow-diving coastal piscivores (loon and grebe spp., cormorant spp.), shallow-diving piscivore/generalists (large gull spp., tern spp.), surface-seizing planktivores (*e.g.* Wilson's Storm-	• There is an Atlantic Herring spawning and overwintering area just offshore of Indian Bay. • (Lagoon ecosystems are known to provide important juvenile fish habitat). • Dominion Beach is Piping Plover (Endangered – SARA) critical habitat. • The Northwest Brook watershed,

Coastal EBSAs (Number on Map)	Uniqueness	Aggregation	Fitness consequences
		petrel, Red Phalarope) and plunge-diving piscivores (*e.g.* Northern Gannet). • (Lagoons are known to be one of the most highly productive ecosystems on the planet). • Significant areas of salt marsh in lagoon area. • Moderate eelgrass coverage	draining into Lingan Bay, has been known to support spawning Atlantic Salmon (Endangered – COSEWIC). • Lagoons are innately vulnerable to human disturbance and environmental variability • **Ecologically Significant Species and Community Properties** o Type 1: Species with a crucial trophodynamic role: Atlantic Herring (known importance just outside of Lingan Bay-Indian Bay EBSA). • Protected Areas: o Dominion Beach o Dominion Beach Provincial Park o Dominion Beach Piping Plover Critical Habitat
Big Glace Bay (33)		• Significant aggregations of American Black Duck, merganser spp., scaup spp., and goldeneye spp. • (Lagoons are known to be one of the most highly productive ecosystems on the planet). • Significant areas of salt marsh in lagoon area. • Moderate eelgrass coverage.	• Significant numbers of Canada Goose use Big Glace Bay Lake as a staging area during migration. • (Lagoon ecosystems are known to provide important juvenile fish habitat). • There is an Atlantic Herring spawning and overwintering area just offshore of Big Glace Bay. • Glace Bay Bar is Piping Plover (Endangered – SARA) critical habitat. • The MacAskill's Brook watershed, draining into Big Glace Lake, has been known to support spawning Atlantic Salmon (Endangered – COSEWIC). • Resilience:Lagoons are innately vulnerable to human disturbance and environmental variability. • importance for ESSCPs • **Ecologically Significant Species and Community Properties** o Type 1: Atlantic Herring (known importance just outside of Big Glace Bay EBSA). • Protected Areas:

Coastal EBSAs (Number on Map)	Uniqueness	Aggregation	Fitness consequences
			o Big Glace Bay Lake Migratory Bird Sanctuary o Glace Bay Beach o Glace Bay Bar Piping Plover Critical Habitat • Designated Areas: o IBA NS007 Big Glace Bay Lake
Morien Bay (32)	• One of five known Black-legged Kittiwake colonies in Nova Scotia. Black-legged Kittiwake is a provincially rare species.	• Port Morien Beach hosts one of the highest concentrations of Red Knot rufa ssp. (Endangered – SARA) in the Atlantic coast sub-region. • Port Morien Beach supports the highest numbers and diversity of shorebirds in Cape Breton. • Significant aggregations of Canada Goose and overwintering Common Eider. • Aggregations of Harlequin Duck (Special Concern – SARA) occur in the area during winter. • (Lagoons are known to be one of the most highly productive ecosystems on the planet). • Significant areas of salt marsh in the lagoon area. • Significant areas of eelgrass in the lagoon area	• Lagoon ecosystems are known to provide important juvenile fish habitat). • Globally significant numbers of nesting Great Cormorant on Northern Head and South Head. • Significant tern spp. colony. • Resilience:Lagoons are innately vulnerable to human disturbance and environmental variability • **Ecologically Significant Species and Community Properties** o Type 2 (Structure-providing species): Eelgrass • Protected Areas: o Port Morien Beach o Port Morien French Mine Site o Nova Scotia Coal Fields (Sydney) National Historic Site o Schooner Pond Beach • Designated Areas o IBA NS053 Northern Head and South Head • Conservation Easements/ENGO Lands/Joint Venture Lands o Wadden’s Cove o South Port Morien
Scaterie Island (31)		• Significant aggregations of scoter spp. • Significant aggregations of overwintering Common Eider in the general area. • Significant at-sea aggregations of shallow-diving coastal piscivores (cormorant spp.), shallow-diving piscivore/generalists (large gull spp., tern spp. Black-legged Kittiwake), pursuit-diving piscivores (*e.g.* murre	• Largest breeding Grey Seal colony in the Atlantic coast sub-region. • Potentially significant Leach’s Storm-petrel colony. • Significant Great Black-backed Gull colony. • Nationally significant numbers of nesting Bicknell’s Thrush (Threatened – SARA). • **Ecologically Significant Species and Community Properties**

Coastal EBSAs (Number on Map)	Uniqueness	Aggregation	Fitness consequences
		spp., Razorbill), shallow pursuit generalists (*e.g.* shearwaters), surface-seizing planktivores (*e.g.* Wilson's Storm-petrel) and plunge-diving piscivores (*e.g.* Northern Gannet). • Diverse coastal habitats	o Type 4: Grey Seal. • Protected Areas: o Scatarie Island Wilderness Area o Scatarie Island Wildlife Management Area • Designated Areas: o IBA NS052 Scatarie Island
Portnova Islands (30)	• Significant aggregations of overwintering Common Eider in the general area	• Globally significant numbers of nesting Great Cormorant. • Significant Great Black-backed Gull colonies.	• Designated Areas: o IBA NS006 Portnova Islands
Islet off of Baleine (29)	• One of five known Black-legged Kittiwake colonies in Nova Scotia. Black-legged Kittiwake is a provincially rare species	• Significant aggregations of overwintering Common Eider in the general area.	
Harbour Rock (28)		• Significant aggregations of overwintering Common Eider in the general area.	• Globally significant numbers of nesting Great Cormorant. • Significant colonies of Great Black-backed Gull. • Designated Areas : o IBA NS049 Harbour Rocks
Green Island (27)	• One of five known Black-legged Kittiwake colonies in Nova Scotia. Black-legged Kittiwake is a provincially rare species.	• Significant aggregations of overwintering Common Eider in the general area.	• Significant colonies of Great Black-backed Gull and tern spp.
Guyon Islands (26)		• Significant aggregations of overwintering Common Eider in the general area.	• Significant colonies of Great Black-backed Gull and tern spp.
Rocks of Cape Fourchu (25)		• Significant aggregations of overwintering Common Eider in the general area.	• Globally significant numbers of nesting Great Cormorant. • Designated Areas: o IBA NS047 Rocks off Fourchu Head
Point Michaud and Basque		• Among the most significant shorebird areas in Cape Breton due	• Globally significant numbers of nesting Great Cormorant.

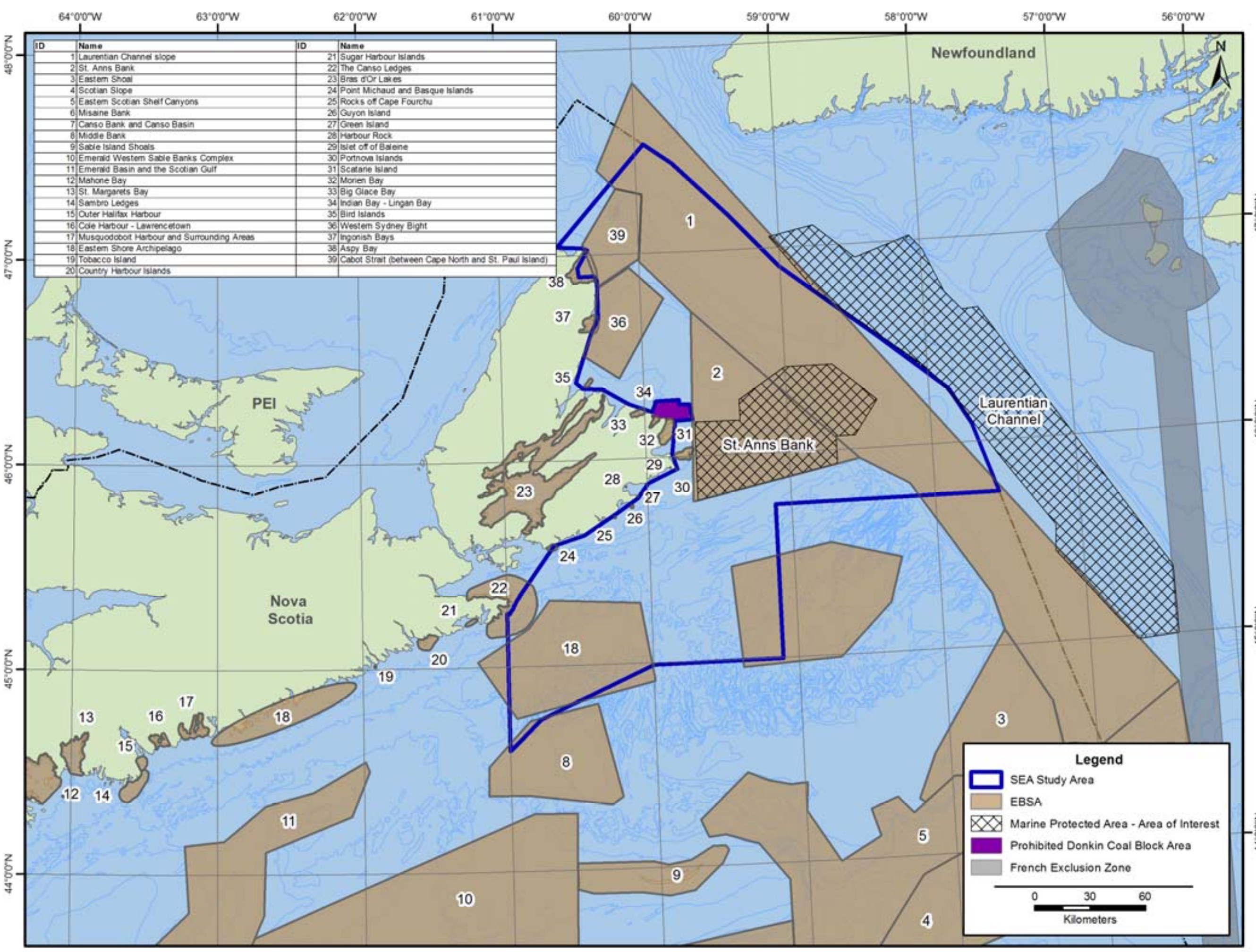
Coastal EBSAs (Number on Map)	Uniqueness	Aggregation	Fitness consequences
Islands (24)		to the diversity of species present. • Significant aggregation of overwintering Purple Sandpiper. • Significant aggregations of overwintering Common Eider in the general area.	• Significant Great Black-backed Gull colonies. • Protected Areas : o Point Michaud Beach • Designated Areas: o IBA NS045 Basque Islands and Point Michaud o Site of Ecological Significance (Point Michaud)
The Canso Ledges (part) (22)	• Chedabucto Bay is unique in its size and depth. • Tongue of deep water on northern shore of peninsula. • Rare coastal habitat for Northern Shrimp.	• The mouth of Chedabucto Bay has been noted for its abundance and diversity of fish. • Historic importance for Atlantic Cod (Endangered – COSEWIC). May still be important area for this species. • Aggregations of Atlantic Wolffish (Special Concern – SARA), Thorny Skate (Special Concern – COSEWIC), and Winter Skate (Threatened – COSEWIC). • Inshore concentration of Fin Whale (Special Concern – SARA). • Significant aggregations of scoter spp., merganser spp., American Black Duck, Common Eider, and Purple Sandpiper. • Significant at-sea aggregations of shallow-diving coastal piscivores (*e.g.* cormorant spp., loon and grebe spp.), pursuit-diving piscivores (*e.g.* murre spp.), shallow pursuit generalists (shearwater spp.), surface-seizing planktivores (*e.g.* Wilson's Storm-petrel), pursuit-diving planktivores (*e.g.* Dovekie), and plunge-diving piscivores (*e.g.* Northern Gannet). • High concentrations of rockweeds (*Fucus* spp.) • Because of its strong depth gradient, the area is a hotspot for invertebrate diversity. • Medium-high productivity predicted for Louse Harbour based on its geophysical characteristics.	• Potentially important juvenile areas for sand lance spp., hake spp., and Grubby. • Formerly a significant spring and fall spawning area for Atlantic Herring. • Overwintering area for Atlantic Herring. • Significant tern spp., Great Black-backed Gull, and Herring Gull colonies. • **Ecologically Significant Species and Community Properties** o Type 1 (Species with a crucial trophodynamic role): Atlantic Herring, Atlantic Cod, Atlantic Wolffish. o Type 2 (Structure-providing species): Rockweed. • Protected Areas o Canso Coastal Barrens Wilderness Area o Grassy Island National Historic Park o Fox Island Main Beach o Lower Half Island Cove Beach o Lower Half Island Cove Beach o Half Island Cove Beach o Queensport Beach

Table 3-35 Offshore ESBAs within the Study Area (DFO 2014)

Offshore EBSAs	
Laurentian Channel (11648 km^2)	• High primary productivity, • High zooplankton biomass, • Important for groundfish (overwintering area for Atlantic Cod and other species, such as redfish, white hake), • Abundant redfish larvae, • High fish biomass, sandlance, • Migratory route (groundfish, cetaceans, leatherback sea turtle), • Sensitive benthic communities (sea pen fields), • High invertebrate species diversity (evenness), • High small fish and small invertebrate species richness
St. Anns Bank (4,661 km^2)	• High primary productivity, • High larval fish genus richness, • Important for groundfish (used by three populations of Atlantic cod, also[3] Atlantic wolffish), • High fish and invertebrate species diversity (ESW[1], evenness), • High small fish species richness, • Located on a migratory route (groundfish, cetaceans, leatherback sea turtle), • Sensitive benthic communities (sea pen fields), • Important for seabirds (particularly plunge diving piscivores)
Canso Bank and Canso Basin (4,113 km^2)	• High fish species diversity (ESW[1], evenness), • High invertebrate species diversity (ESW[1]), • High larval fish genus richness, • High invertebrate biomass, • High small fish species richness, • Commercial (northern shrimp, snow crab) and non-commercial invertebrates, • High primary productivity, • Important for groundfish (American plaice), sandlance, • Relatively high naturalness (bank portion), • Important seabird habitat (several functional guilds)
12. Misaine Bank (4,599 km^2) (a portion of this EBSA lies within the SEA Study Area)	• High fish species diversity (evenness), • High invertebrate species diversity (ESW[1], evenness), • High invertebrate biomass, important for commercial invertebrates (Northern Shrimp, Snow Crab), • Important for groundfish (Atlantic cod, American plaice, thorny skate), sandlance, • Relatively high naturalness (bank portion), • Important seabird habitat (particularly pursuit diving piscivores)
10. Middle Bank (2,748 km^2) (a small portion of this EBSA lies within the SEA Study Area)	• Important for groundfish (Atlantic cod spawning and nursery area), • High larval fish genus richness, • High invertebrate species diversity (ESW[1], evenness), • High small fish species richness, • High invertebrate biomass, • Important seabird habitat (most functional guilds)

[3] Exponential of Shannon-Weiner Index

Figure 3-31 Coastal and Offshore Ecologically and Biologically Significant Areas (EBSAs) within and adjacent to the Study Area (Hastings *et al*. 2014, DFO 2014).



3.2.12.4 Marine Protected Areas (MPAs) and Areas of Interest (AOI)

Fisheries and Oceans Canada (DFO) is mandated with establishing a network of Marine Protected Areas through Canada's Oceans Act. A Marine Protected Area (MPA) designation provides protection for marine ecosystems and their resources in areas that are ecologically significant, with species and/or properties that require special consideration. The first step in MPA establishment is the identification of Areas of Interest (AOI), which then undergo detailed evaluation and public consultation before a decision is made concerning formal designation. St. Ann's Bank AOI is located entirely within the Study Area and a portion of the Laurentian Channel AOI is located very near the Study Area (Table 3-36, Figure 3-32). These AOIs have been identified due to the presence of unique, rare or endangered species or their ability to support high productivity or habitat diversity (DFO 2014).

Table 3-36 Marine Protected Areas (Areas of Interest) in the Study Area

Name/Location	Description/Special Features	Conservation Status
St. Ann's Bank AOI/Atlantic Ocean East of Cape Breton Island	Habitat types range from shallow waters of the Bank to deeper waters of the Laurentian Channel, which is a migration corridor for many fish and marine mammal species Sensitive ocean bottom habitats and species, such as corals and sponges High diversity of fish species. Important habitat for Species At Risk (*e.g.* Atlantic wolffish), depleted species (*e.g.* Atlantic cod) and several commercial species with low biomass levels (American plaice, white hake, redfish, witch flounder) Summer foraging area for Endangered leatherback sea turtle	Identified as a MPA area of interest in June 2011 Existing fisheries and other activities are permitted during designation process Proposed new industrial activities will be planned with consideration of ecological importance of the area
Laurentian Channel AOI/Atlantic Ocean from Gulf of St. Lawrence to Continental Shelf off Newfoundland	Deep submarine valley that provides a critical migration route for marine mammals moving in and out of the Gulf of St. Lawrence. Important spawning, nursery and feeding area for a variety of species including porbeagle shark and	Identified as a MPA area of interest in June 2010. MPA will likely protect a portion of the large (estimated 17,950 km^2) AOI.

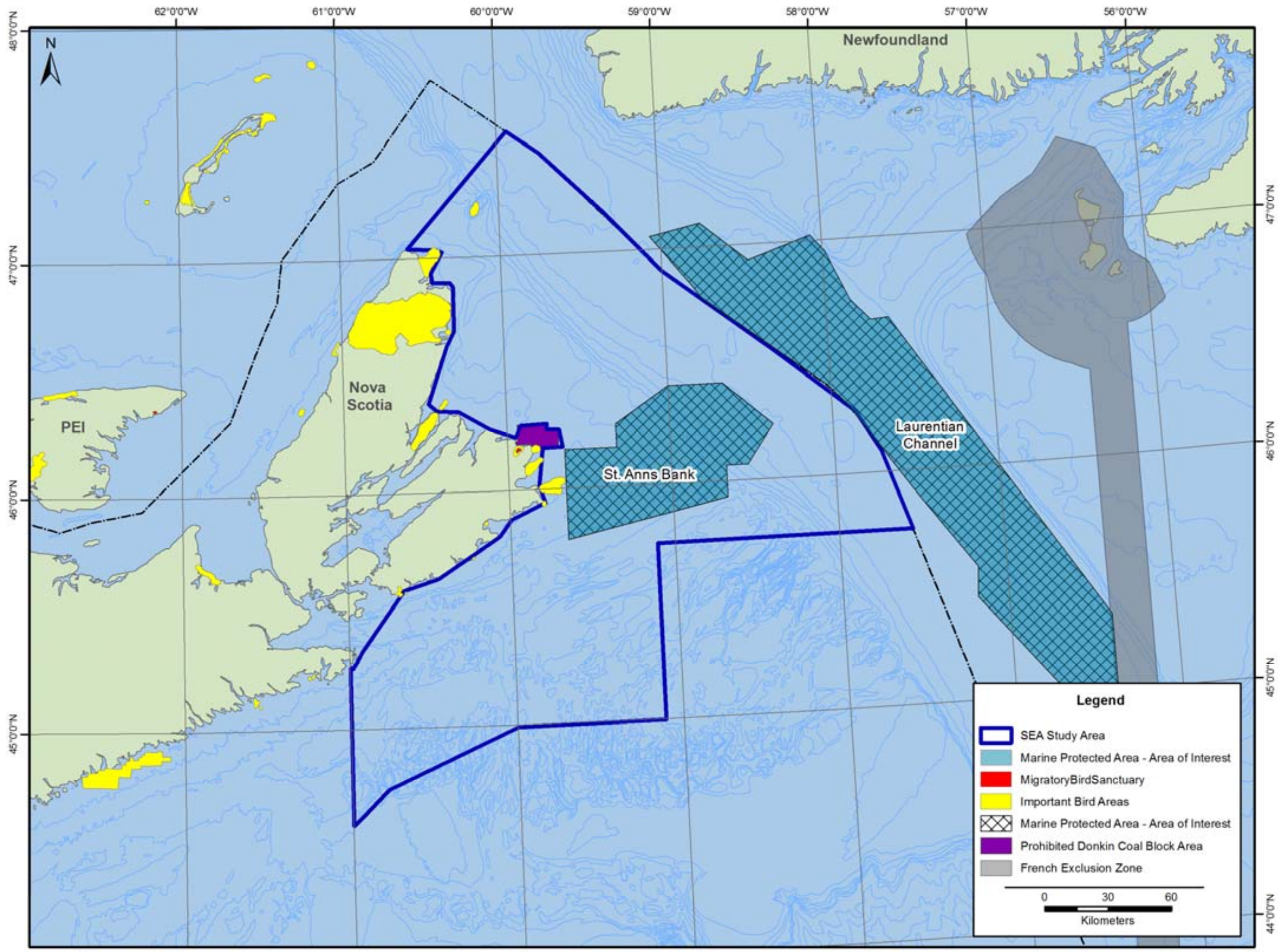
Name/Location	Description/Special Features	Conservation Status
	smooth skate. Contains the highest concentration of black dogfish in Canadian waters and is the only place where pupping occurs. Home to several Species At Risk, including northern wolffish, blue whale and leatherback sea turtle.	

3.2.12.5 National Marine Conservation Areas (Preliminary Representative Marine Areas)

Parks Canada establishes National Marine Conservation Areas (NMCAs) under the Canada National Marine Conservation Areas Act. NMCAs are marine areas managed for ecologically sustainable use and contain smaller zones of protection. NMCAs include the seabed, the water column above it and may also take in wetlands, estuaries, islands and other coastal lands. Conservation is the principal goal of NMCA protection but traditional fishing activities are permitted (PC 2013 [Canada's National Marine Conservation Areas System Plan]; PC 2014 [Creating New National Marine Conservation Area of Canada]). No NMCAs have yet been established in the Study Area or elsewhere in Atlantic Canada.

Parks Canada's long term goal is to establish at least one national marine conservation area in each of its 29 Marine Regions that encompass all of Canada's coastlines including the Great Lakes. To achieve this, the agency has begun a process of identifying preliminary Representative Marine Areas (RMAs). Along with scientific study, formal establishment is subject to consultations with governments, stakeholders and the public. The Study Area meets the boundaries of Region 9 Scotian Shelf and is adjacent to Region 6 Magdelan Shallows (PC 2013 [Canada's National Marine Conservation Areas System Plan], PC 2014 [Creating New National Marine Conservation Areas of Canada]).

Figure 3-32 Areas of Interest as Potential Marine Protected Areas



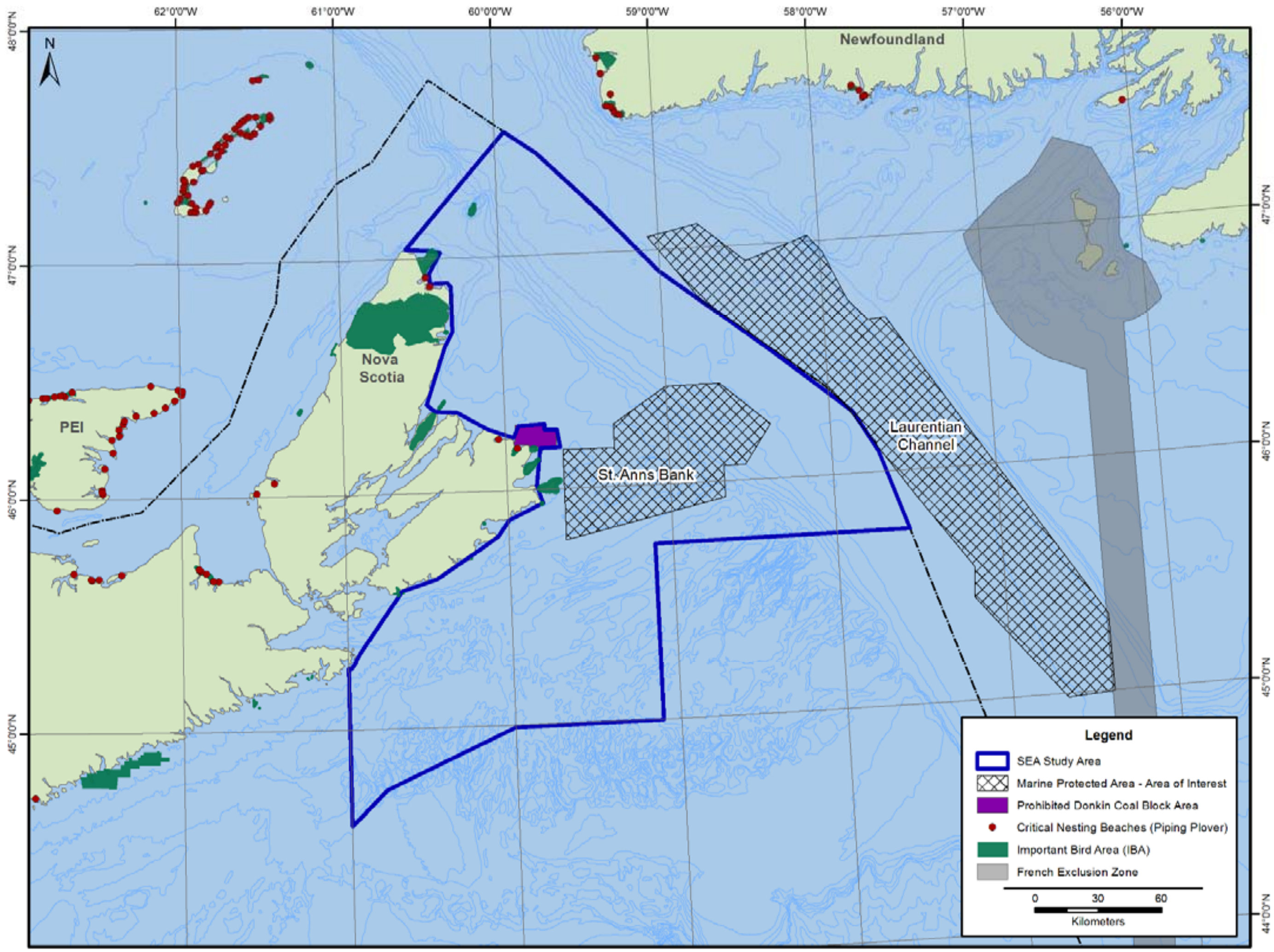
3.2.12.6 National Wildlife Areas and Migratory Bird Sanctuaries

Through the Canada Wildlife Act, the Government of Canada has established 54 National Wildlife Areas on federally owned lands for the purposes of wildlife conservation, research and interpretation. These areas, some of which are relatively undisturbed, protect approximately one million hectares of nationally significant plant and animal habitats, with nearly half of the total area protecting marine habitats (EC 2015 [National Wildlife Areas]). Nova Scotia has six national wildlife areas; none of which are located in the Study Area.

In 1994, the Canada Wildlife Act was amended to allow identification of Marine Wildlife Areas (MWAs) beyond the 12 nautical mile territorial sea limit out to the 200 nautical mile Exclusive Economic Zone limit. No MWAs have yet been identified, but several candidate sites are currently being evaluated in Canada (EC 2015 [Protected Areas]).

Environment Canada has also established 92 Migratory Bird Sanctuaries (MBS) that provide marine and terrestrial habitat for migratory birds. The Migratory Bird Sanctuary Act and Regulations prohibit the taking, injuring or destruction of migratory birds or their nests or eggs, and hunting migratory species, within a Migratory Bird Sanctuary. Eight MBS have been established in Nova Scotia. (EC 2015) Big Glace Bay Lake Migratory Bird Sanctuary (Figure 3 27) is located within 10 km of the Study Area.

Figure 3-33 Protected and Special Areas for Marine Birds



3.2.12.7 Provincial Parks and Protected Areas

The Province of Nova Scotia establishes and manages a network of provincial parks, each of which is designed to fulfill various recreational, tourism, research and educational goals. The Parks and Recreation Division of the Renewable Resources Branch of the Department of Natural Resources is responsible for administering these parks through the Parks Act and Trails Act (NSDNR 2013). The Protected Areas Branch of Environment and Labour administers the protected areas program which plays an integral role in protecting the Nova Scotia's natural heritage (NSDEL 2014).

In 2013, the Province of Nova Scotia published an updated parks and protected areas system plan with an objective of providing legal protection for at least 12 percent of Nova Scotia's total landmass by 2015. This plan included adding new provincial parks, wilderness areas and nature reserves as well as expanding existing provincial parks, wilderness areas and nature reserves. As of June 2015, the province has achieved legal protection for 43 additional land parcels in wilderness areas and nature reserves under the new plan (PNS 2013, PNS 2015).

Six existing provincial parks and protected areas are located within the Study Area (Figure 3-34). These areas, which are listed and described briefly in Table 3-37, include marine and coastal parks and protected areas. In addition, 33 other parks and protected areas including portions of 15 provincial parks, 11 wilderness areas, four nature reserves, two land trusts and a national park are located within a 10 km buffer of the Study Area (PNS 2013 [Andrews Island Provincial Park], PNS 2015 [Cape Smokey Provincial Park], NSDEL 2015 [Protected Areas], PNS 2015 [Our Parks and Protected Areas]).

Table 3-37. Provincial Parks and Protected Areas in the Study Area

Park Name	Location/Status	Purpose/Usage
Andrews Island Provincial Park Reserve	A coastal island off the community of Canso in Guysborough County Majority of land in Crown ownership and managed as a supporting park	Representation of two ecosections. Outstanding concentric raised bog and coastal barren Shoreline access for canoeing and kayaking
Cape Smokey Provincial Park	Top of Smokey Mountain on Cabot Trail near Ingonish, Victoria County	Rest stop and scenic viewing area for travelers on Cabot Trail and Cape Breton Highlands National Park. A 10 km trail provides landscape views and photo opportunities
Gabarus Wilderness Area	South side of Cape Breton Island near Louisbourg, Cape Breton County	Includes a stretch of the Atlantic coastline associated with typical coastal features: boulder, cobble and barrier beaches, lagoons and dune complexes
Scatarie Island Wilderness Area	An island off the community of Main-a-Dieu, Cape Breton County Provincial wildlife management area, with regulations to permit waterfowl and deer hunting, but prohibit hunting	Interior supports coastal spruce-fir forest, perimeter and a small island consists of exposed coastal bog and barren complexes, cliffs, headlands and beaches Hosts a variety of rare or unusual flora, generally

Park Name	Location/Status	Purpose/Usage
	or trapping of fur-bearing mammals and upland fauna	adapted to cool climate, coastal exposure, and associated site conditions Scatarie Island, Main-a-Dieu Important Bird Area Coastal hiking, picnicking and sea kayaking with several summer cottages
Basque Islands Nature Reserve (Pending)	Coastal islands off Point Michaud, Richmond County New nature reserve pending designation	Seabird nesting colonies including Great Cormorant and Common Eider species Basques Islands and Michaud Point Important Bird Area Bird watching
Fourchu Coast Wilderness Area (Pending)	Coastal area near Fourchu, Richmond County New nature reserve pending designation	Relatively remote and large tract of coastal land including sand and barrier beaches, dunes, islands, tidal flats and low cliffs. Coastal spruce/fir rain forest with extensive wetland complexes. Representative of Fourchu Till Cliffs and Beaches Natural Landscape Regionally important staging and nesting areas for shorebirds, waterfowl and seabirds. Provincially vulnerable and national species of special concern New Jersey rush Sea kayaking and canoeing, bird watching and coastal hiking, hunting, fishing and trapping

3.2.12.8 National Parks, Historic Sites and Other Protected Areas

Parks Canada establishes National Parks and National Historic Sites under the *Canada National Parks Act*. National Parks are created to protect representative examples of Canada's 39 terrestrial natural regions, while national historic sites commemorate persons, places and events determined to be of national historic significance. A portion of Cape Breton Highlands National Park is located within 10 km of the Study Area (Figure 3-34 and Table 3-38). No national historic sites are located within the Study Area but six are located within 10 km (NSDEL 2015). These include Canso Islands, Fortress of Louisbourg, Grassy Island Fort, Marconi National Historic Site, Royal Battery and Wolfe's Landing.

Cape Breton Highlands National Park, which includes an area of 950 km2, is one of the largest protected wilderness areas in Nova Scotia. The Park is known for its upland and ocean scenery as well as being the location of the Cabot Trail, a scenic highway that partially runs through the Park. As the Park is partially located on the coast, it includes intertidal zones and marine habitats from Neil's Harbour to Ingonish Beach on the Atlantic Ocean and from Pleasant Bay to Petit Etang in the Gulf of St. Lawrence (PC 2012, PNS 2015).

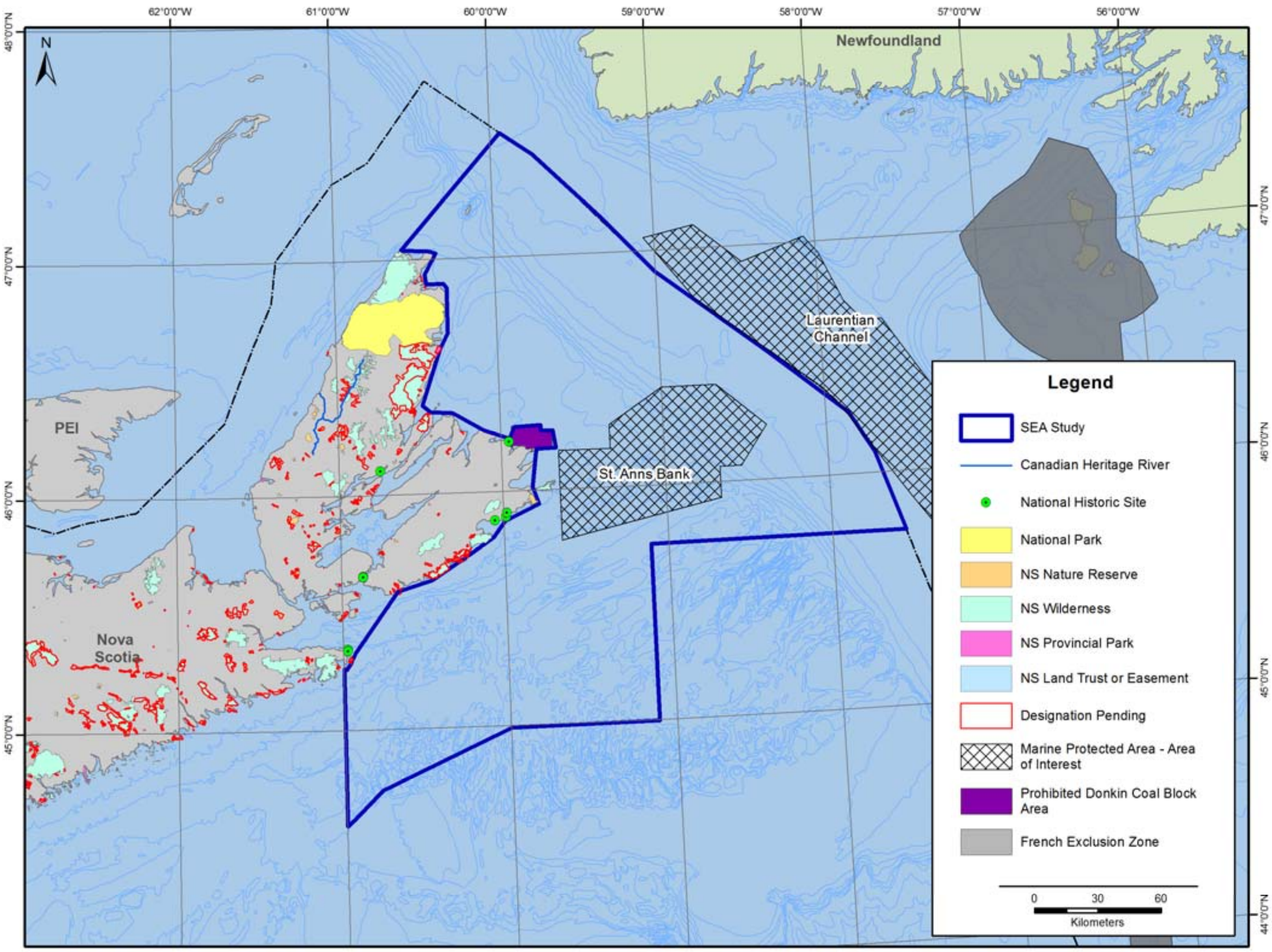
Table 3-38 Cape Breton Highlands National Park

Park or Historic Site	Location	Key Characteristics or Features
Cape Breton Highlands National Park	Northern part of Cape Breton Island	Protects part of the Maritime Acadian Highlands natural region including old-growth forests of international importance Unique blend of Acadian, Boreal and Taiga habitats, plants and animals not found anywhere else in Canada Several dozen species of rare or threatened plants and animals, as well as old growth forests of international importance. Small populations of Arctic-alpine plants from the last ice age

3.2.12.9 Canadian Heritage Rivers

The Canadian Heritage Rivers System (CHRS) was established in 1984 by federal, provincial and territorial governments to recognize and manage Canadian rivers with outstanding natural, cultural and recreational importance, and to encourage public enjoyment and appreciation. Through this program, 38 Canadian Heritage Rivers have been designated (another four have been nominated) under various legislations. Nova Scotia has two Heritage Rivers: the Margaree-Lake Ainslie River System and the Shelburne River (CHRB 2011). Neither of these rivers are located within the Study Area but the Margaree system, which runs from the Cape Breton Highlands to the Gulf of St. Lawrence, is located inland from the Study Area Figure 3-34.

Figure 3-34 Parks and Protected Areas



3.2.12.10 Identified Special Areas of International Importance

Other sensitive or special areas are identified for study and management and/or potential future protection. In some cases these areas, or portions of them, are already included in other types of national, provincial or local protected areas. The following sections identify various types of special areas that exist in Nova Scotia and discuss their relationship to the Study Area as appropriate.

3.2.12.11 Important Bird Areas

The Important Bird Area (IBA) program is coordinated by BirdLife International, and administered in Canada by the Canadian Nature Federation and Bird Studies Canada (IBA 2015). This program identifies areas of important habitat using internationally standardized criteria based on the presence of species at risk, species with restricted range, habitats holding representative species assemblages, or a congregation of a nationally and/or globally significant proportion of a species' population during one or more season. In eastern Nova Scotia, in proximity to the Study Area, there are a total of 15 designated IBAs (Figure 3-35,Table 3-39).

Table 3-39 Important Bird Areas in proximity to the Study Area

IBA Name	Area (km^2)	Location	Significance
Rocks off Fourchu Head (NS047)	1.39	A small series of rocks located off Fourchu Head, which juts into the Atlantic Ocean approximately 3 km east of the southeastern Cape Breton community of Fourchu.	• Supports at least 2% of the North American breeding population of Great Cormorants • Designated as an EBSA due to significant aggregations of Common Eider in the winter months, as well as globally significant numbers of nesting Great Cormorants (Hastings *et al.* 2014)
Harbour Rocks (NS049)	3.34	Located 12 km southwest of Louisbourg, off Cape Gabarus in southeastern Cape Breton.	• More than 2% of the North American breeding population of Great Cormorants • Designated as an EBSA due to significant aggregations of Common Eider in the winter months, as well as globally significant numbers of nesting Great Cormorants (Hastings *et al.* 2014)
Basque Islands and Point Michaud (NS045)	11.21	Point Michaud is a rocky, wooded headland connected by a gravel barrier beach to the west and a sandy beach to the east, and the Basque Islands are four low rocky islets located within 3 km of the southern tip of the point, to the east.	• Supports approximately 3.6% of the North American breeding population of Great Cormorants, as well as a large number of nesting Great Black-backed Gulls • Designated as an EBSA due to significant aggregations of Purple Sandpiper and Common Eider in the winter months, fall migrating shorebirds, as well as nesting cormorants and gulls (Hastings *et al.* 2014) • Important pupping and haul-out area for gray seals • One of just a few locations in Cape Breton that regularly harbours a variety of shorebird species, including Willet, Wilson's Snipe, and Semipalmated, Spotted and Least

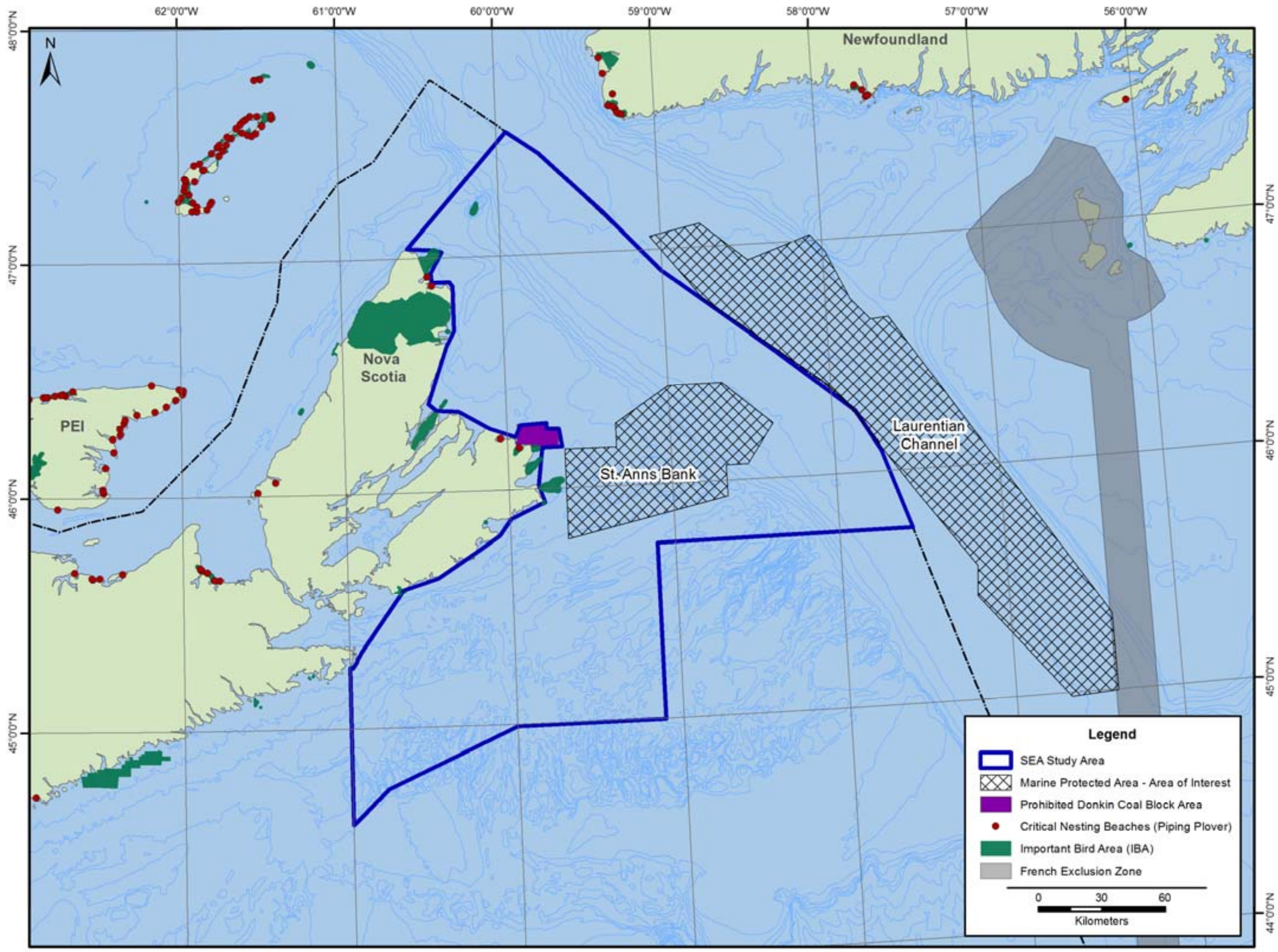
IBA Name	Area (km²)	Location	Significance
			Sandpipers • In the mouth of nearby Grand River, more than 100 pairs of Common Eiders nest and Canada Geese and other waterfowl are regularly observed during spring and fall migration
Portnova Islands (NS006)	4.78	Includes Portnova Island and other small rocky, treeless nearby islands, approximately 13 km southeast of Louisbourg.	• Approximately 2.5% of the North American breeding population of Great Cormorants • Designated as an EBSA due to significant aggregations of Common Eider in the winter months, as well as significant numbers of nesting Great Cormorants and Great Black-backed Gulls (Hastings *et al.* 2014)
Scatarie Island (NS052)	67.65	A large, forested island off the eastern tip of Cape Breton Island.	• Approximately 1% of Canadian population of Bicknell's Thrush (10 to 25 pairs) • Supports breeding colonies of Leach's Storm-petrels, Common Eider, Double-crested and Great Cormorant, Black Guillemot, Common and Arctic Terns and Black-legged Kittiwake (Ford and Serdynska 2013) • Large numbers of Whimbrel and occasionally Buff-breasted Sandpiper feed on berries during fall migration • Provincially designated Wilderness Area • Designated as an EBSA due to significant aggregations of Common Eider and other sea ducks such as scoters in the winter months, as well as aggregations of many other seabird taxa, including alcids, cormorants, kittiwakes, storm-petrels and gannets (Hastings *et al.* 2014)
Northern Head and South Head (NS053)	50.36	Located approximately 10 km east of Glace Bay, Northern and South Head enclose Morien Bay.	• Over 6% of the North American breeding population of Great Cormorants, as well as a colony of Black-legged Kittiwakes • Morien Bar, within Morien Bay, supports the largest number and diversity of migrating shorebirds in Cape Breton in the late summer and fall months (Hastings *et al.* 2014) • Schooner Pond, inland from Northern Head, attracts many vagrant landbirds • Part of the Morien Bay EBSA, designated due to its importance to shorebirds (including the Red Knot) and wintering waterfowl (including Harlequin Duck), as well as nesting terns and Great Cormorants (Hastings *et al.* 2014)
Big Glace Bay Lake (NS007)	16.19	A coastal lagoon enclosed by a barrier beach, located in northeastern Cape Breton Island east of the	• Large numbers of Canada Geese regularly observed during spring and fall migration • Regularly used by a variety of other waterfowl species, as well as shorebirds and terns • Designated critical habitat beach for Piping Plovers

IBA Name	Area (km^2)	Location	Significance
		town of Glace Bay.	• Designated as an EBSA due to significant aggregations of waterfowl during staging, as well as the presence of critical Piping Plover habitat (Hastings *et al.* 2014)
Central Cape Breton Highlands (NS061)	82.54	South of the Cape Breton Highlands National Park.	• Globally significant numbers of Bicknell's Thrush.
Bird Islands (NS001)	10.89	Composed of two long, narrow islands, Hertford and Ciboux, 4 km off Cape Dauphin in northeastern Cape Breton.	• Largest colony of Great Cormorants in North America • Largest colonies of Razorbill, Atlantic Puffin and Black-legged Kittiwake in Nova Scotia (Hastings *et al.* 2014) • Breeding area for many other species, including Herring Gull, Great Black-backed Gull, Black Guillemot,Spotted Sandpiper, Greater Yellowlegs and Great Blue Heron • Provincially designated Wildlife Management Area • Designated as an EBSA partly due to its significant seabird colonies as well as providing roosting and feeding habitat for Bald Eagles (Hastings *et al.* 2014)
Cape Breton Highlands National Park (NS056)	956.48	Includes approximately one third of the highlands in northern Cape Breton.	• Globally significant numbers of Bicknell's Thrush • Nesting habitat for Greater Yellowlegs, Least Sandpiper and Solitary Sandpiper
Ingonish Island (NS055)	5.66	A partly wooded island located 1 km off the shore of the northern head of the Ingonish Bay	• Globally significant numbers of Great Cormorant, as well as colonies of Great Black-backed Gull and Herring Gull • Designated as an EBSA partly due to important seabird colonies (Hastings *et al.* 2014)
Cape North (NS030)	72.82	A peninsula at the northernmost tip of Cape Breton.	• Globally significant numbers of Bicknell's Thrush • Possible Boreal Owl nesting site
St. Paul Island (NS032)	20.27	A 5 km long island located 25 km north of Cape Breton Island.	• Globally significant numbers of Bicknell's Thrush • Leach's Storm-petrel are believed to breed on the island • Designated as an EBSA partly due to important Bicknell's Thrush and Leach's Storm-petrel colonies, as well as significant aggregations of foraging seabirds in the Cabot Strait (Hastings *et al.* 2014)
Sable Island (NS025)	461.89	A 41 km long sandbar located 150 km off the eastern shore of Nova Scotia.	• Nationally significant numbers of Roseate Tern • Almost the entire population of "Ipswich" Savannah Sparrow (*princeps* subspecies) • Continentally significant numbers of Herring Gull, Great Black-backed Gull and Common Tern • Important pupping area for gray and harbour seals
Country Island Complex	16.35	Located off southeastern Nova Scotia, near Country Harbour and Tor	• Overlaps with the Country Harbour and Sugar Harbour Islands EBSAs, and designated as Critical Habitat for the Roseate Tern (Hastings *et al.* 2014)

IBA Name	Area (km^2)	Location	Significance
(NS028)		Bay, the complex is made up of Country and Goose Islands, as well as some smaller islands and a peninsula.	• Important aggregation area for many waterfowl and seabird species, and significant numbers of Purple Sandpiper occur on islands within Tor Bay in the winter (Hastings *et al.* 2014) • Globally significant numbers of Roseate Terns and Leach's Storm-petrels, along with many Arctic and Common Terns • Herring Gull, Great Black-backed Gull, American Crow and Common Raven nesting is being actively discouraged in order to reduce predation pressure on Roseate Terns

Source: Important Bird Areas of Canada (IBA 2015), unless otherwise noted.

Figure 3-35 Important Bird Areas and Piping Plover Beaches in the Study Area



A number of EBSAs have been identified along the Atlantic coast of Nova Scotia, many for their important attributes related to birds and their habitats. The EBSAs are further discussed in Section3.2.12.3 and many of the EBSAs that are of significance to birds are also designated as IBAs (Table 3-34,
Table 3-35).

Other designated sites that are important to migratory birds include federal Migratory Bird Sanctuaries (MBS) and provincially designated wilderness areas and nature reserves. Migratory Bird Sanctuaries are designated by Environment Canada and are protected by the *Migratory Bird Sanctuary Regulations* regarding the taking, injuring, destruction or molestation of migratory birds or their nests or eggs in the sanctuaries. Hunting of migratory species not permitted in any Migratory Bird Sanctuary. There is one MBS in the area, the Big Glace Bay Lake MBS, which is also an IBA and is described in the preceding table. The two types of provincially protected areas in Nova Scotia offer varying degrees and forms of protection. Wilderness areas (including Scatarie Island) are protected from certain uses but also support uses including recreation, hunting, sport fishing, trapping, and other uses; nature reserves protect unique or rare species or features and are mostly used for education and research. These protected areas are further discussed in Section 3.2.12

Nesting sites for colonial seabirds and rare species also constitute particularly important areas and habitats. Table 3-40 summarizes the major nesting sites for gulls, terns, alcids and storm-petrels in eastern Nova Scotia from the Atlantic Canada Colonial Waterbird Database maintained by EC-CWS; these are also shown on Figure 3.36. Many of these colonies are also designated EBSAs and/or IBAs (Hastings *et al.* 2014; IBA 2015). As well, critical habitat beaches for Piping Plover in the Study Area include North Harbour Beach and South Harbour Beach (near Aspy Bay), Big Glace Bay Lake, and Dominion Beach (Figure 3.36). The abundance and distribution of birds in the Study Area changes throughout the year. Information on key locations and times of year for bird taxa, including species at risk, is found in the preceding sections.

Table 3-40. Estimated Colony Sizes of Seabirds along Coastal Areas of the Study Area

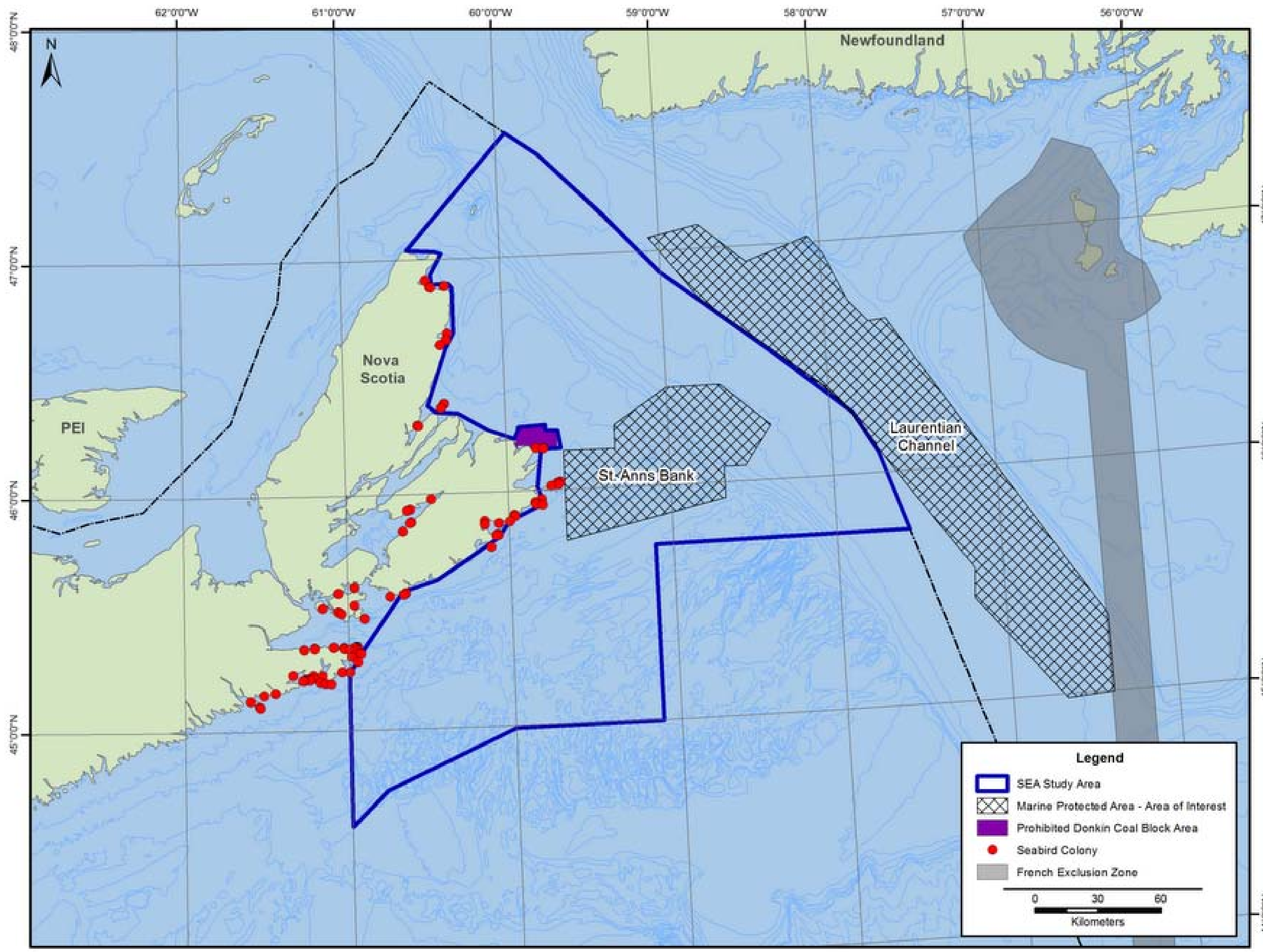
Colony Name	Great Black-backed Gull (individuals)	Herring Gull (individuals)	Black-legged Kittiwake (individuals)	Common and/or Arctic Tern (individuals)	Atlantic Puffin (individuals)	Razorbill (pairs)	Black Guillemot (pairs)	Leach's Storm-petrel (individuals)
Lead Island	85							
White Point Island, Aspy Bay	59	7	6					
small unnamed island, South Harbour				14				
small unnamed island, South Harbour				25				
Ingonish Island		70						
Steering Island		18						
south bar of Ingonish Beach				34				
Bird Islands, Ciboux	310	165	326		339	810	426	
Bird Islands, Hertford	240	120	315		213	764	387	
St. Anne's Beach				16				
St. Anne's Beach, opposite side of channel				2				
Wreck Point			87					
Flint Island	99	11						
Flint Island SW Rock #1	20	20						
Scatarie Island, Eastern Head			130					
Scatarie Island, Rock Point			6					3
Hay Island	160							
Scaterie Island, Northwest Cove								3
Cossitt Point, Bras D'Or				15				
Isle Aux Cannes	160							
Baleine, islet S of			280					
Baleine Head rock #1	6	13						
Portnova Islands	20	20						

Colony Name	Great Black-backed Gull (individuals)	Herring Gull (individuals)	Black-legged Kittiwake (individuals)	Common and/or Arctic Tern (individuals)	Atlantic Puffin (individuals)	Razorbill (pairs)	Black Guillemot (pairs)	Leach's Storm-petrel (individuals)
Christmas Island, East Bay Bras D'Or Lake				45				
Christmas Pond, east of		10						
Battery Island	38	13						
Green Island (Louisbourg)	50		20					
Sandspit, MacPhersons Pond, East Bay Bras D'Or Lake				34				
Irishvale				3				
Morrisons Cove	1							
White Point	1							
Kennington Rocks	3	3						
Harbour Rock	3							
Sandpsit at Irish Vale, East Bay Bras D'Or Lake				15				
Shallop Rock, off Cape Gabarus	16							
Green Island, off Cape Gabarus	120	80	106					
Joyces Rock, Cape Gabarus			80					
Guyon Island	60							
Quetique Island	28	112						
Berry Island	5	4						
East Basque Island	11							
South Basque Island	13							
Red Island	4							
Les Rochers	55							
Green Island (Janvrin Harbour)	56	84						
Crid Island, east	5							

Colony Name	Great Black-backed Gull (individuals)	Herring Gull (individuals)	Black-legged Kittiwake (individuals)	Common and/or Arctic Tern (individuals)	Atlantic Puffin (individuals)	Razorbill (pairs)	Black Guillemot (pairs)	Leach's Storm-petrel (individuals)
Crid Island, west	7							
Jerseyman Island rock #1	5	3						
Green Island	126	54						
Gunning Rocks, east	7	1						
Derabies Bar	12							
Fox Island	28	12						
Derabie Island	10							
Tickle Island	25							
Half Island		5						
Big Goosberry Island	15							
Half Island				12				
Pigeon Island	26							
Tickle Island				1				
Rook Island	50	6						
Davis Island				4				
Crow Island (DB)	5							
Frying Pan Shoal	38	9						
Cranberry Island				8				
small unnamed island, Spinney Gully				16				
Gull Island, Canso	2							
small unnamed island, Dover Bay				12				
Dover Bay, unnamed island south	3	2						
small unnamed island west of Forster Island, Tor Bay				16				
Hog Island Spit, Tor Bay				32				

Colony Name	Great Black-backed Gull (individuals)	Herring Gull (individuals)	Black-legged Kittiwake (individuals)	Common and/or Arctic Tern (individuals)	Atlantic Puffin (individuals)	Razorbill (pairs)	Black Guillemot (pairs)	Leach's Storm-petrel (individuals)
Harbour Island		120						
Harbour Ledge	4							
unnamed island Tor Bay				16				
Sugar Harbour Island, East	60							
Cooks Island	1							
Middle Sugar Harbour Island	18							
unnamed island beside Cook's Island				80				
Sugar Harbour Island, West	35							
Topstone Ledge	5							
Inner Gull Ledge				160				
Middle Gammon Island	10	2						
Millstone Island	5							
Shoal Point	23	8						
Thrumcap Island (CH)	8							
Harbour Island (CH)	60							
Frying Pan (CH)	19							
Country Island				950			560	23980

Figure 3-36 Seabird Colonies Monitored in the Atlantic Colonial Waterbird Database in the Study Area



3.2.12.12 Convention on Wetlands of International Importance

The 1998 Convention on Wetlands of International Importance (also referred to as the Ramsar Convention) is an intergovernmental treaty for conservation of important wetland habitats. Canada, which became a Contracting Party to the Ramsar Convention in 1981, has designated 37 Sites of which 17 are also National Wildlife Areas or Migratory Bird Sanctuaries (EC 2013 [International Programs and Conventions]). Three Ramsar sites have been identified in Nova Scotia (Musquodoboit Harbour, Southern Bight-Minas Basin, Chignecto) none of which are located within or near the Study Area (RCS 2014).

3.2.12.13 Western Hemisphere Shorebird Reserve Network

The Western Hemisphere Shorebird Reserve Network (WHSRN) conservation strategy was created in 1986 by North and South American scientists to protect key habitats to sustain healthy populations of shorebirds. Of the seven identified Canadian sites, only one is located in Eastern Canada. The Bay of Fundy WHSRN designation includes two areas: Bay of Fundy (Shepody Bay) in New Brunswick and Bay of Fundy (Southern Bight Minas Basin) in Nova Scotia, neither of which is located within or near the Study Area (WHSRN 2009).

3.2.12.14 The UNESCO World Biosphere Reserve Program

Biosphere reserves are nominated by their respective national governments and identified by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Biospheres remain under national jurisdiction and are studied for interdisciplinary approaches to understanding and managing changes and interactions between social and ecological systems. A total of 651 biosphere reserves have been designated (UNESCO 2015). No biosphere reserves are located within the Study Area but the Bras d'Or Lake Biosphere Reserve is found at Bras d'Or Lake, which is a salt-water inland sea surrounded by Cape Breton Island (PNS 2015 [UNESCO Sites in Nova Scotia]).

3.3 Socioeconomic Environment

3.3.1 Commercial Fisheries

Commercial fishing represents an important economic activity in the coastal communities along and adjacent to the Study Area. But the fishery represents more than a source of employment to most coastal communities. The commercial fishery is a source of culture, which is an important aspect of livelihood and community relationships. While people have migrated away from coastal communities across Canada to seek employment and income, the culture of the Atlantic Canadian communities is founded upon their history and relationship with the resources upon which they were built. The following provides a brief synopsis of the evolution of the commercial fishery in the Study Area. The cultural importance of the fishery is a result of this long historical relationship with the land and coastal resources in the region.

3.3.1.1 Historical Overview of Fisheries in Atlantic Canada

The fishery has been an important component of the social, economic and cultural fabric of communities along the coast of Cape Breton and eastern Nova Scotia for millennia. Prior to the arrival of Europeans, Mi'kmaq harvested fish, shellfish and crustaceans along the coast and in the nearshore and offshore waters in the region. It was these same resources that prompted Basque, French, and English fishers to later fish and eventually settle in the area.

The commercial fishery was initially founded on the rich groundfish resources in the region (Lear 1998). During the early 1500s, European fleets would fish with hook and line in the region. With the defeat of the French in the region in 1763, British settlers poured into the region and the cod fishery expanded and other groundfish (halibut, haddock and Pollock) became more important to the commercial fishery. By the mid-1800s the longline fishery was introduced to the groundfish fishery, along with larger fishing schooners, with a resultant significant increase in catch. Markets expanded in Europe and the Caribbean for dried salted cod from the many small fishing communities along the Atlantic Coast of Canada (CCPFH 2015).

Mechanization of small and medium sized vessels owned by independent fishers lead to an increase in efficiency and as a result an eventual decline in the estuarial and nearshore stocks. This lead to a shift in economic activities and a diversification of species important to the commercial fishery. By the mid-20th century, shrimp and scallops gained importance as significant contributors to fishers incomes. By the latter part of the century, large trawler companies, which operated their own fish processing facilities had emerged as an important part of the commercial fishery. These could match the groundfish catch of the many more smaller inshore vessels, which often caught other species (CCPFH 2015). The dramatic increase in harvesting efficiency eventually lead to the eventual collapse of the groundfish fishery and the bankruptcy of many of the trawler companies. Small boat fishers were forced to diversify their harvesting efforts into other species. Currently, snow crab, lobster, shrimp and other species have become the main contributors to fishers' incomes. Government fisheries managers and fishers have continued to collaborate in the development of new sustainable commercial fisheries.

In addition to the mechanization of vessels, advancements have been made to fishing gear used to harvest commercially important fish resources. Four factors have determined the methods and technologies employed in the various fisheries. Historically, aquatic environmental factors such as the water depth, substrate type and nature of the habitat, the size and mobility of the target species, the availability of materials to construct fishing gear, and the socio-cultural environment have all played a role in defining acceptable and popular fishing methods (CCFPH 2015). Today these continue to be significant factors in the commercial fishery. The introduction of the otter trawl in the mid-20th century created higher yields for local fishing enterprises and increased incomes for fishers. New emphasis on environmental protection, sustainable harvesting and cost efficiency have led to social pressure on the selection of harvesting technologies. Environmental and social activism have created Eco-certification programs that have led to the decline in the dragger fleet, improvements in gear selectivity to reduce bycatch and incidental killing of other non-fishery species (marine mammals, sea turtles and birds), and increased social benefit of the commercial fishery to local communities (fair trade fishing) (CCPFH 2015).

Commercial fisheries for most of Canada's Atlantic groundfish stocks were placed under moratoria by 1994, thereby reducing the annual Atlantic groundfish landings. Several groundfish stocks have failed to recover many years after the moratoria were initially imposed. In the interim, there have been some very limited re-openings of small commercial fisheries for cod (Parsons 2010). In contrast, the major shellfish stocks on the Atlantic coast became extremely abundant. A decade's long surge in Atlantic lobster landings continued, and there were major increases in the abundance of shrimp and snow crab. These fisheries replaced groundfish in many areas of Atlantic Canada. However, there are concerns that the shellfish abundance (snow crab, shrimp, and lobster) on the Atlantic Coast, which is currently supporting much of the Atlantic fishing industry, could take a downturn (Parsons 2010). Parsons cautions that despite repeated warnings over the past few decades about a possible imminent decline, lobster landings continue at record levels. Should the shellfish bubble burst, the implications could be catastrophic for Atlantic coastal communities and fishers as they have now become extremely dependent on lobster or crab, depending on the area.

3.3.1.2 Management of Commercial Fisheries

Fisheries and Oceans Canada (DFO) manages fisheries in accordance with the roles and responsibilities outlined in the *Fisheries Act*, using credible, science-based, affordable and effective practices (DFO 2015a). Key priorities for fisheries management in Canada include:

- environmental sustainability;
- economic viability; and
- the inclusion of stakeholders in decision-making processes.

Fisheries decisions set out the management measures in place for a specific fishing season and are generally divided by species (or group of species) and fishing area. Information included in a fisheries decision may include:

- opening and closing dates for the season,
- total allowable catches, and
- management plans.

Certain fisheries are managed through multi-year Integrated Fisheries Management Plans. In this case, seasonal adjustments may be made through the fisheries decision process. DFO collaborates with other North Atlantic fishing nations through a joint management organization, the Northwest Atlantic Fisheries Organization (NAFO). NAFO is an intergovernmental fisheries science and management body whose objective is to contribute, through consultation and cooperation, to the optimum utilization, rational management and conservation of the fishery resources of the NAFO Convention Area. The NAFO Fisheries Commission is responsible for the management and conservation of the fishery resources of the Regulatory Area (waters outside the Exclusive Economic Zone (EEZ). It annually decides on the NAFO fisheries regulations, Total Allowable Catches (TAC) and quotas (NAFO Conservation and Enforcement Measures).

Canada also collaborates internationally on the management of Atlantic salmon through the North Atlantic Salmon Conservation Organization (NASCO). NASCO's objective is to conserve, restore, enhance and rationally manage wild Atlantic salmon. NASCO is an international organization, established by an inter-governmental Convention in 1984.

The Nova Scotia Department of Fisheries and Aquaculture has responsibility for some aspects of the commercial fishery. These include: recreational fishing, sea plant harvesting, training and development, licensing of buyers and processors, aquaculture, the Fisheries and Aquaculture Loan Board, and enforcement.

3.3.1.3 Fishery Management Zones

The Department of Fisheries and Oceans has established various fisheries management areas for the purposes of administrative management of the commercial fishery. These zones are used for stock assessment, management purposes (such as licensing and reporting) and seasonal distribution of fishing effort to ensure ecological and economic sustainability of the fishery. Some of the fishery zones used by DFO have been defined through the Northwest Atlantic Fisheries Organization (NAFO) fisheries commission's zonal management scheme for the wider Northwest Atlantic region. The use of NAFO districts ensures consistency in the domestic management processes with Canada's involvement with international efforts to collaborate in fishery management. The areas within the Study Area include:

- Lobster Fishing Areas (LFAs) 27, 28, 29, 30, and 31a
- Crab Fishing Areas (CFAs) 20, 21, 22, 23, and 24
- Shrimp Fishing Areas 13, 14, and 15
- NAFO Areas 4Vn, 4Vs, and 4W

•Figure 3-37 to Figure 3-40 illustrate the various fishery management areas

Figure 3-37 NAFO Areas

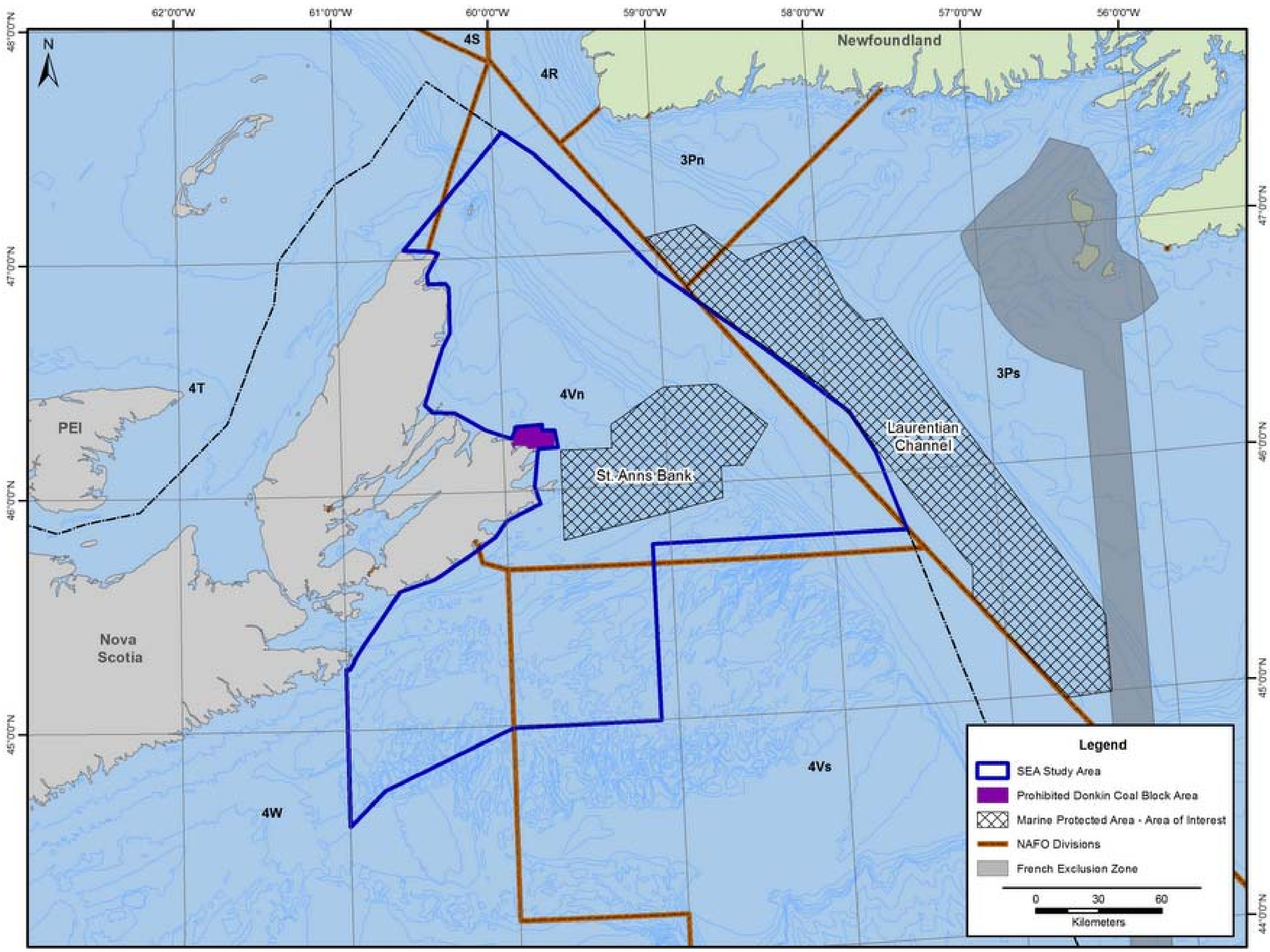


Figure 3-38 Crab Management Areas

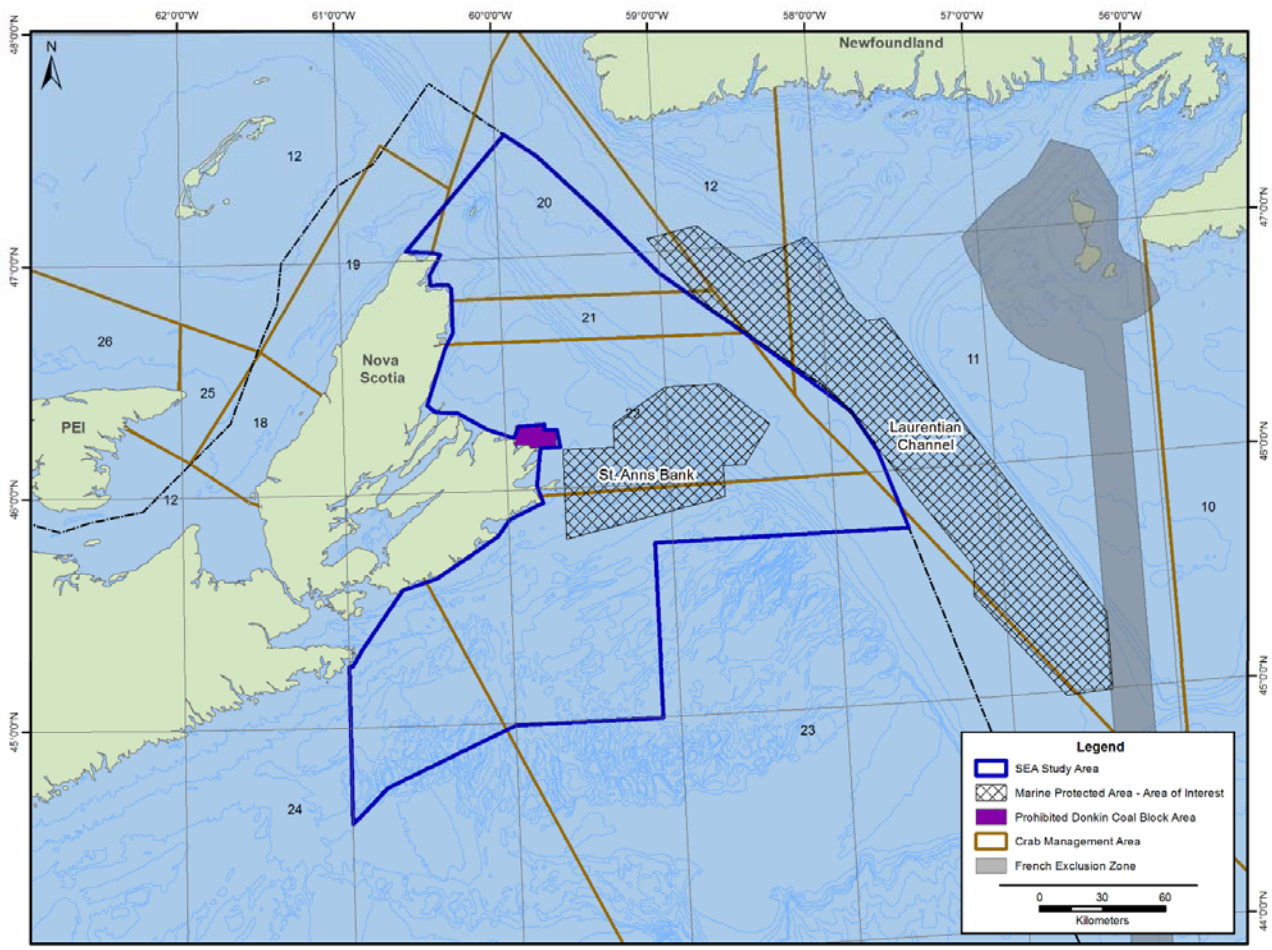


Figure 3-39 Lobster Management Areas

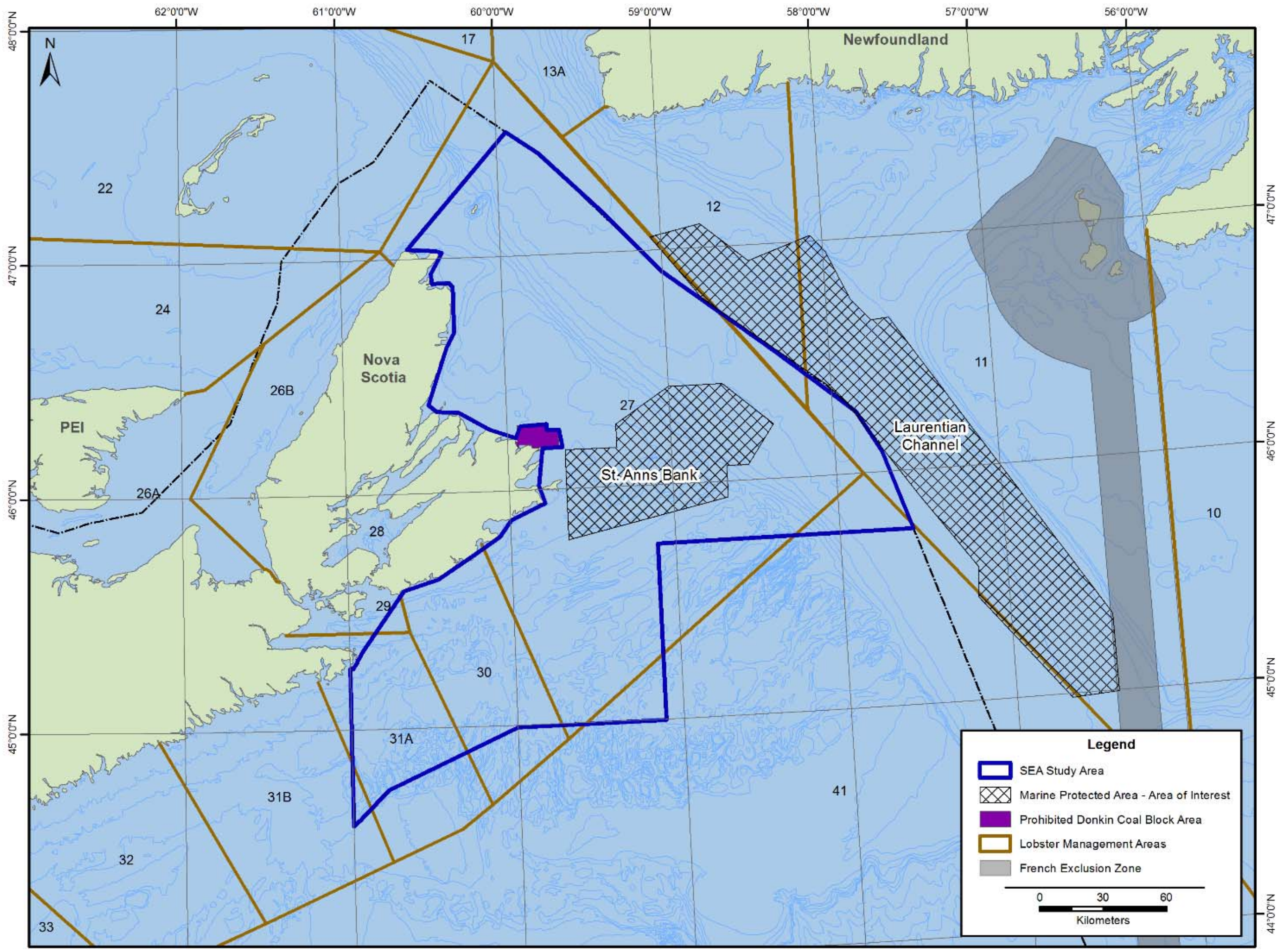
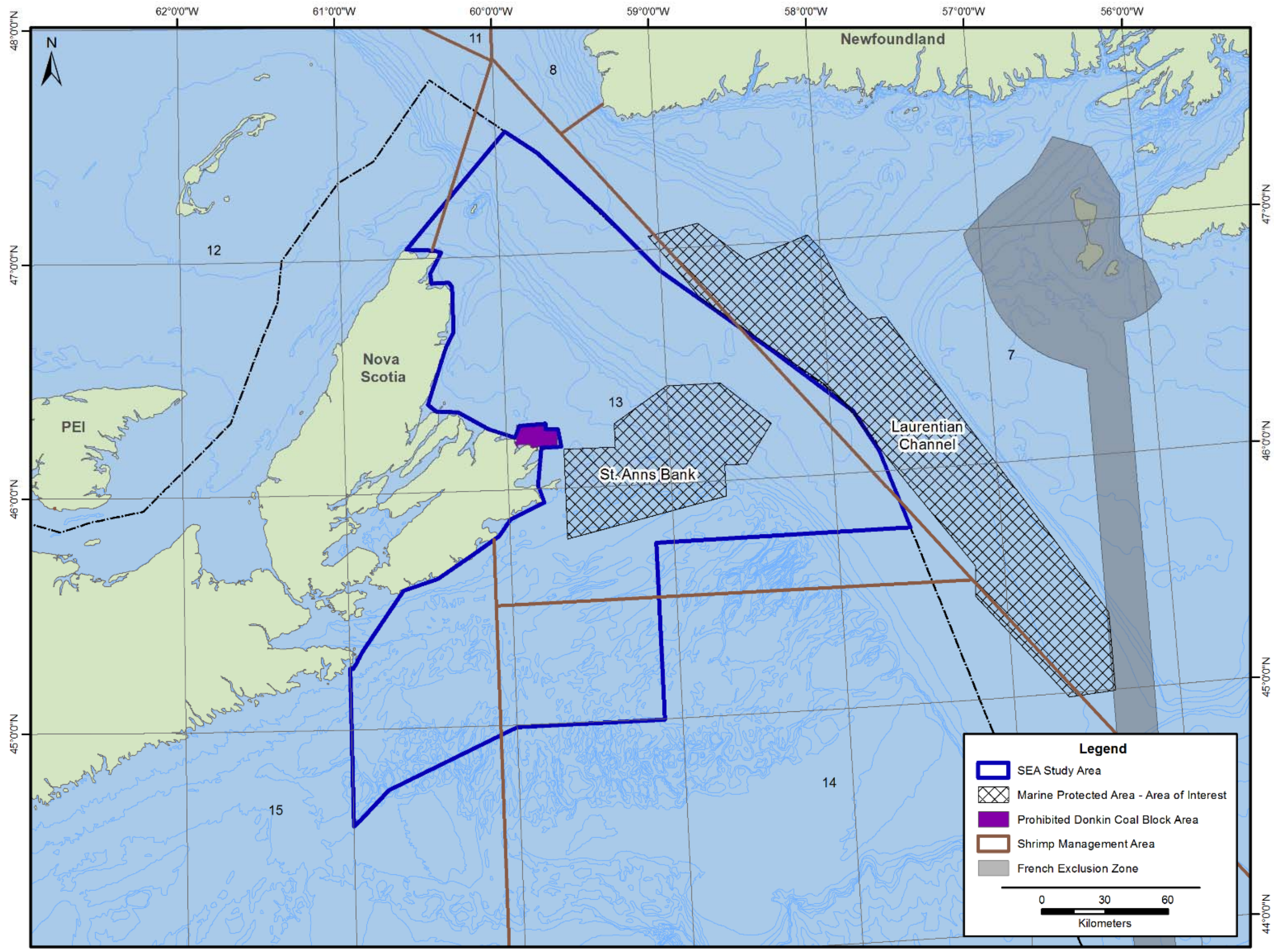


Figure 3-40 Shrimp Management Areas



3.3.1.4 Data Sources

Information on commercial fishing operations is compiled and maintained in various forms by multiple government agencies and industry organizations. The Department of Fisheries and Oceans collects fish harvesting information through fishers' logbooks, which are maintained as a condition of license. Since the 1950's information from landings slips issued by buyers are provided to DFO, Stats Canada, Canada Revenue Agency and Service Canada (for Employment Insurance purposes).

For reasons of confidentiality, individual data is not accessible to the general public. Government policy is to only release aggregated data, with a minimum aggregation of five licenses, or five vessels. As a result, in areas where there is limited fishing activity information is inaccessible.

Information on fish buyers and fish processing operations is compiled and maintained by the Provincial Department of Fisheries and Aquaculture (NSDFA) who have responsibility for issuing fish buying and fish processing licenses. The NSDFA is also responsible for management of aquaculture in the coastal waters of Nova Scotia. Information on farm location, production and employment are compiled and maintained by the department.

Additional data on the commercial fishery is also available through peer reviewed publications and government research reports. This information is available from technical journals and publications accessible through university libraries.

3.3.1.5 Harvesting Seasons

Fishing activity is seasonal, as a result there are specific times of the year when the various fishing grounds contribute to the local economy. During these times, various areas will be traversed by fishing vessels accessing the prime fishing grounds where gear will be deployed to harvest the resources that are in season and available (present in sufficient abundance to economically harvest). Refer to section 3.3.1.6 for areas where various gear types are used. Table 3-41 provides information on the seasons for the harvest of commercially important species.

Table 3-41 Summary of Fishing Seasons for Commercial Fisheries (Breeze and Horseman 2005)

Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pelagic Species												
Albacore Tuna												
Bigeye Tuna												
Bluefin Tuna												
Mackerel												
Porbeagle Shark												
Swordfish												
White marlin												

Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Groundfish Species												
American Plaice												
Atlantic Cod												
Atlantic Halibut												
Cusk												
Greysole-Witch Flounder												
Haddock												
Monkfish												
Pollock												
Redfish												
Red Hake												
Silver Hake												
Striped Catfish (Wolffish)												
Turbot (Greenland Halibut)												
White Hake												
Invertebrate Species												
Lobster												
Scallop												
Snow Crab												
Lobster seasons: LFA 31a - April 29 to June 30, LFA 31b - April 29 to June 20, LFA 30 - May 19 to July 20, LFA 29 - May 10 to July 10, LFA 28 - May 9 to July 9, LFA 27 May 15 to July 15												

	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

3.3.1.6 Harvesting Methods (Gear Type)

Multiple methods of harvesting are employed in the commercial fishery in the study area. The following provides a brief summary of the methods used for the various fisheries.

3.3.1.7 Pelagic Fisheries

Several commercially important species occur in the Study area and are harvested using a variety of fixed and mobile gear.

Gaspereau

The gaspereau (alewives) commercial fishery continues to be an important fishery in Nova Scotia. Historically used both as food, either fresh or salted, gaspereau are now widely used as bait for a variety of fisheries including lobster, crab, cod, haddock, pollock and mackerel. As they migrate up river a number of different gear types are used to catch them including trapnets (used in the lakes or the lower river and estuary of larger rivers), gillnets (used in lakes, estuaries and rivers), dipnets (used in rivers at the foot of rapids or other obstructions), weirs (used in rivers), and squarenets, which is a large pole mounted dipnet braced on a pivot (used in rivers) (DFO 2015a).

Atlantic Herring

The Atlantic Herring fishery is an important commercial fishery in many areas of Atlantic Canada. Herring are harvested for both food and bait in the spring and summer. The gear used to harvest herring in the Study area include purse seines, tuck seines, midwater trawls, and gillnets; however weirs are also used in other areas in Nova Scotia (DFO 2015b).

American Smelt

In the Atlantic, anadromous smelt stocks are harvested during the fall and winter before the species migrate to their spawning sites. Commercially harvested smelt are caught in gillnets, gag nets are also used in areas of higher tidal current (DFO 2015b).

During winter most smelts are caught through the ice. The ‘double-ender’ box net is the most popular gear used to harvest in these conditions.

Smelts are also a popular sport fish. During the summer months, fishers in the Maritimes fish for smelt using hook and line from docks. Dip nets are used during the spring, although activity is limited by regulation. In the winter, fishers throughout the Maritimes and Quebec erect small shacks for ice fishing, where hook and line or spears are used (NSDFA 2015b).

Atlantic Bluefin Tuna

The Bluefin tuna fishery is conducted between July and November along the coast of Atlantic Canada. Tuna are harvested by hook and line, electric harpoons or traps.

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for the coordination of Bluefin tuna management on an international level. Fisheries and Oceans Canada implements management measures adopted by ICCAT, and applies catch level and minimum size restrictions. (DFO 2015b).

Atlantic Mackerel

When Europeans arrived in Canada, a number of First Nations were already harvesting mackerel using gillnets. In the early 2000s gillnets, jiggers and traps accounted for the majority of Canadian mackerel catches. Today purse seines and tuck seines (a modified bar seine) account for the majority of landings (DFO 2015g).

There is a recreational fishery for mackerel in Nova Scotia. Recreational fishers use hand line or rod and reel in the inshore and coastal waters.

Squid

Squid are fished both inshore and offshore. The inshore squid fishery uses two types of gear to harvest squid: traps or by jigging. The larger commercial (offshore) fishery is dominated by foreign trawlers on the Scotian Shelf (DFO 2015b).

3.3.1.8 Benthic Fisheries

Like Pelagic fisheries, fishermen use a variety of fishing gear to harvest fish that live and feed on the ocean floor. Some harvesting involves mobile gear while other fisheries use fixed gear.

Witch Flounder

Witch flounder is mainly a by-catch of the otter trawl fishery for cod and redfish in wintertime. There is a more or less small directed fishery by Danish seiners in summertime still carried out in St. George's Bay, with some taken by Danish seiners near Cape Breton Island (DFO 2015b).

White Hake

White hake has historically been the third or fourth most important groundfish fishery in the southern Gulf of St. Lawrence. Harvesting is largely carried out by small inshore vessels during the summer and fall months. A variety of different gear types are used, including gillnets, hooks and lines, bottom trawls and seines (DFO 2015b).

Yellow Flounder

The most common gear type used in the yellow flounder fishery is the otter trawl. The main Canadian commercial fisheries for yellow flounder are on northeastern Georges Bank and on the Grand Banks. There is a small industrial fishery for bait in the southern Gulf of St. Lawrence and in the Study Area (DFO 2015b).

Atlantic Hagfish

In 2004, the hagfish fishery was initiated with a harvesting season lasting from September to December. The gear used for the hagfish fishery consists of strings of barrel-type baited traps with holes of 14.3 mm and 15.1 mm diameter escape holes (DFO 2015b).

Atlantic Cod

A variety of gears have been traditionally used in the inshore cod fishery, including cod traps, line trawl, longline, gillnet, hand line, jigger, and cod seine. The coastal and offshore banks fishery, historically, used line trawls (longlines) set out and hauled by fishermen in dories from schooners.

With the introduction of the motorized trawler (dragger) and the otter trawl there was a considerable increase in the harvesting efficiency of the fleet. Technological advances continued with the introduction of the stern trawler, more powerful winches, echo sounders for fish detection and automated floating fish factories to process and freeze catches at sea (DFO 2015b).

Atlantic Halibut

Atlantic halibut were initially fished using hand lines equipped with a single hook baited with fish scraps and weighted with lead so that it could reach the bottom. As the fishery became more profitable, the longline, which consists of a main ground line equipped with many lighter secondary lines several meters apart, was employed and has remained the most effective method of fishing halibut today. Longliners are equipped with hydraulic winches to drag the fishing gear aboard where the halibut can then be detached from the hooks (DFO 2015b)

Haddock

Haddock are harvested commercially with otter trawls, longlines, handlines and gillnets. The majority of the commercial harvest is from the Georges Bank area in southwestern Nova Scotia. (DFO 2015d)

Redfish

There are three redfish species in the Northwest Atlantic, *S.fasciatus* (Acadian redfish), *S.mentella* (deepwater redfish) and *S.marinus* (golden redfish). Catches are usually reported by genus only (*Sebastes* spp.). Because of difficulties with identification and separation, all three species are reported together as 'redfish' in the commercial fishery (DFO 2015e). Redfish are harvested commercially with otter trawls and longlines. While some harvesters target Redfish, a significant portion of the landings are as bycatch in the cod and haddock fishery (DFO 2015f).

3.3.1.9 Shellfish and Crustaceans

Harvesting of shellfish and crustaceans are also conducted with different gear. Shellfish harvesting involves a form of raking, either mechanized or dragged across the bottom of the fishing grounds, or hand held smaller rakes. Crustaceans are harvested predominantly with traps designed specifically for the species and harvesting conditions.

American Lobster

Baited traps, placed on the sea floor, are used to catch lobster. The majority of the lobster fishery activity takes place in shallow waters of less than 40 metres. Trap sizes and specification of escape hatches are included in the license conditions, as are minimum carapace sizes of harvest lobsters (DFO 2015b)

American Oyster

Oysters are harvested by rakes. The gear is constructed of two rakes attached by a hinge. The fisher opens and closes the rakes allowing them to scrape oysters off the sea floor. This process, referred to as ‘tonging’, lifts oysters away and also cleans the substrate on the ocean floor, which helps new oysters spat to settle.

Oyster farming, or aquaculture, is becoming an important part of the fishery and acts as a means of ensuring there are enough oysters to meet the demands of the expanding fishery. Farmed oysters are grown in cages over a three-year period, by the end of which they are ready for market. The fishery also seeds the reefs along the Atlantic coast in order to restore the ecosystems (DFO 2015b).

Northern Shrimp

Northern shrimp are harvested from boats equipped with otter trawls. Trawls have a funnel-like net that is dragged along the ocean bottom (DFO, 2015b). When shrimp are landed, they are either kept fresh or frozen onboard until they are processed at a plant for cooking and peeling.

In SFA 15 shrimp are harvested with conical traps (modified crab trap) (GCIFA, pers comm. 2015).

Snow Crab

The snow crab fishery is a trap fishery which is managed by season, trap limits, quota, and size limits. There are also restrictions on gender caught in some areas. The vessels used in the snow crab fishery vary in size depending on whether it is the inshore, mid-shore or offshore fishery. Bait used in the traps includes herring, mackerel or squid, so there is a close dependence on other local fisheries (DFO 2015b).

3.3.1.10 Seals

Harp Seal

Established by the early 18th century, the harp seal was the basis of a traditional sealing industry in Atlantic Canada. In the early years, nets were the main gear type used to harvest seals, but this has been replaced by clubs, hakapiks and rifles.

Although the large-vessel hunt in March is well known, smaller vessels are also used to hunt seals. "Lands-men" in small boats and larger vessels up to 20 m in length (longliners) from the Magdalen Islands, the North Shore of Quebec, and Newfoundland take pups and older seals from late December to May (DFO 2015b).

Grey Seal

There is a small commercial hunt for grey seals along the coast of Nova Scotia (DFO Science Advisory Report, 2010). On average over the past five years 655 animals have been harvested each year. In addition, some grey seals have been killed under a nuisance seal permit provision of the Marine Mammal Regulations (DFO 2015b).

The seal fishery has been a long standing coastal industry which has been both economically and culturally important to many communities, including those in the study area. Harp seals have been hunted commercially since the early 18th century. A ban on the importation of whitecoat pelts implemented by the European Economic Community in 1983 severely reduced the market, ending the traditional large-vessel hunt, and subsequent catches have been much lower. Catches in recent years have been extremely low due to a combination of poor ice conditions, reduced effort and alternative fisheries. Recent harvests of 100,000/yr are significantly lower than mid 90’s harvests of 262,000 and much lower than historical highs of over 700,000. Young seals that have moulted their whitecoat (referred to as 'beaters') make up over 95 % of the harvest since 2000. Grey seals have also been an important part of the fishery, and recent increases in their abundance has led to calls for an increase in harvest levels to control their impact on other commercially important species.

The commercial harvest of seals in Atlantic Canada is managed under the Atlantic Seal Management Strategy (ASMS) using renewable 5 year management plans. In 2010, DFO reviewed the impacts of grey seals on cod in the Scotian Shelf (4VsW). Some of the main results indicate that seal predation was noteworthy but not as significantly causal for cod mortality as in the southern Gulf region.

3.3.1.11 Gear Use Areas

The following figures illustrate the general areas in which various types of fishing gear are used within the Study Area. This information was compiled by the Department of Fisheries and Oceans.

Figure 3-41 Areas where Bottom Mobil Gear is used (Oct-Dec)

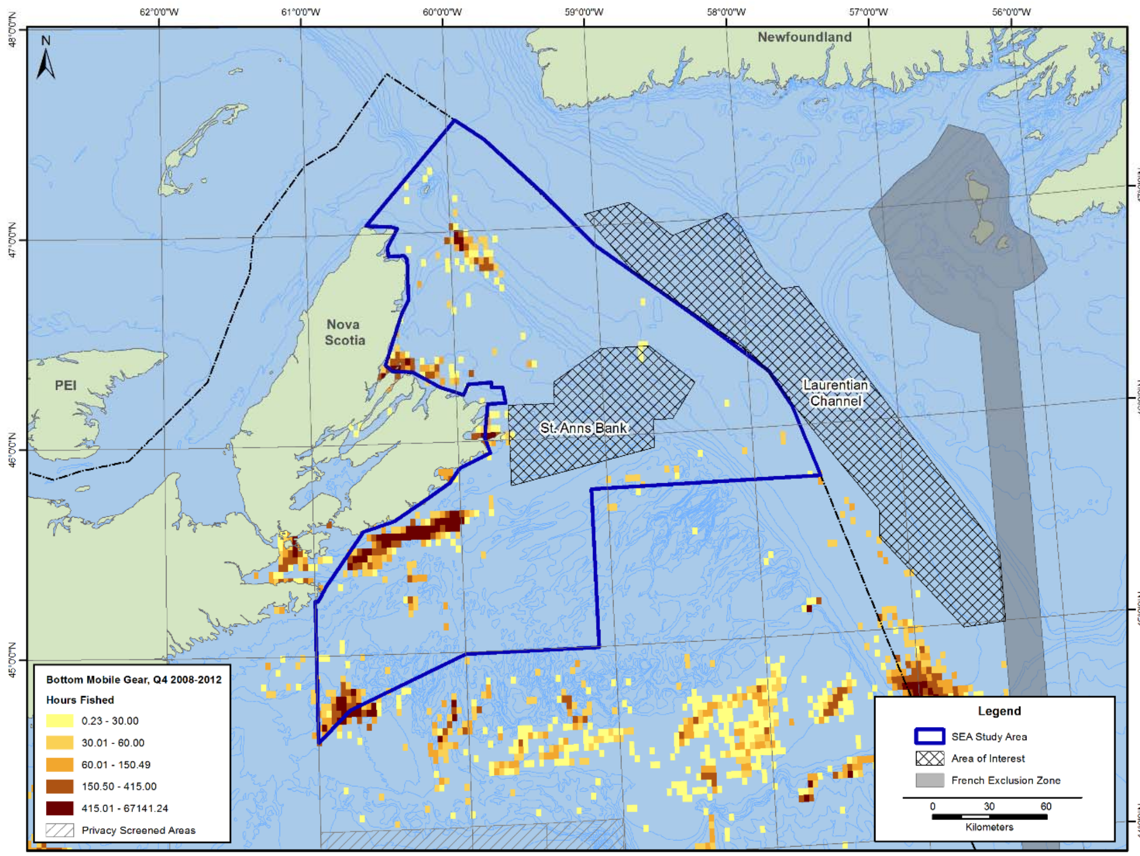


Figure 3-42 Areas where Bottom Mobil Gear is used (July –Sept)

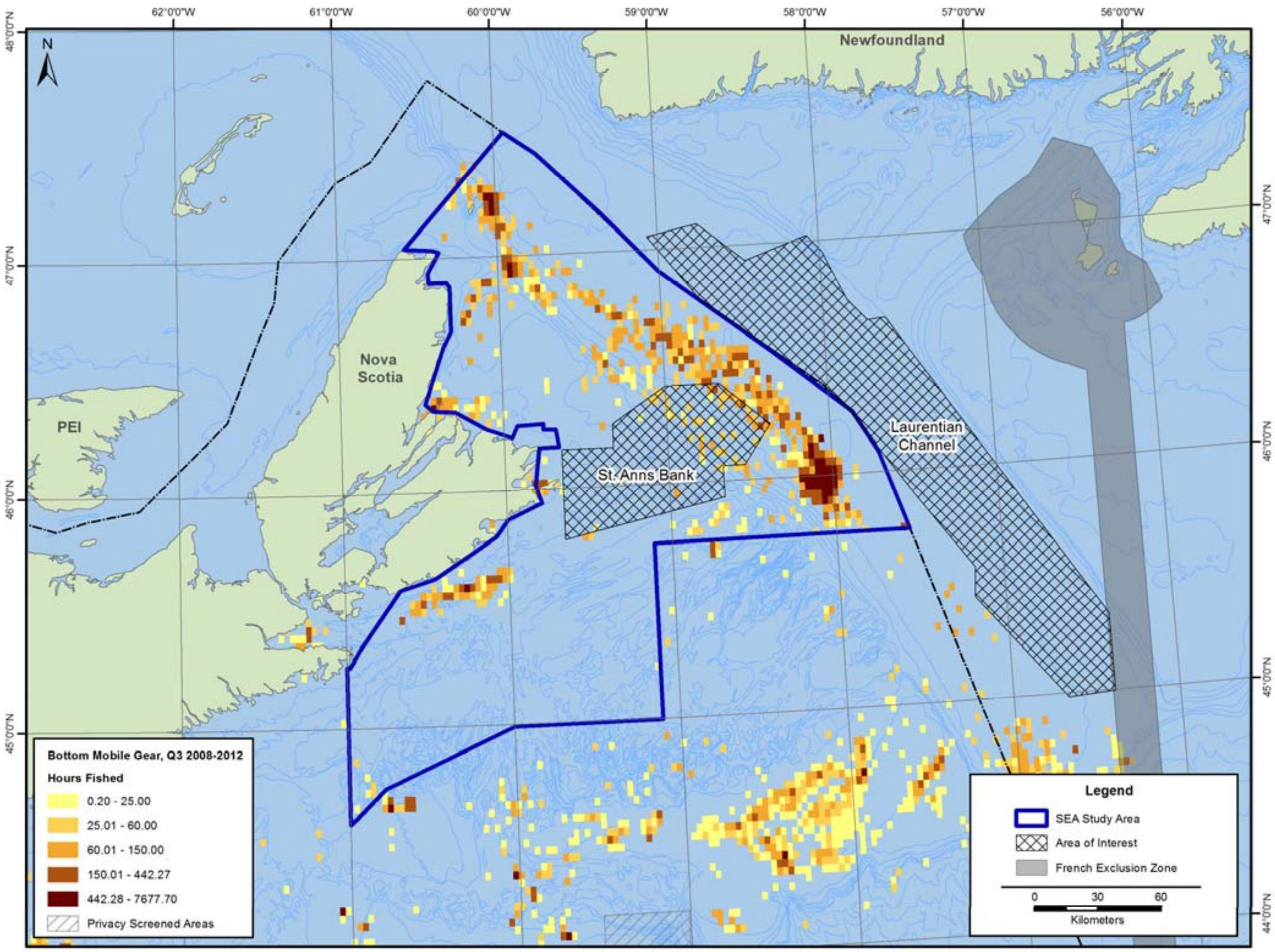


Figure 3-43 Areas where Bottom Mobil Gear is used Jan -Mar

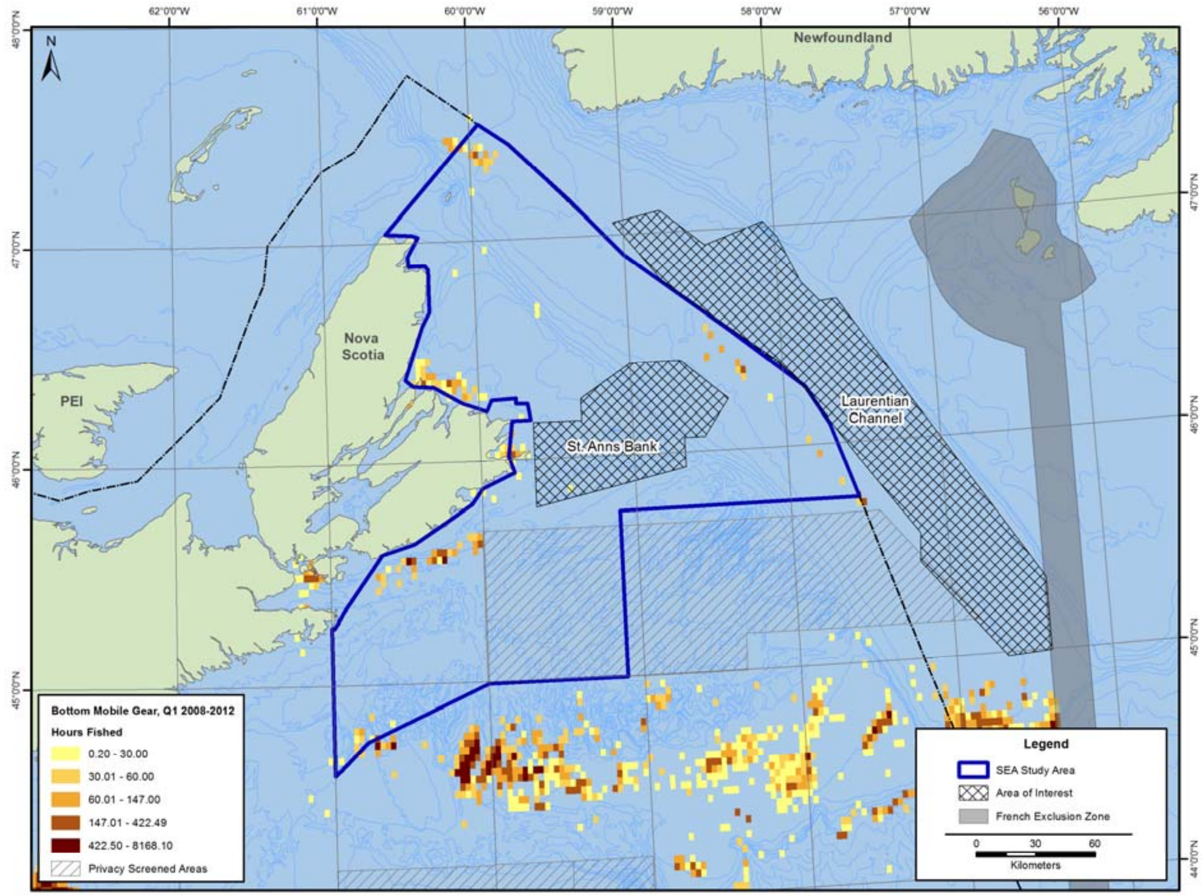


Figure 3-44 Areas where Bottom Longline Gear is used

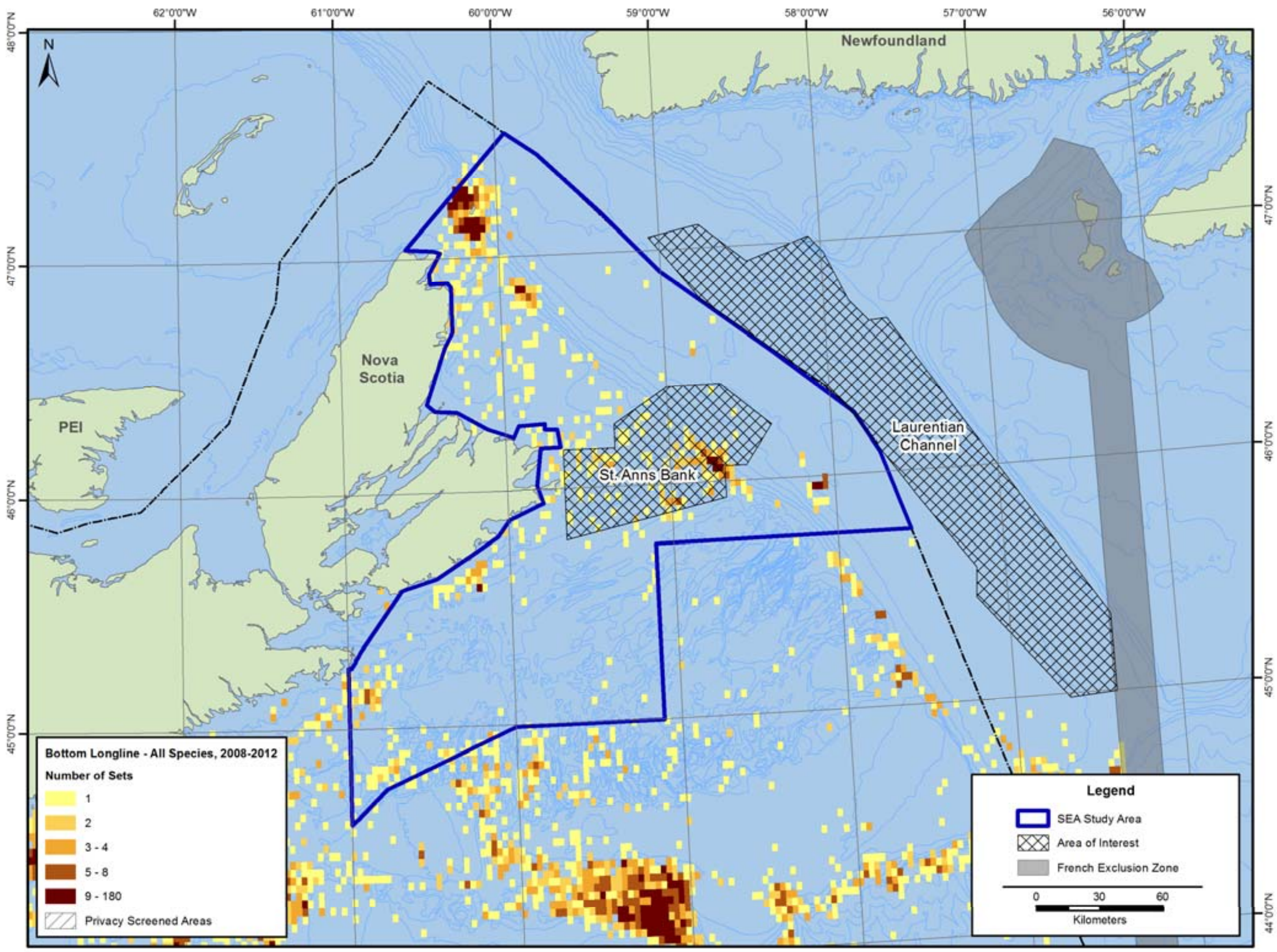


Figure 3-45 Areas where Shrimp Bottom Trawl gear is used

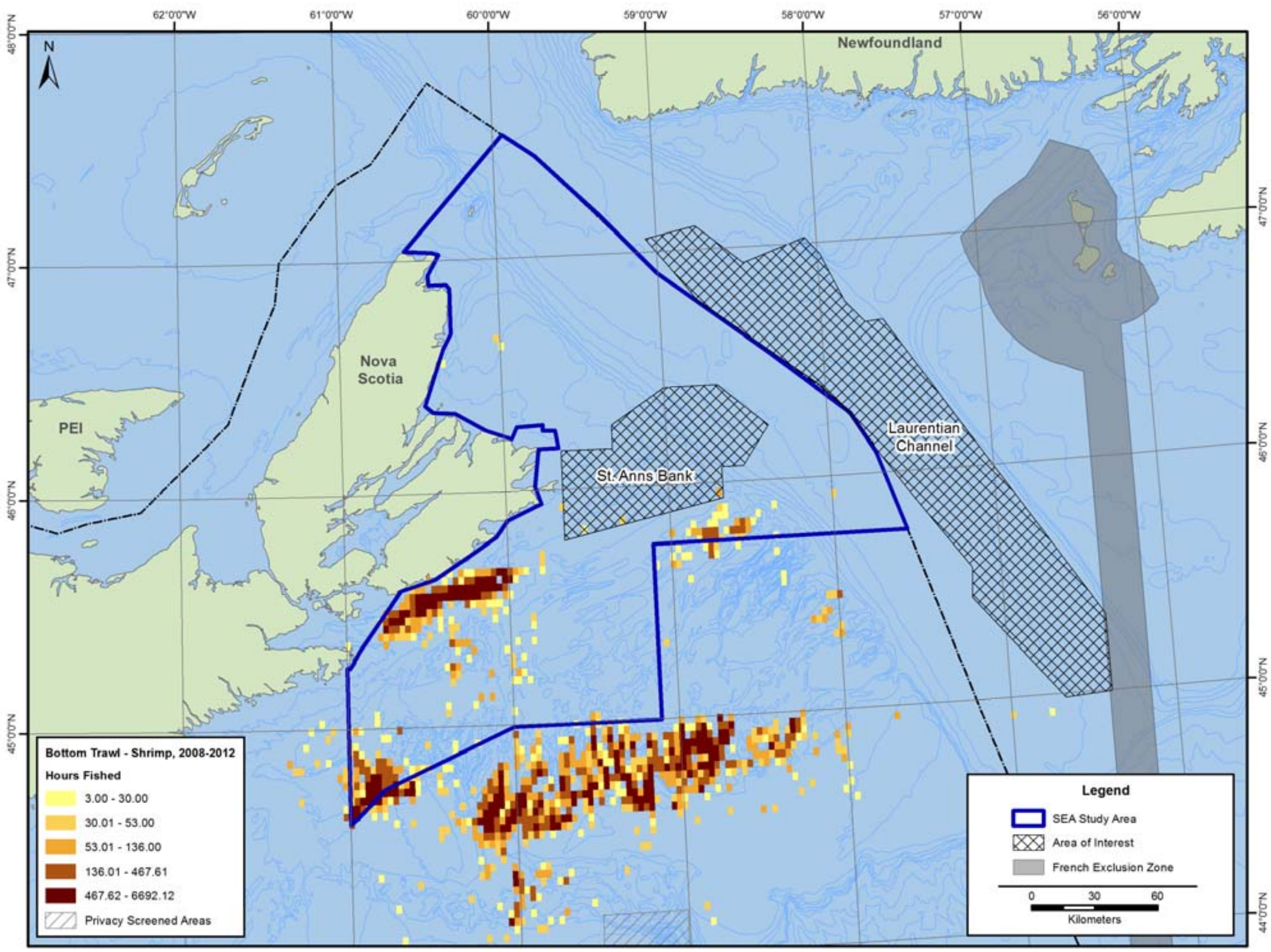


Figure 3-46 Areas where Redfish Bottom Trawl gear is used

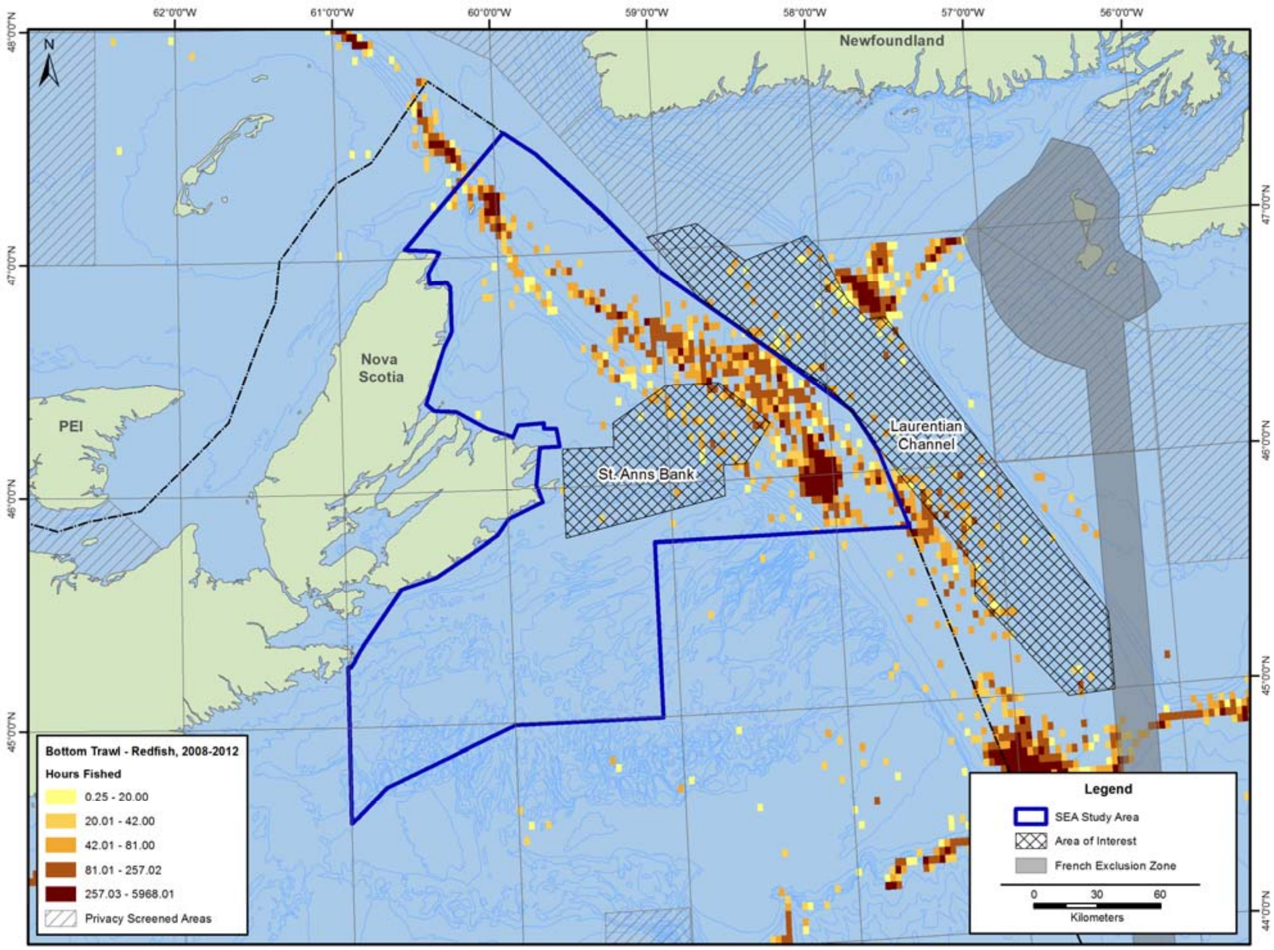


Figure 3-47 Areas where Groundfish Otter Trawl gear is used

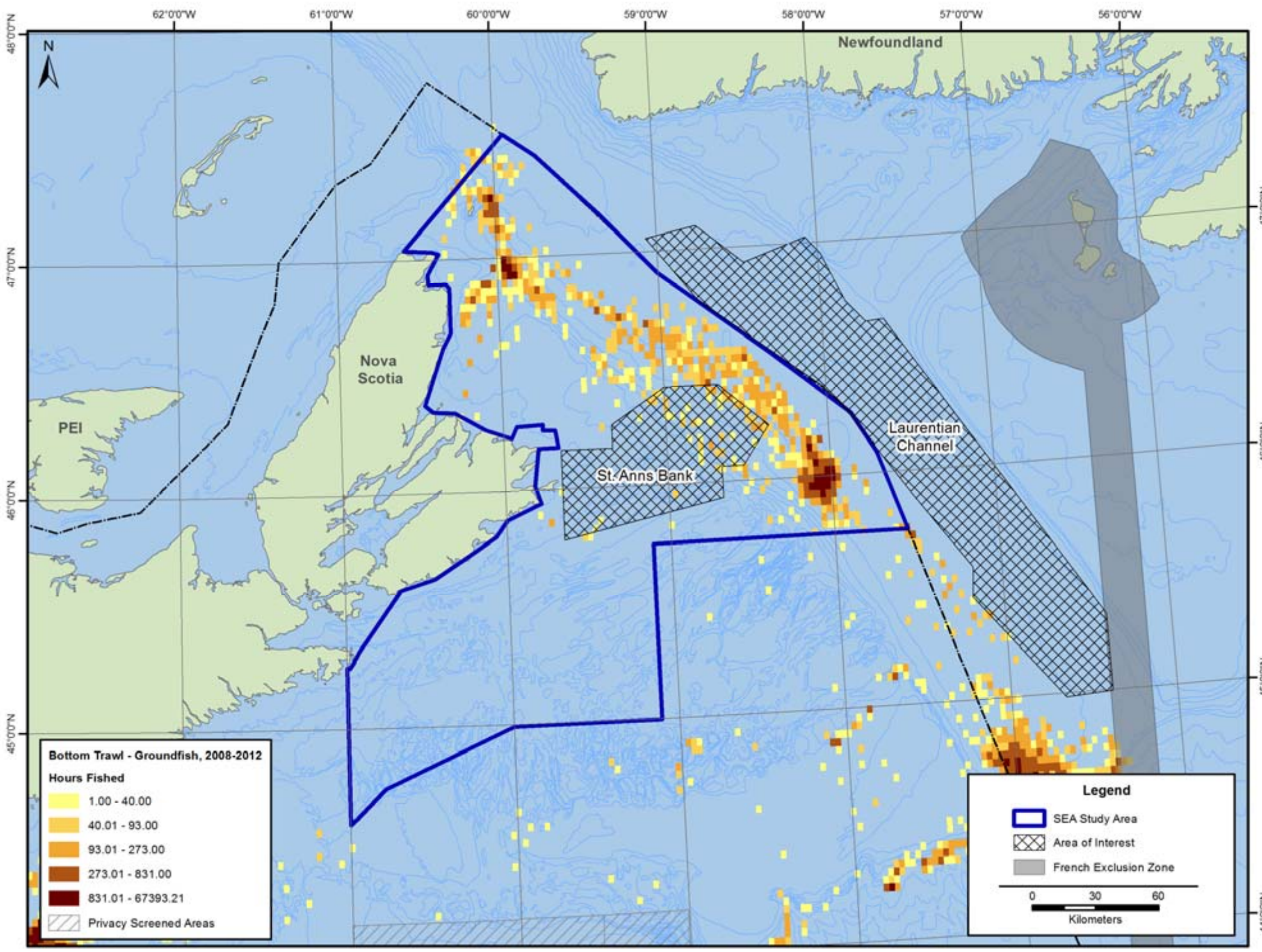


Figure 3-48 Areas where Flatfish Bottom Trawl Gear is used

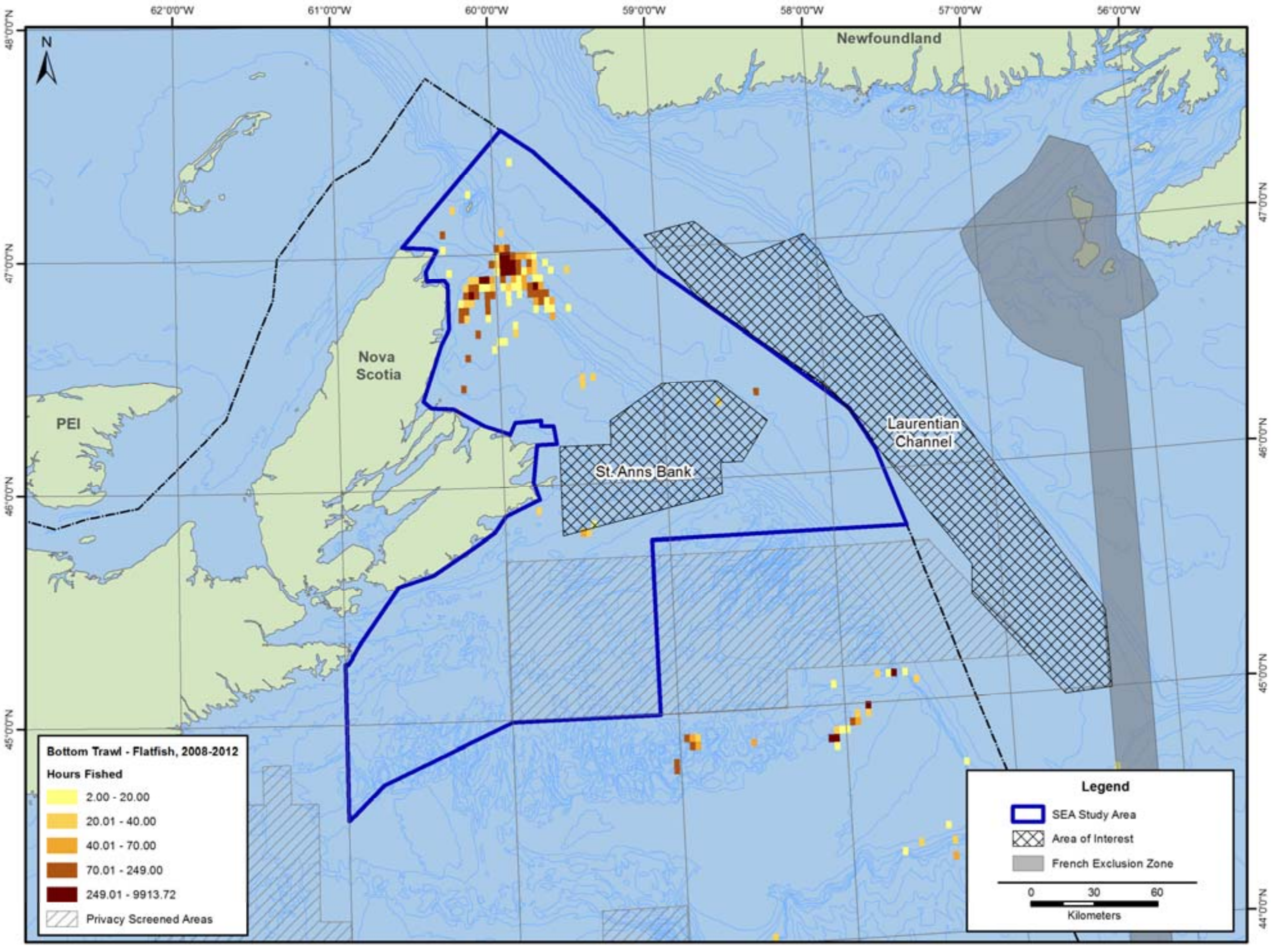


Figure 3-49 Areas where Cod Haddock and Pollock Bottom Trawl Gear is used

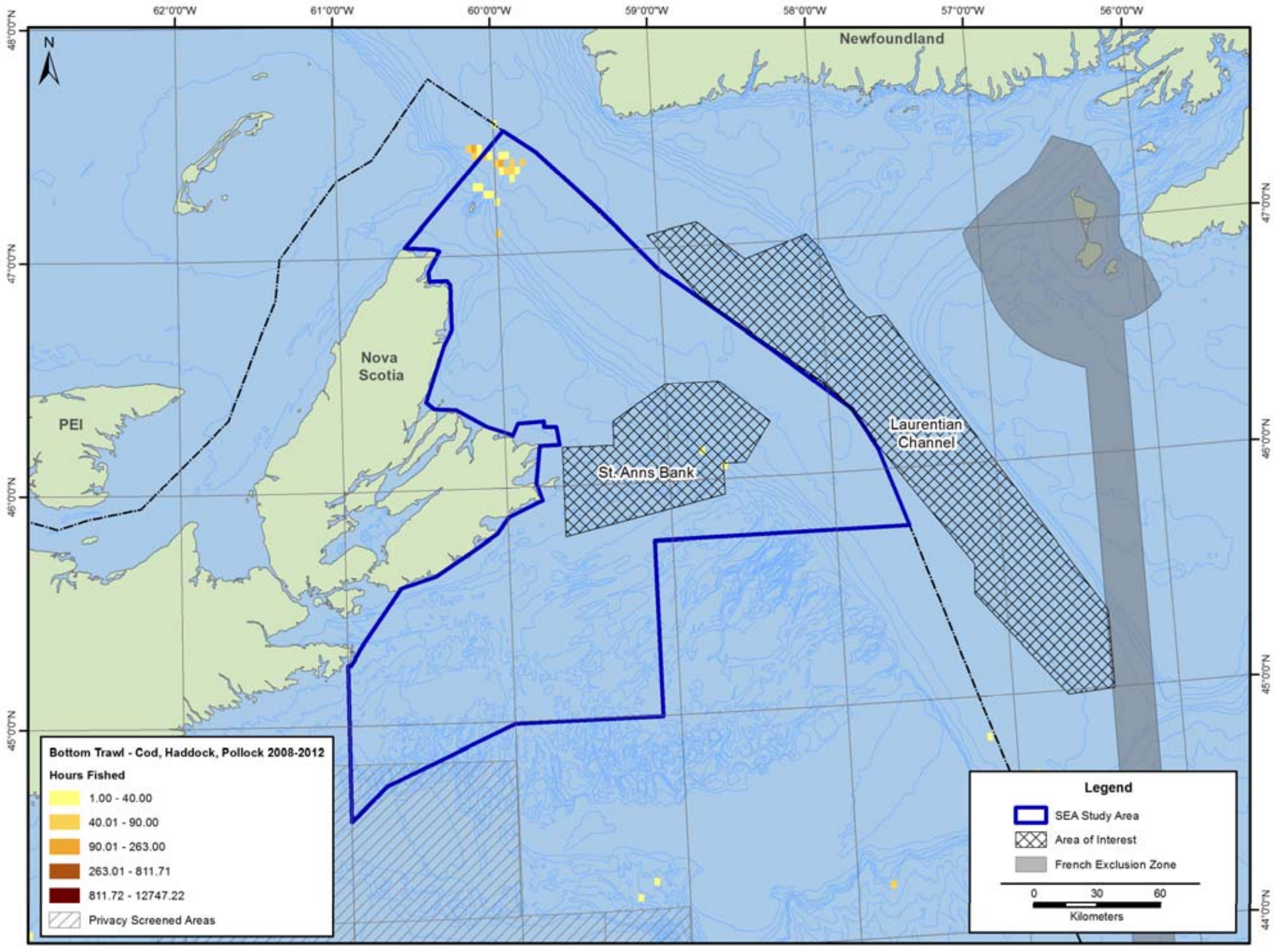


Figure 3-50 Areas where Scallop Dredge Gear are used

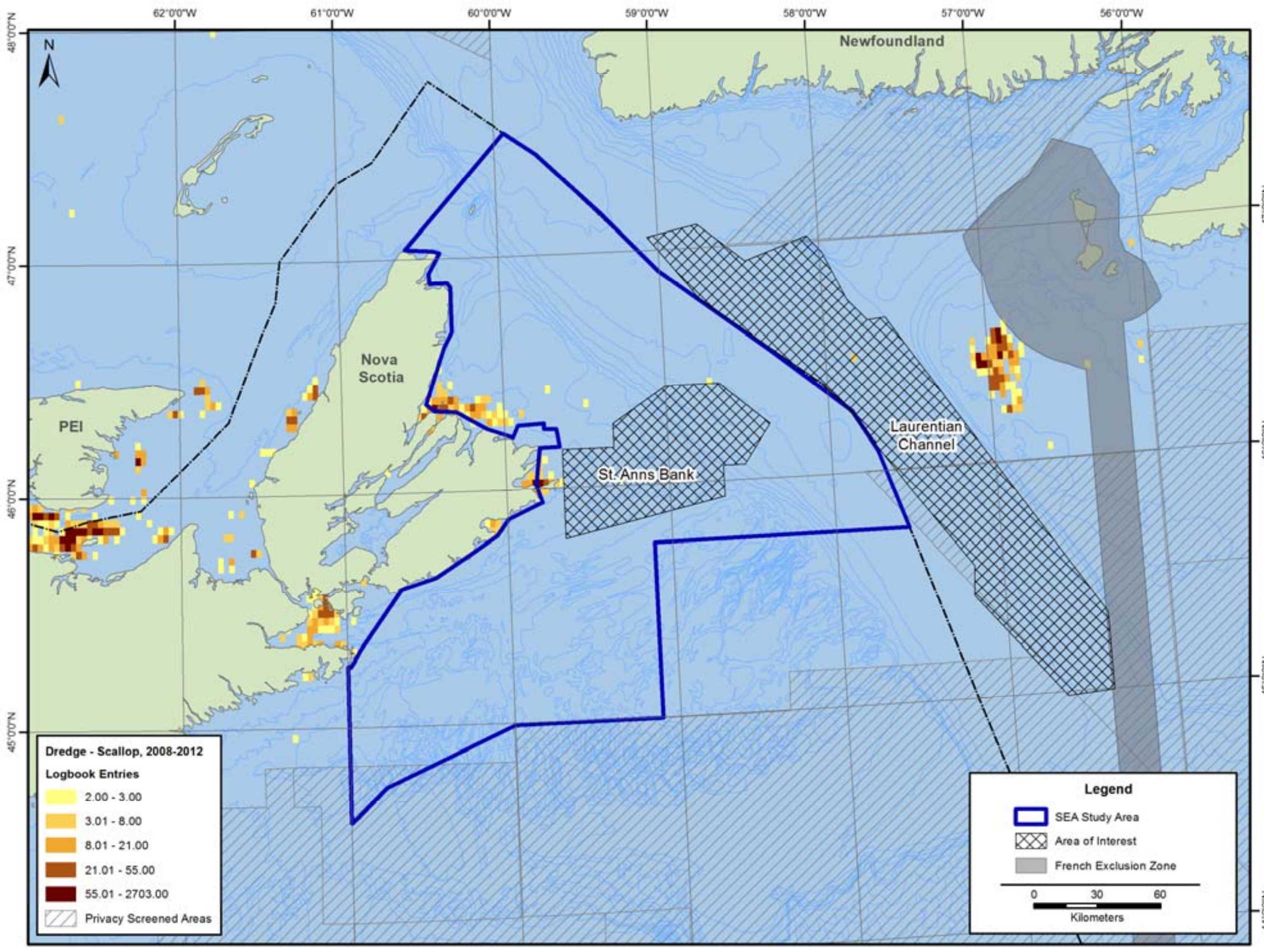


Figure 3-51 Areas where Clam Dredging Gear is used

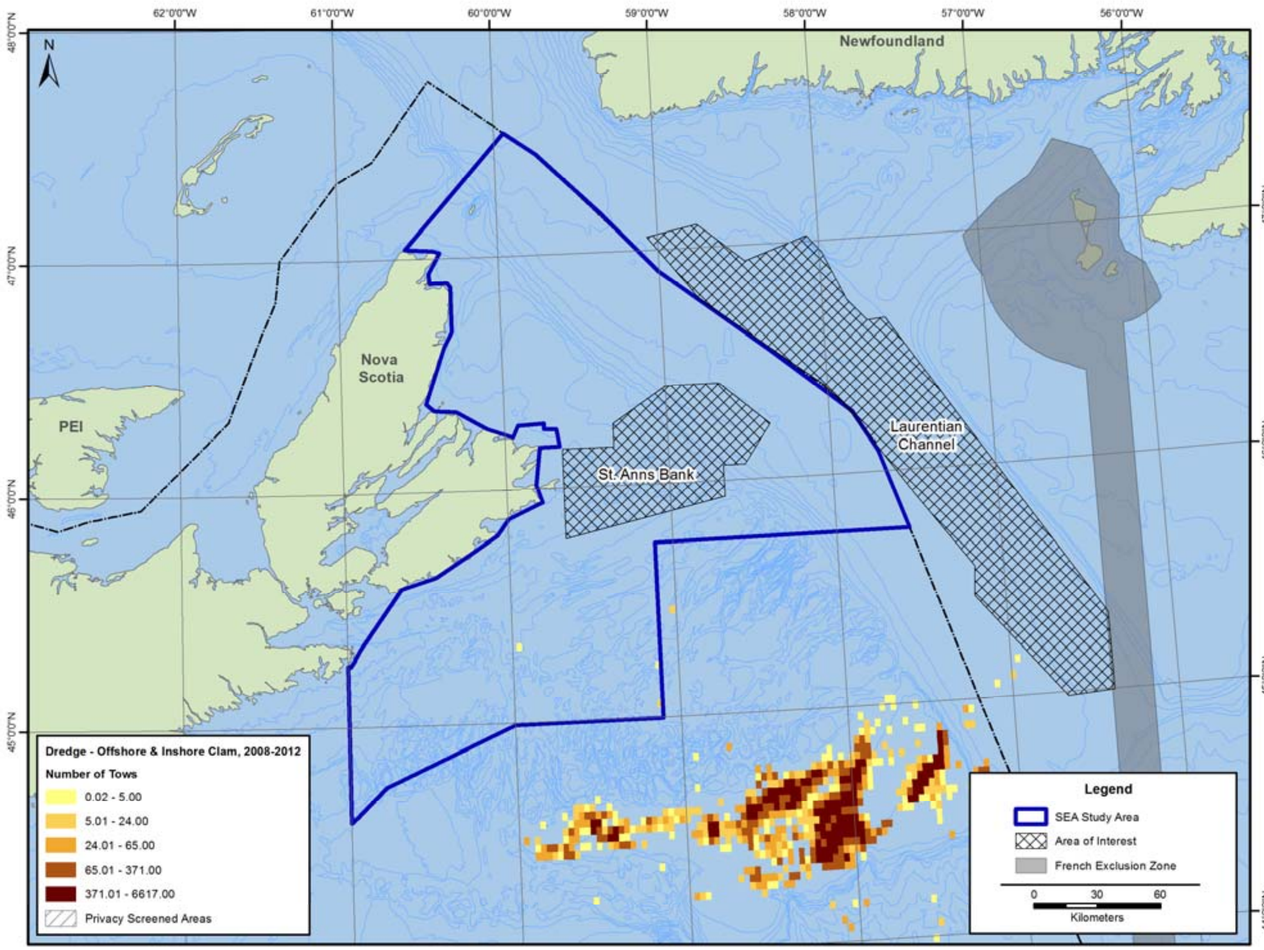


Figure 3-52 Areas where Groundfish Gillnets are used

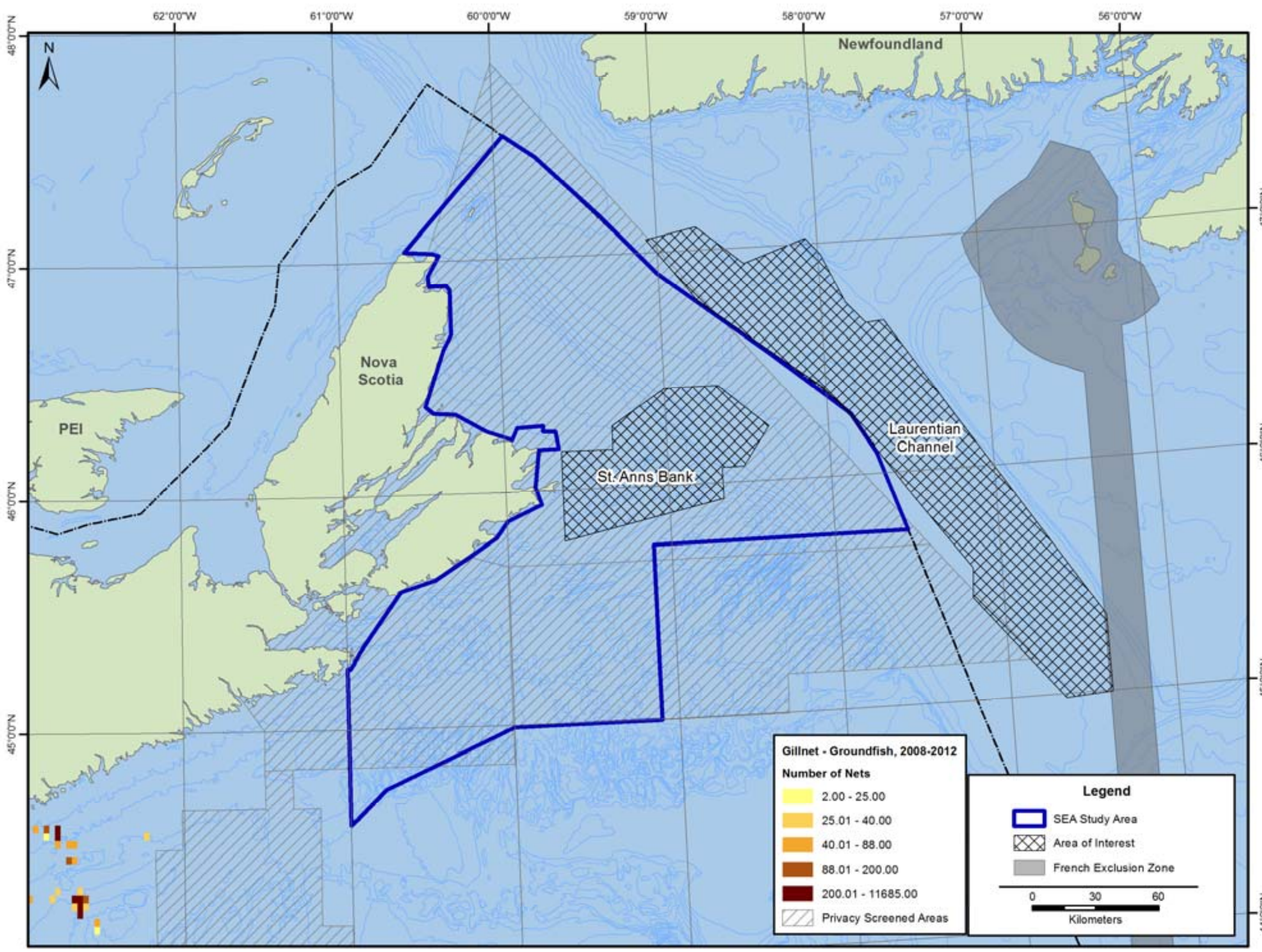


Figure 3-53 Areas where Herring Gillnets are used

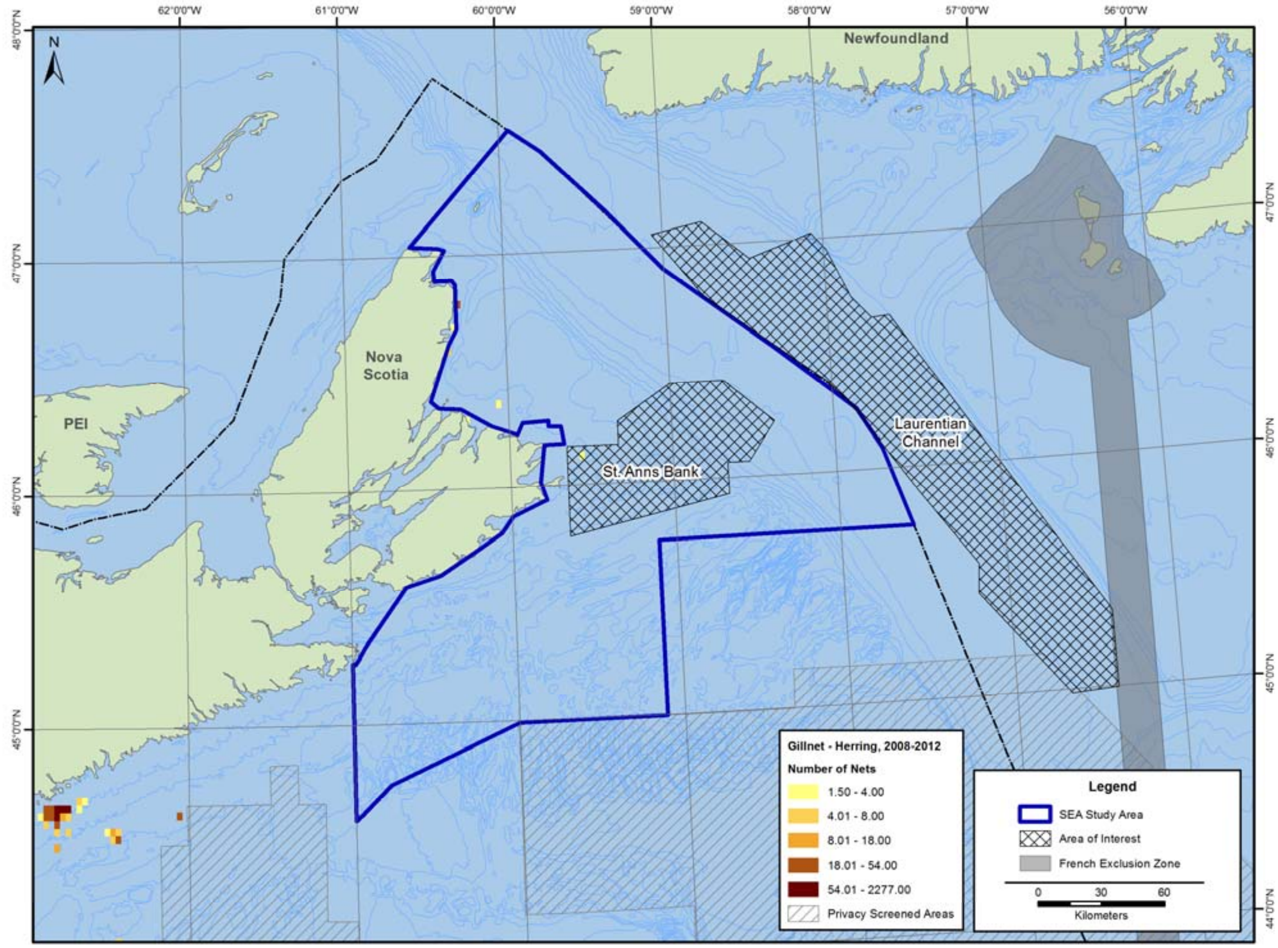


Figure 3-54 Areas where Swordfish Harpoons are used

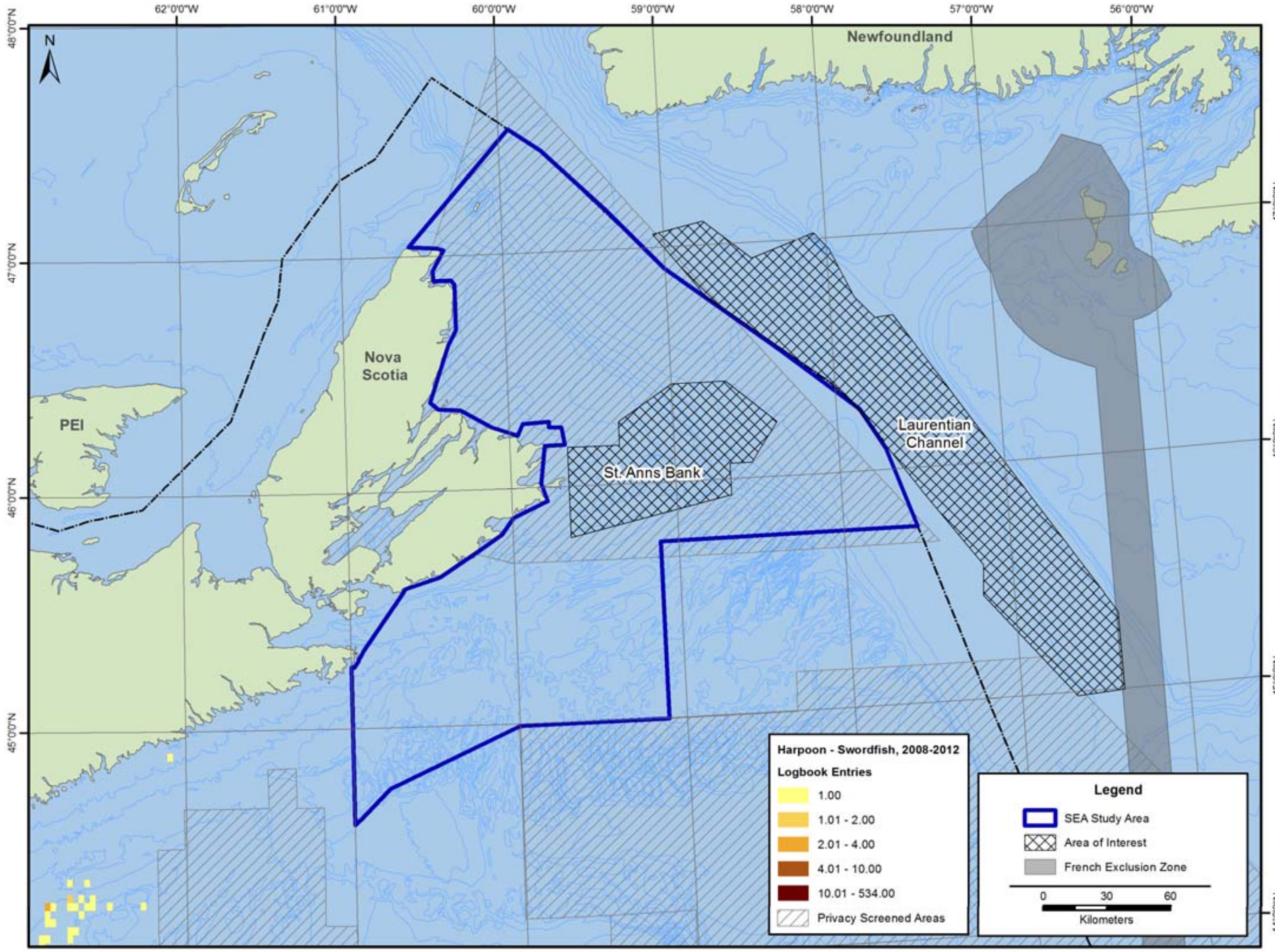


Figure 3-55 Areas where Tuna Harpoons are used

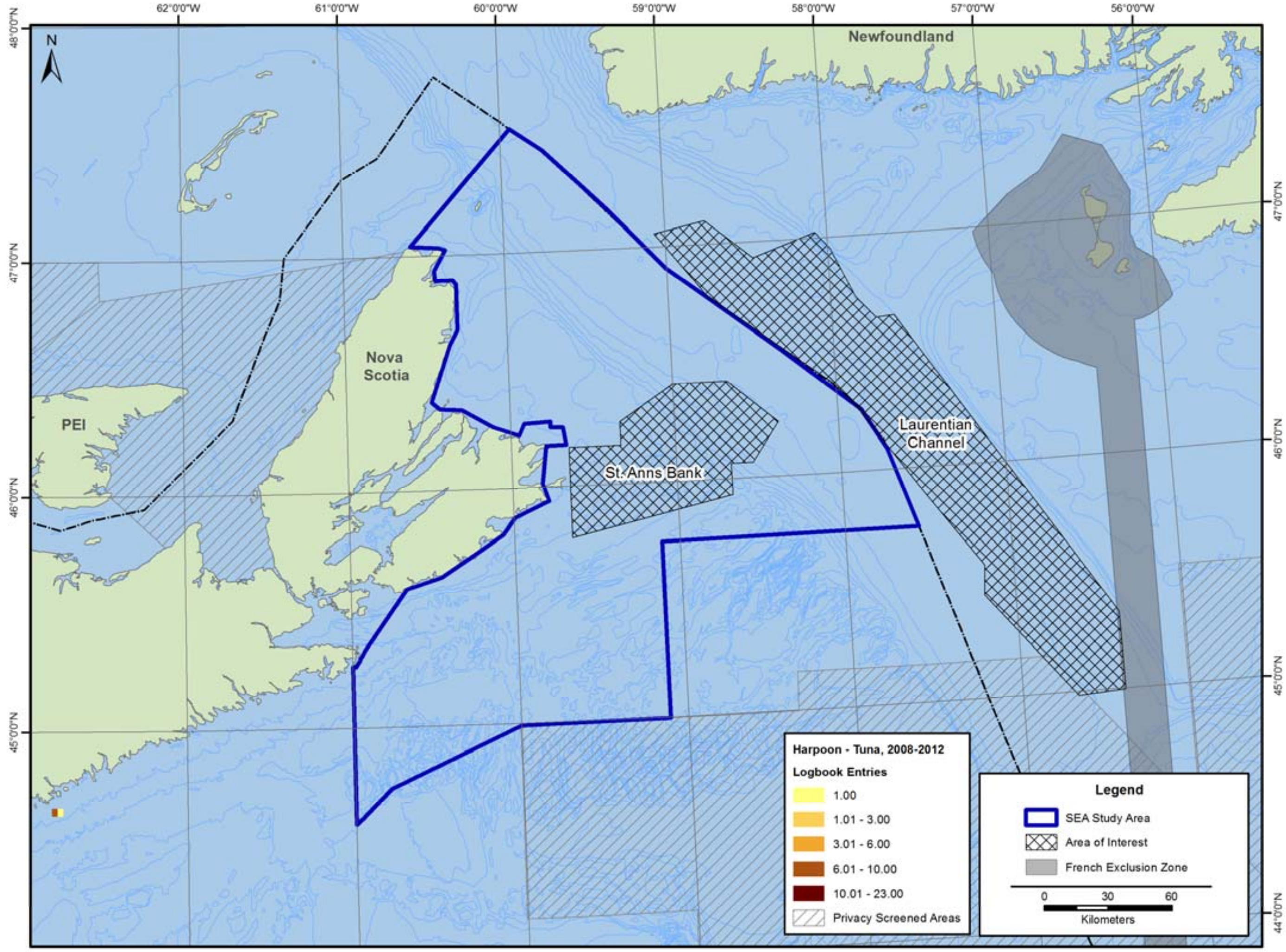


Figure 3-56 Areas where Pelagic Longline Gear is used

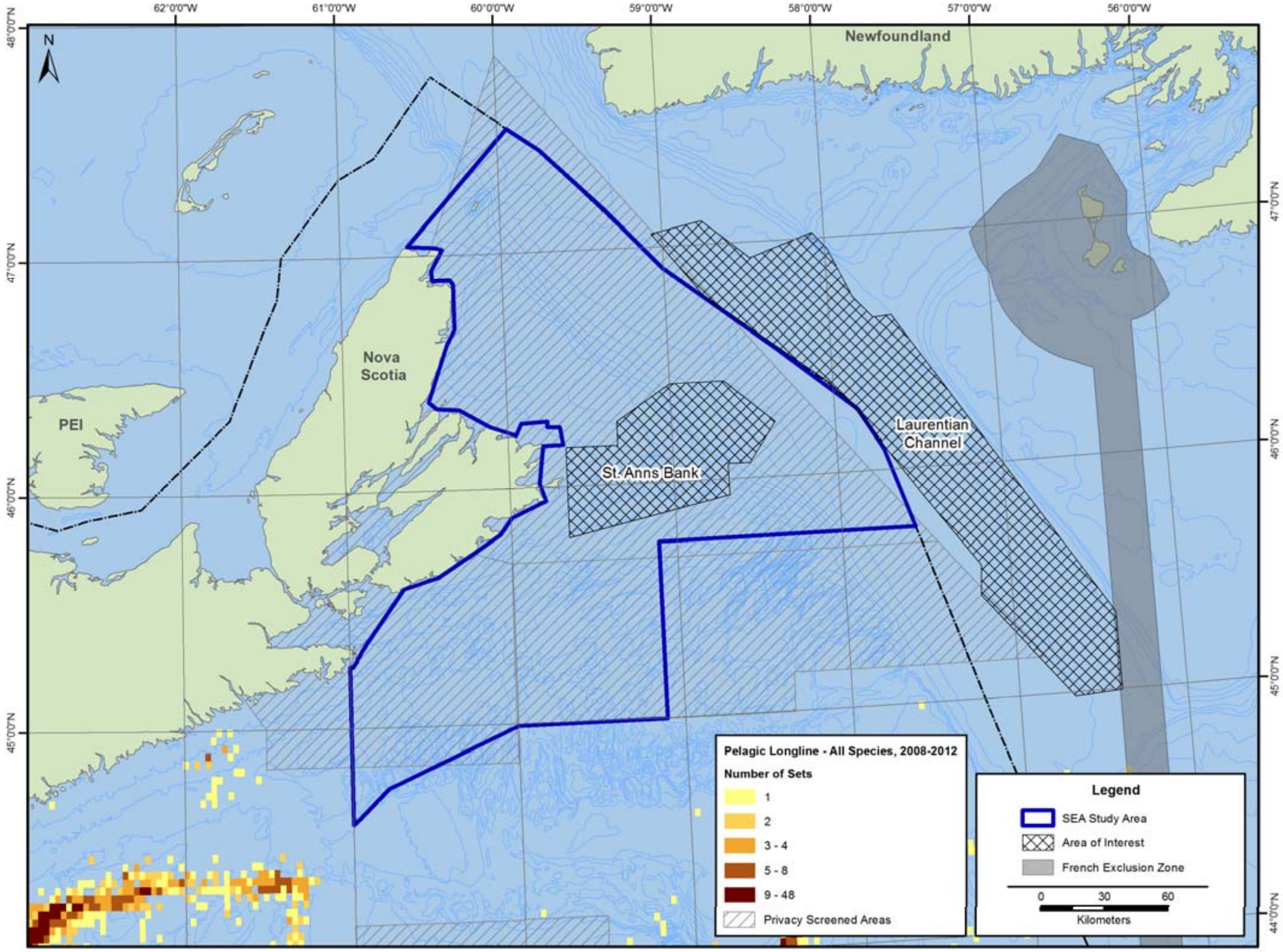


Figure 3-57 Areas where Shrimp Traps are used

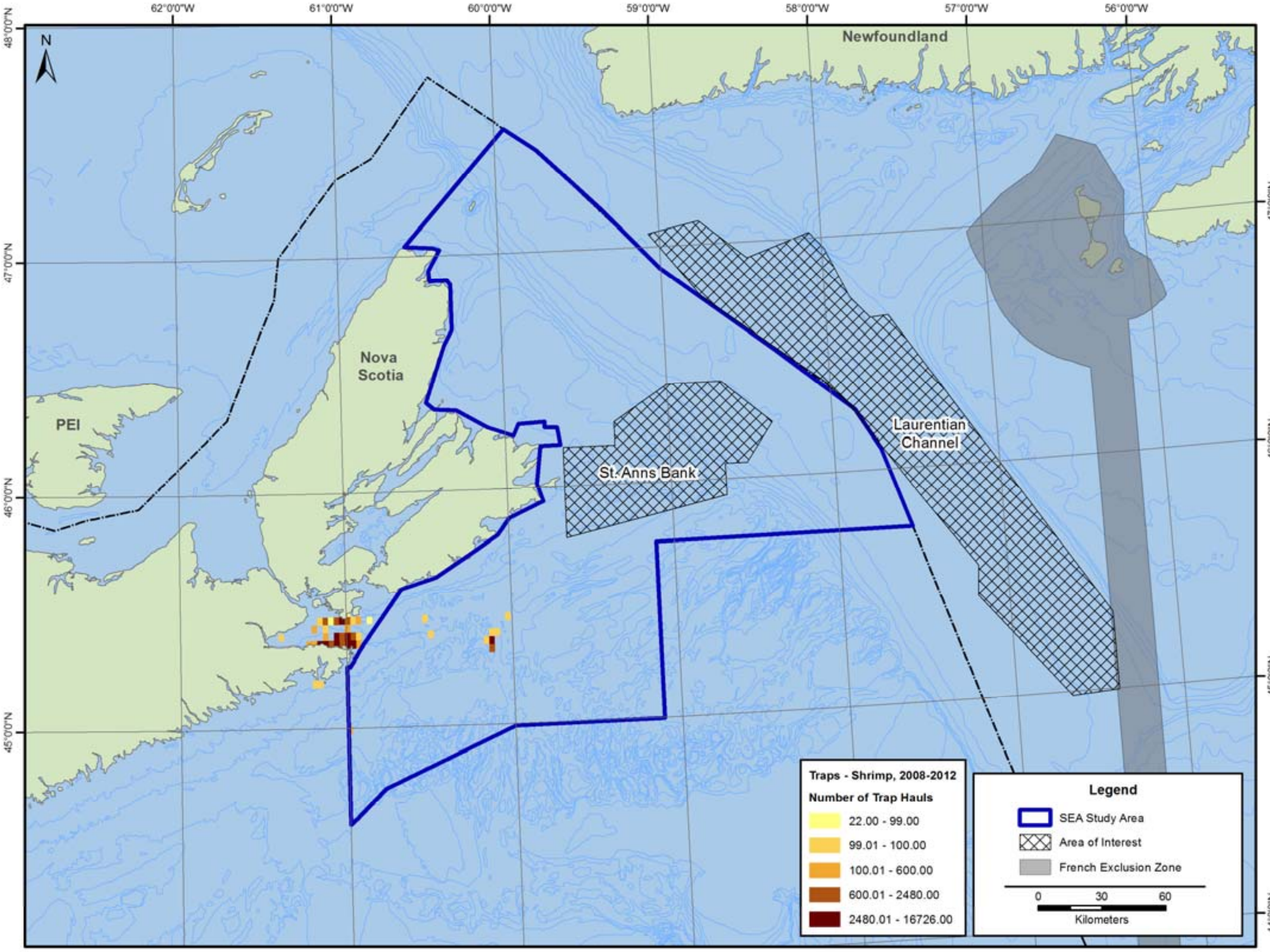


Figure 3-58 Areas where Rock Crab Traps are used

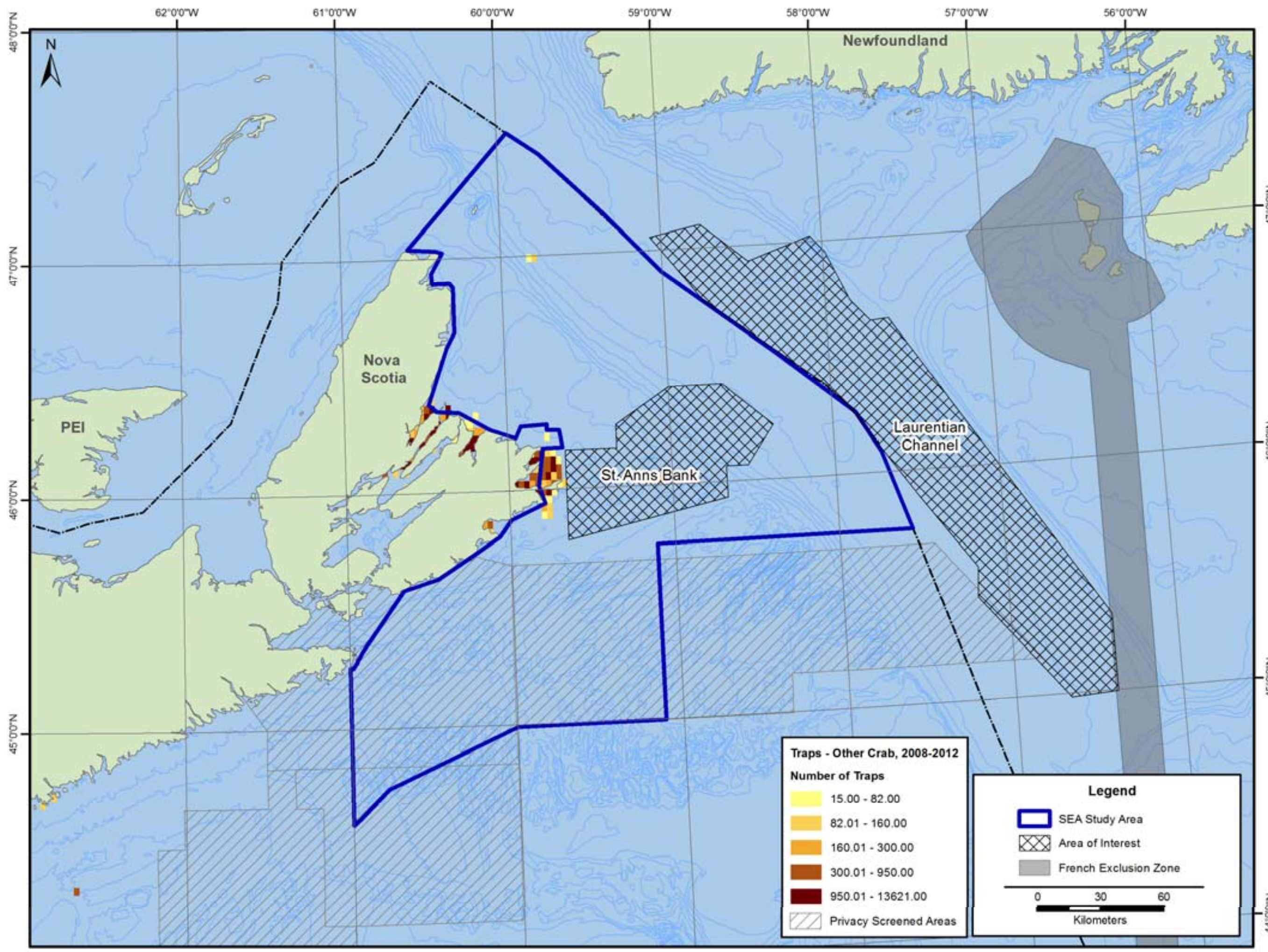


Figure 3-59 Areas where Snow Crab Traps are used

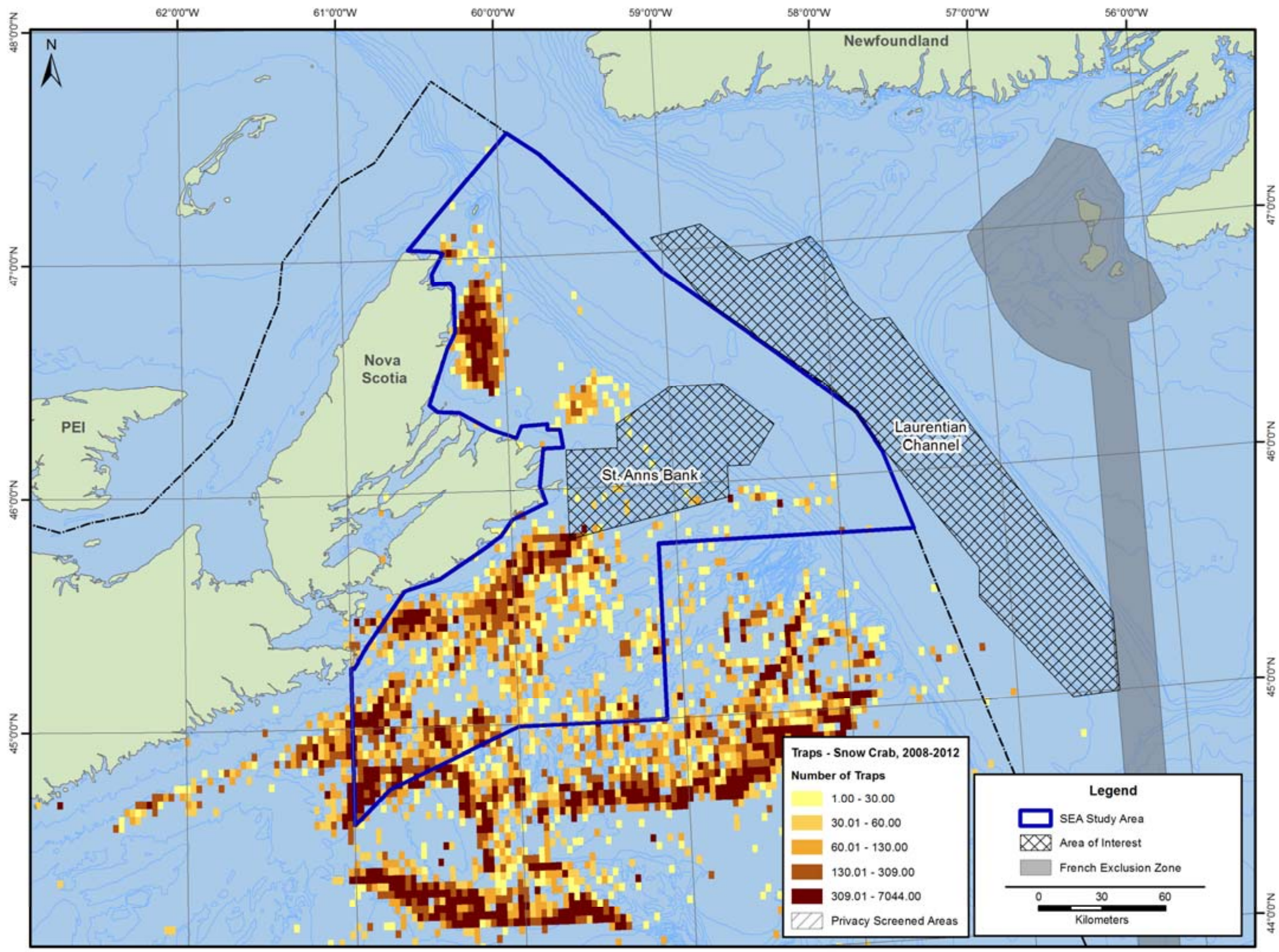
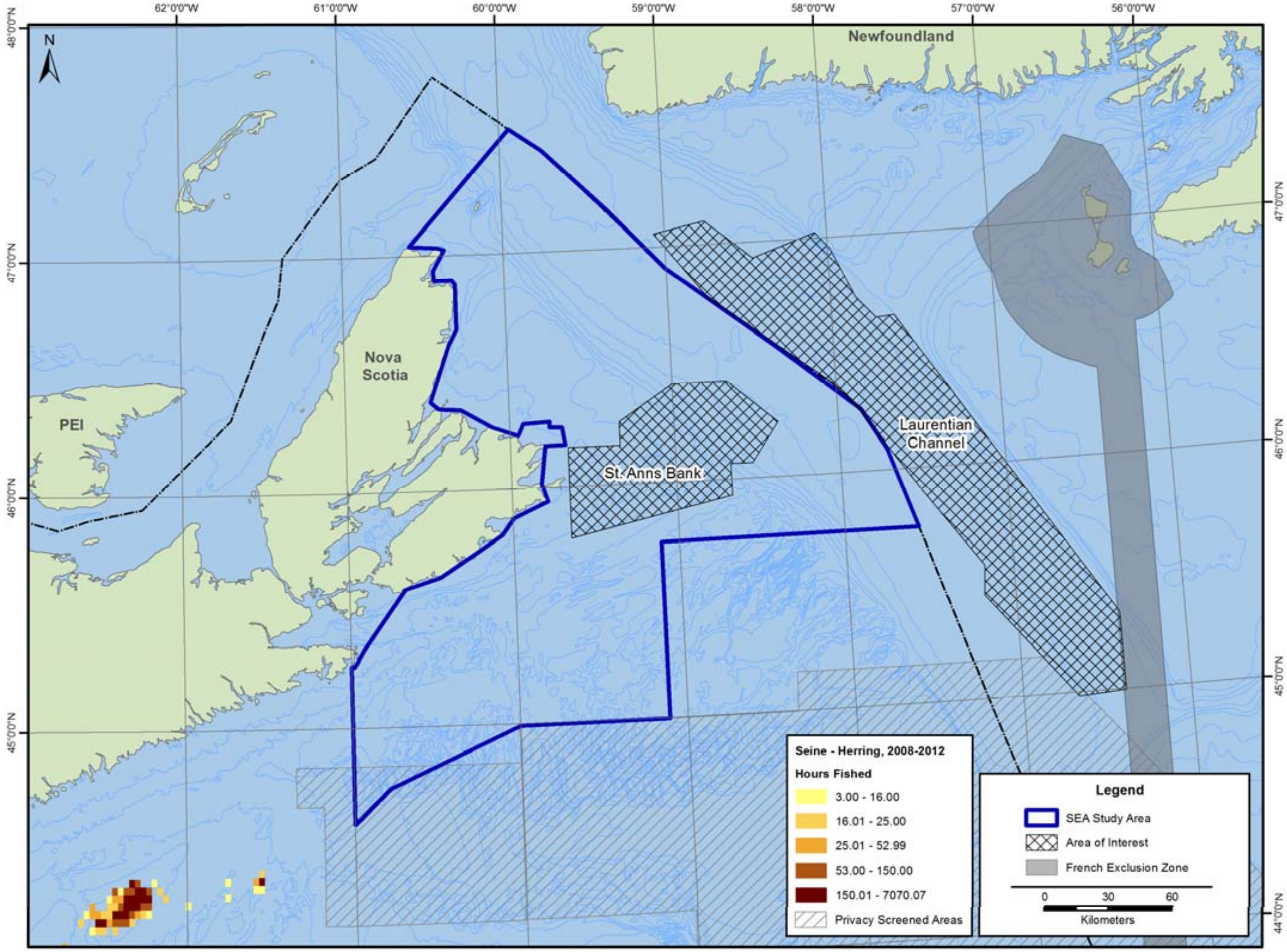


Figure 3-60 Areas where Herring Seines are used



3.3.1.12 Licenses and Enterprises

Table 3-42 provides an overview of the number of fishers currently active in the harvest of fish in the Study Area. The number of active fishers can fluctuate depending on the value of landings, total quotas and costs of fishing. The availability of alternative employment may also play a role in the level of activity within the fishery, particularly with respect to availability of crew.

Table 3-42 Number of active licenses by fishery and year

Species	Fishing Area	Active Licenses 2010	Active licenses 2011	Active licenses 2012	Active licenses 2013p	Active licenses 2014p
Benthic						
Haddock	4VN	14	24	13	23	32
Haddock	4VS	16	51	24	21	16
Haddock	4W	47	0	49	53	50
Pollock	4VN/4VS/4W	63	63	68	74	64
Redfish	4VN	34	27	29	32	49
Redfish	4VS	18	17	20	14	0
Redfish	4W	32	32	37	41	44
White Hake	4VN	42	42	42	43	60
White Hake	4VS	23	21	23	19	13
White Hake	4W	67	75	71	66	76
Greenland Halibut/Turbot	4VN	27	31	37	24	36
Greenland Halibut/Turbot	4VS	16	12	16	17	13
Greenland Halibut/Turbot	4W	24	30	38	37	29
Greysole/Witch Flounder	4VN/4VS/4W	20	22	27	23	27
Grouped Groundfish	4VN/4VS/4W	24	19	24	26	21
Monkfish	4VN/4VS/4W	37	46	44	38	41
Pelagic						
Herring	4VN/4VS/4W	103	84	91	86	65
Mackerel	4VN/4VS/4W	39	26	52	40	37
Swordfish	4VN/4WS	10	15	10	14	19
Swordfish	4W	44	52	41	47	91
Bluefin Tuna	4VN/4VS/4W	54	73	58	58	67
Shellfish/Crustaceans						
Snow Crab	CFA 20 & 21	44	44	39	34	33
Snow Crab	CFA 22I & 22O	37	23	33	37	39
Snow Crab	CFA 23	46	47	42	41	42
Snow Crab	CFA 24E & 24W	50	47	46	42	39

Species	Fishing Area	Active Licenses 2010	Active licenses 2011	Active licenses 2012	Active licenses 2013p	Active licenses 2014p
Lobster	LFA 27 & 28	458	461	462	449	450
Lobster	LFA 29	66	63	64	63	62
Lobster	LFA 30	18	19	19	19	19
Lobster	LFA 31A	69	67	67	68	66
Shrimp, *Pandalus borealis*	SFA 13 & 14	23	21	18	19	16
Shrimp, *Pandalus borealis*	SFA 15	26	28	25	27	24
Scallop	4VN/4VS/4W	33	36	38	32	30

3.3.1.12.1 Fish Harvests (Landings)

Landings have fluctuated over the years in the study Area. These fluctuations are a result in changes in quota (due to variation in abundance) as well as changes in market condition. Table-3-43 provides a summary of landings for the principle commercial fisheries in the Study Area. All data in Table-3-43 have been aggregated by DFO in accordance with reporting policies that respect and protect the income and identity of harvesters and business confidentiality. Furthermore, specific values of landings for each species were not available from DFO due to confidentiality reasons. The departmental representatives stated that there were fluctuations in process that make it difficult to determine direct valuation of catches over time.

Table-3-43 Summary of Fishery Landings (Data provided by Department of Fisheries and Oceans, Ecosystem Management Branch)

Species Landed	Fishing Area	Amount Landed 2010 (‘000)	Amount Landed 2011 (‘000)	Amount Landed 2012 (‘000)	Amount Landed 2013 (‘000)	Amount Landed 2014 (‘000)	Average Landings (‘000)	Average Landings/license (‘000)
Benthic Fishery								
Haddock	4VN	299	17,223*	102	225	605	308	12
Haddock	4VS	7,791		28,681	16,736	12,241	16,362.25	411
Haddock	4W	8,311	4,852	14,101	28,838	27,276	15,705	237
White Hake	4VN	22,541	34,083	12,947	16,058	21,274	21,381	467
White Hake	4VS	19,817	9,721	8,935	9,248	6,775	10,899	550
White Hake	4W	110,038	73,761	59,158	102,839	80,789	85,317	1,202
Pollock	4VN/4VS/4W	549,845	283,495	207,799	47,415	88,667	235,444	3,546
Redfish	4VN	657,428	448,606	703,187	739,545	1,491,793*	637,192	18,631
Redfish	4VS	2,792,160	1,825,919	3,376,505	378,575		2,093,290	151,688
Redfish	4W	637,915	697,899	620,233	1,369,980	1,677,351	1,000,676	26,900
Greenland Halibut/Turbot	4VN	12,440	16,731	19,355	12,728	19,545	16,160	521
Greenland Halibut/Turbot	4VS	1,592	1,969	1,725	954	1,163	1,481	100
Greenland Halibut/Turbot	4W	6,491	10,301	10,099	9,016	5,304	8,242	261
Greysole/Witch Flounder	4VN/4VS/4W	155,844	154,439	184,730	169,043	216,904	176,192	7,403
Grouped Groundfish	4VN/4VS/4W	5,835	5,432	165,257	250,008	65,331	98,373	4,315
Monkfish	4VN/4VS/4W	2,597	17,484	3,457	9,877	21,380	10,959	266
Pelagic Fishery								

Species Landed	Fishing Area	Amount Landed 2010 ('000)	Amount Landed 2011 ('000)	Amount Landed 2012 ('000)	Amount Landed 2013 ('000)	Amount Landed 2014 ('000)	Average Landings ('000)	Average Landings/license ('000)
Herring	4VN/4VS/4W	9,873,006	11,493,536	1,802,546	2,971,455	1,221,975	5,472,504	63,782
Mackerel	4VN/4VS/4W	135,613	19,087	326,702	162,276	363,034	201,342	5,189
Swordfish	4VN/4WS	93,957	91,280	60,277	115,705	197,954	111,835	8,223
Swordfish	4W	628,656	595,539	517,960	803,127	879,158	684,888	12,453
Bluefin Tuna	4VN/4VS/4W	73,725	64,395	68,858	89,853	79,112	75,189	1,213
Shellfish/Crustaceans								
Scallop	4VN/4VS/4W	343,749	306,994	660,689	800,568	410,946	504,589	14,929
Shrimp	SFA 13 & 14	1,905,964	2,520,121	2,351,981	2,587,833	2,909,531	2,455,086	126,551
Shrimp	SFA 15	2,433,698	1,748,452	1,388,352	943,818	1,309,580	1,564,780	60,184
Snow Crab	CFA 20 & 21	323,741	340,631	305,402	325,163	326,695	324,326	8,359
Snow Crab	CFA 22I & 22O	252,688	194,882	297,770	457,940	454,445	331,545	9,809
Snow Crab	CFA 23	6,701,632	6,582,777	6,326,150	6,146,373	6,084,669	6,368,320	146,062
Snow Crab	CFA 24E & 24W	6,303,266	5,896,022	5,580,695	5,311,323	5,276,443	5,673,550	126,642
Lobster	LFA 27 & 28	2,436,461	2,548,777	2,600,787	3,599,474	3,688,820	2,974,864	6,524
Lobster	LFA 29	913,912	726,759	729,078	607,342	758,701	747,158	11,748
Lobster	LFA 30	371,157	383,447	416,373	461,103	454,712	417,358	22,200
Lobster	LFA 31A	910,727	757,385	806,998	670,824	805,580	790,303	11,726

*Data has been amalgamated data due to DFO reporting policies. Amalgamated data is not included in calculation of averages.

Landings information illustrates the significance of the commercial fishery to the local economy through employment and income. As is the case with much of Atlantic Canada, the lobster and snow crab fisheries provide the greatest level of employment (seasonal) however, other fisheries may contribute to greater levels of employment in post-harvest processing within the province, since lobsters are seldom processed in the region (NSDFA 2015).

In general there has been a continued decline landings. This has been evident through discussions with DFO representatives regarding limitations in data availability. Information on landings was aggregated across regions due to the lack of sufficient numbers of individual harvesters (minimum aggregate size of five licenses for aggregation purposes) with reported landings for some groundfish species. Redfish has been a small but important fishery for the past several decades (since the general collapse of the groundfish fishery in the early 1990's) however, there are signs of decline that have precipitated efforts to define quotas based on rigorous application of the precautionary approach (DFO 2012). As a result, fishers have become more dependent on fewer species, particularly high valued species such as snow crab and lobster, for income. Some fish plants have maintained employment through processing imported groundfish.

Figure 3-61 Benthic Fishery Average Landings

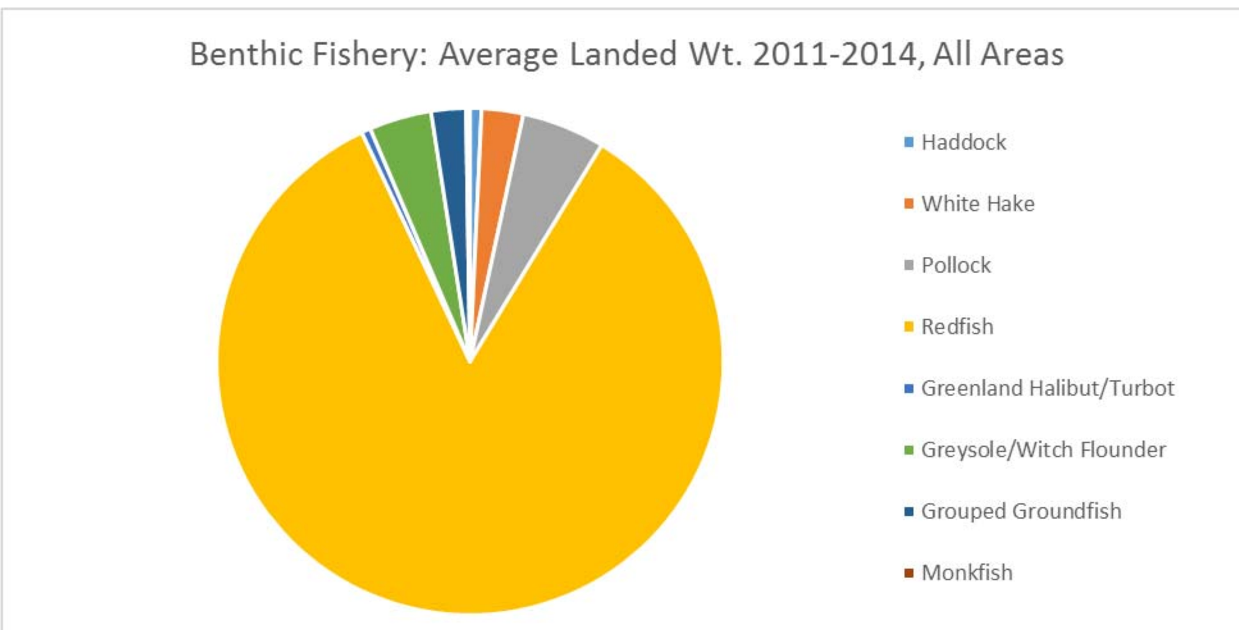


Figure 3-62 Pelagic Fishery Average Landings

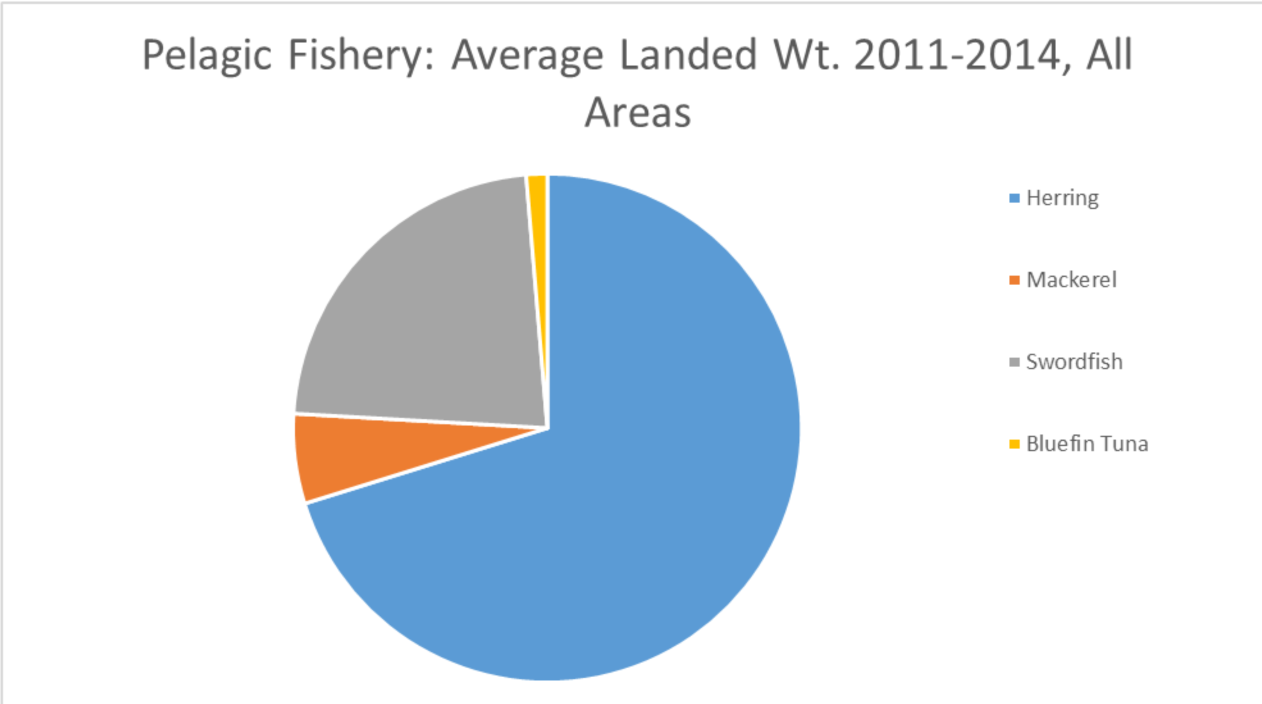


Figure 3-63 Shellfish Average landings

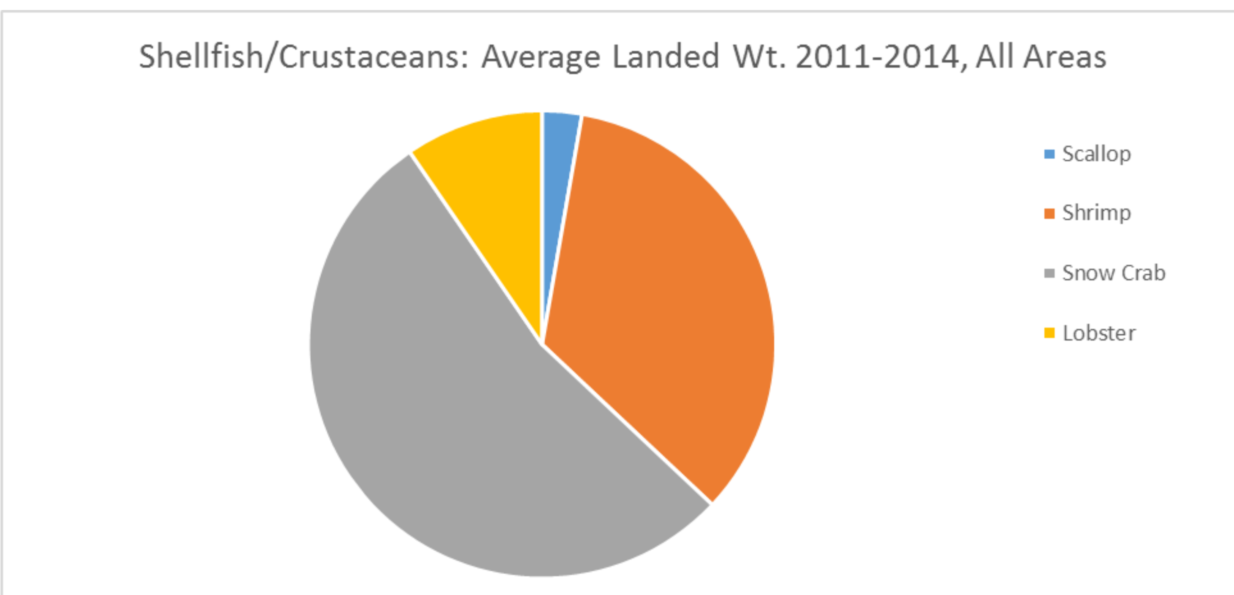


Figure 3-64 Average landings by license

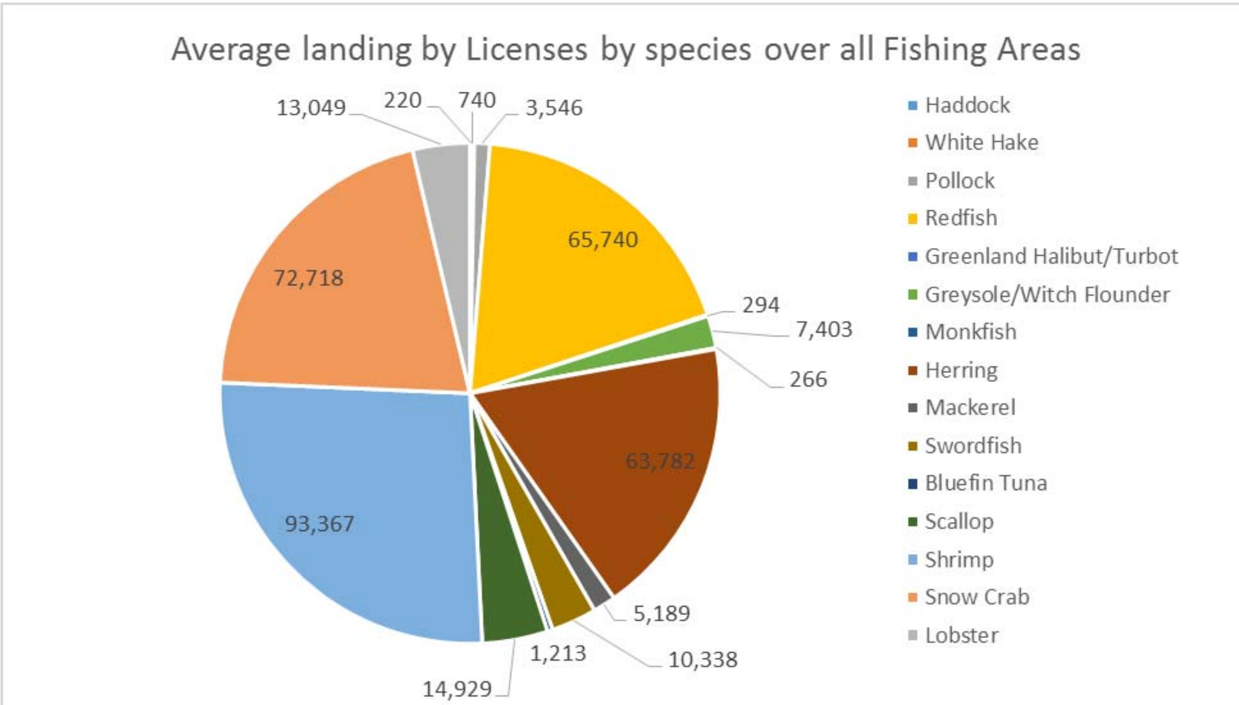


Figure 3-65 to Figure **3-85** illustrate the locations of fishing activity for the above noted landings (in alphabetical order). These fisheries represent a source of income and employment for fishing communities along the coast of the Study Area and adjacent areas.

Figure 3-65. Atlantic Halibut Harvesting Areas

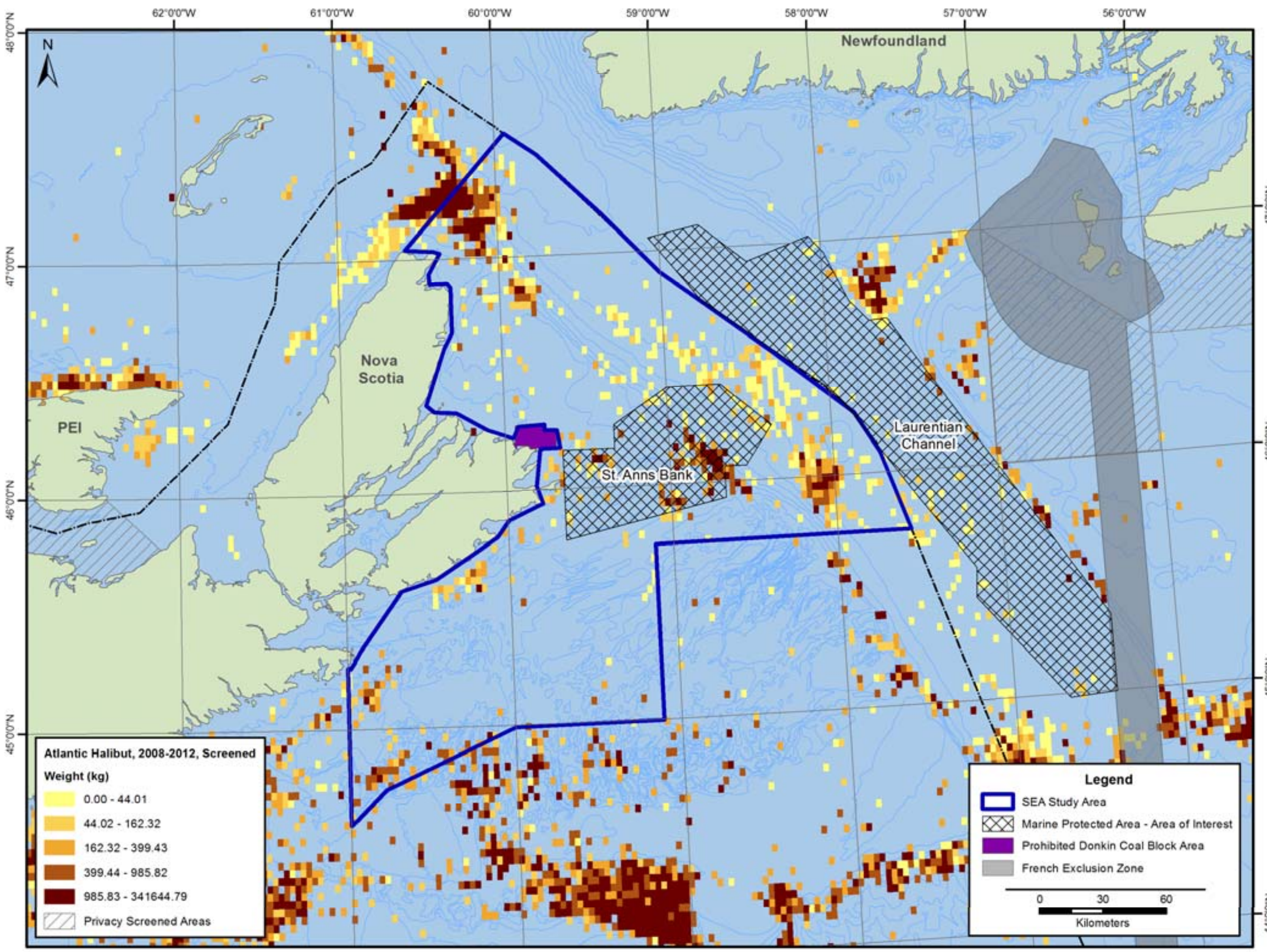


Figure 3-66. Atlantic Bluefin Tuna Harvesting Areas

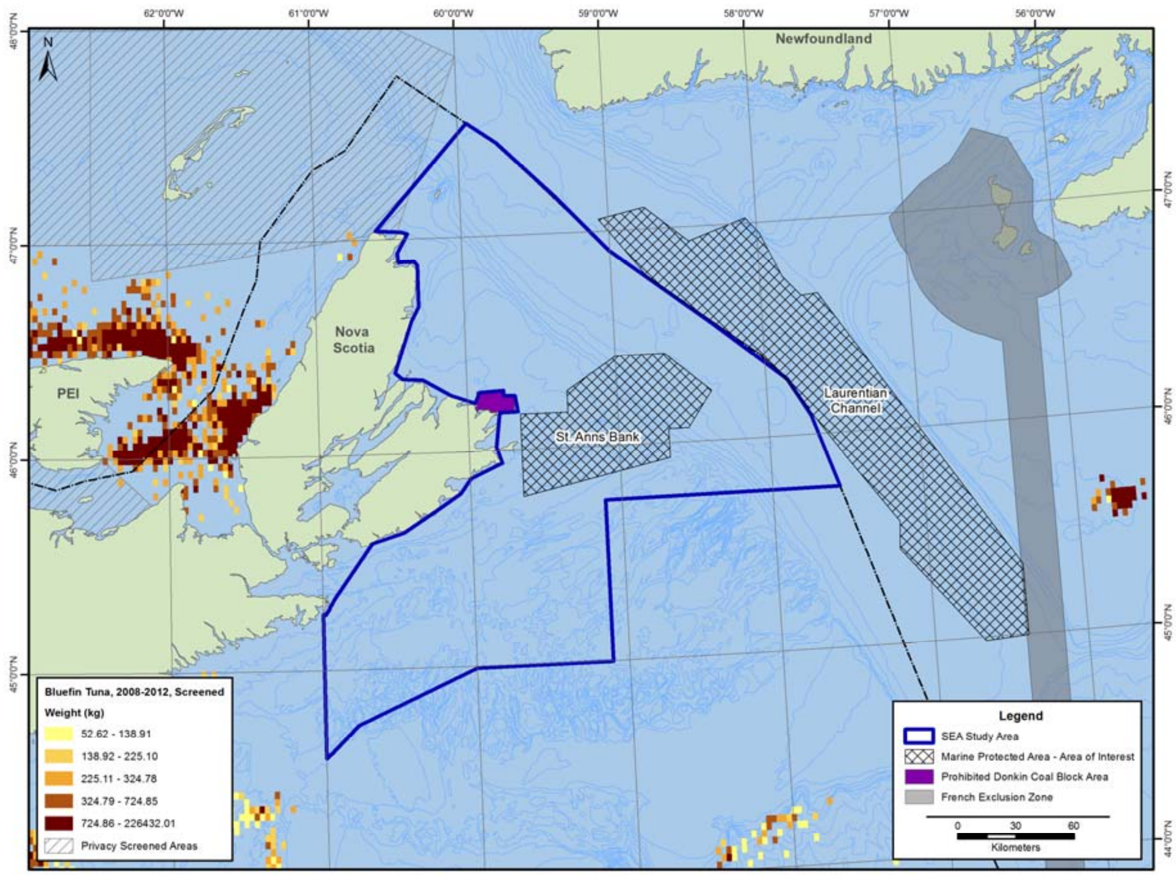


Figure 3-67. Clams Harvesting Areas

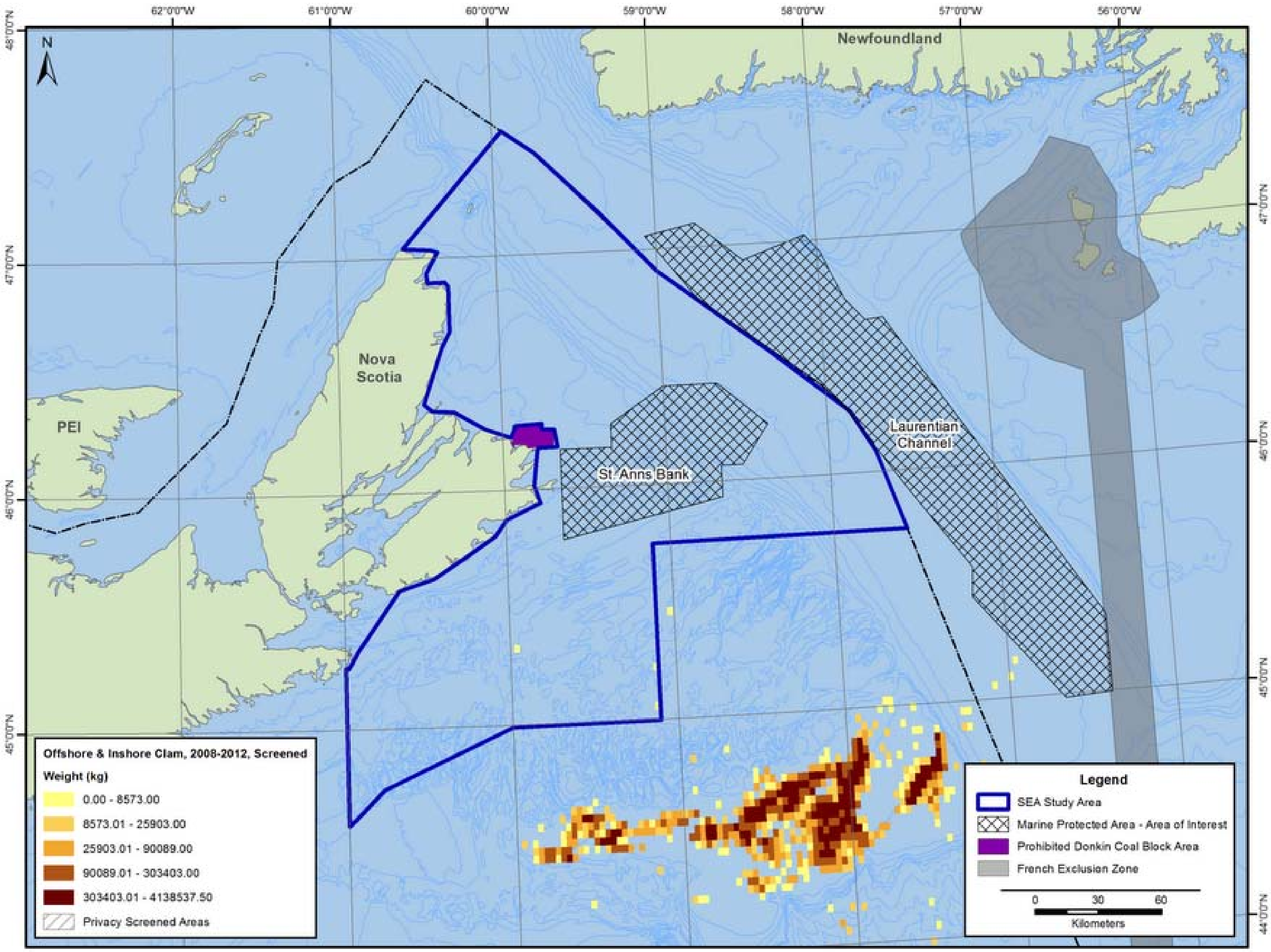


Figure 3-68. Flatfish Harvesting Areas

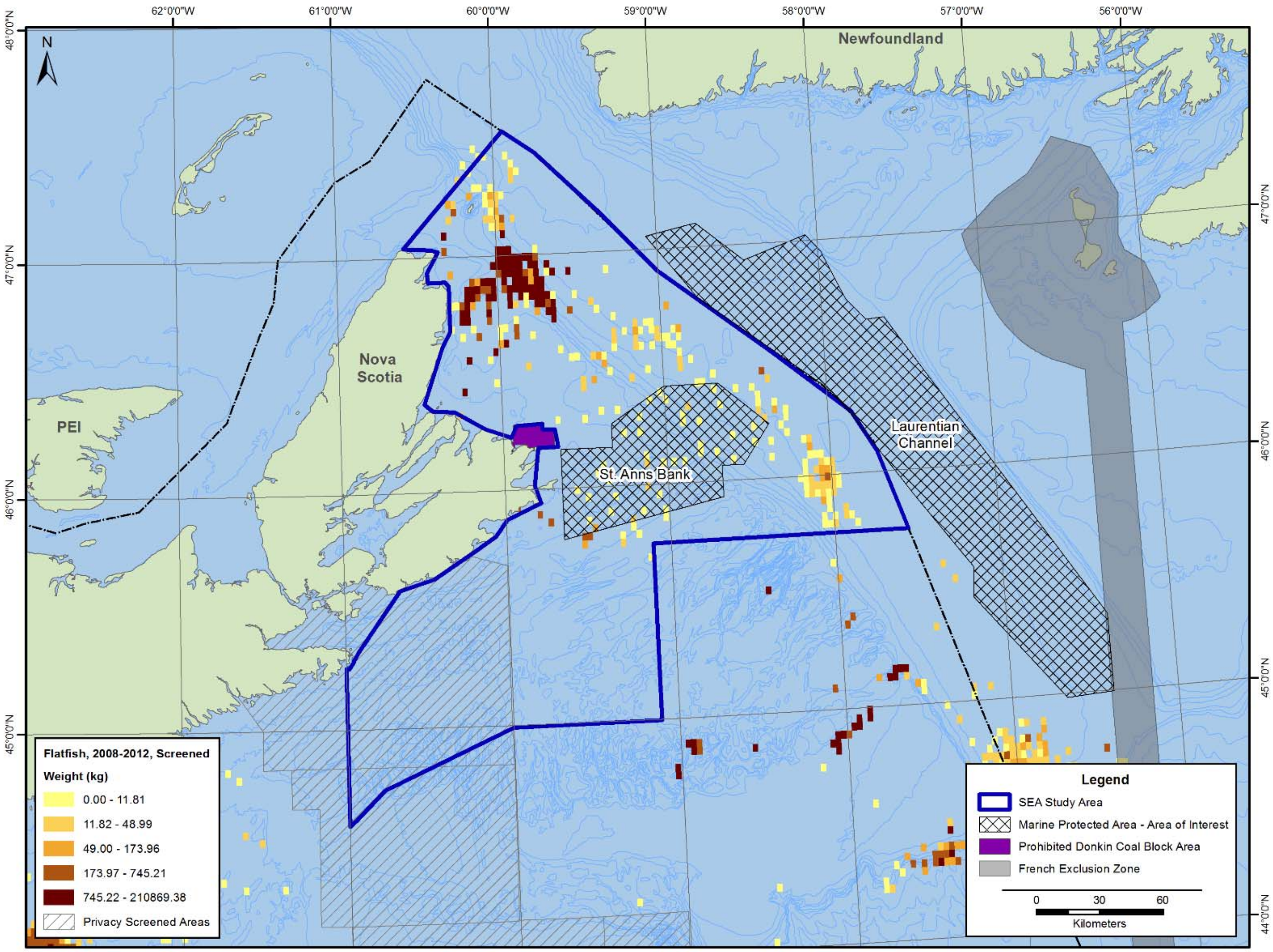


Figure 3-69. Greenland Halibut Harvesting Areas

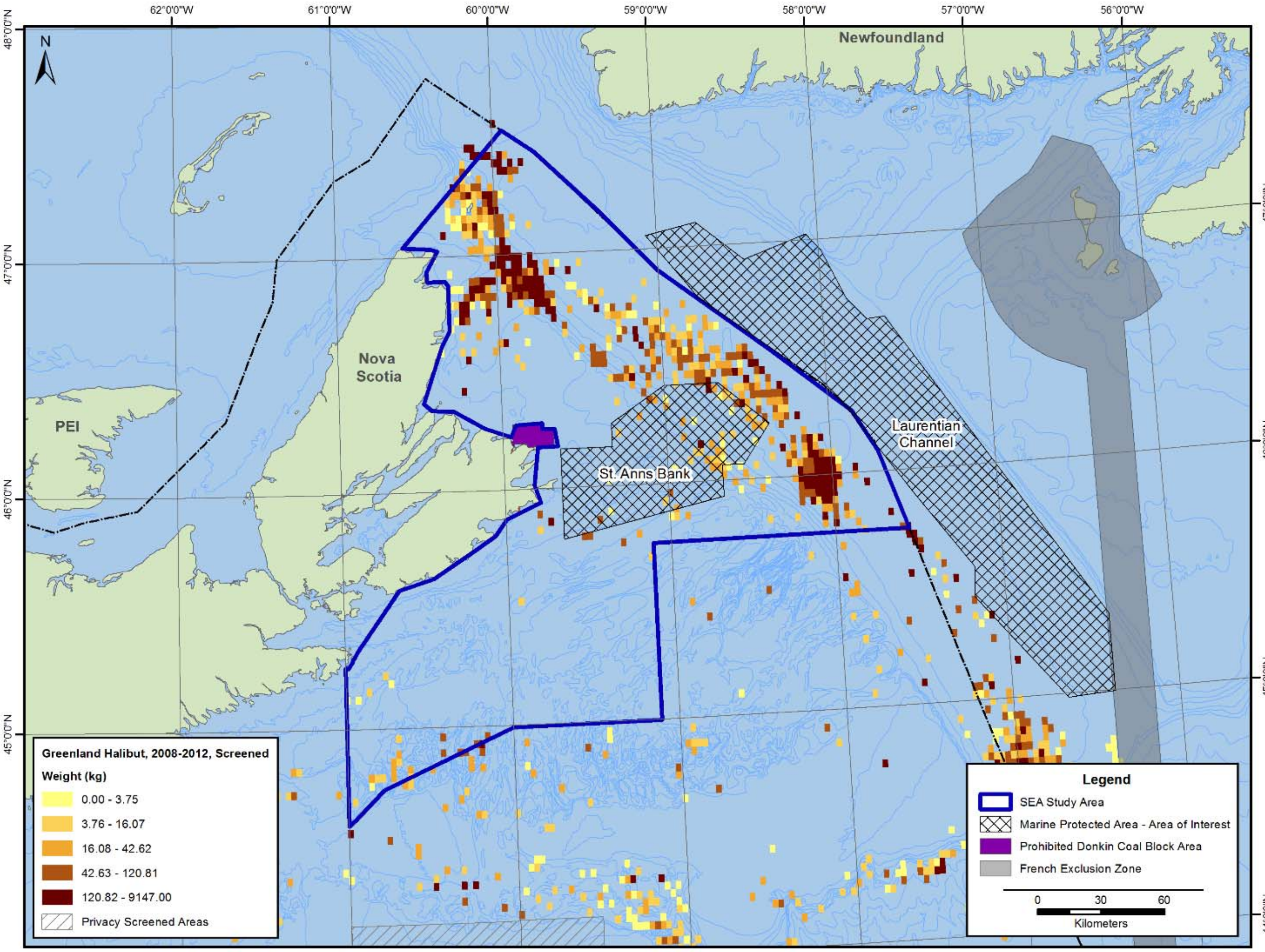


Figure 3-70. Groundfish Harvesting Areas

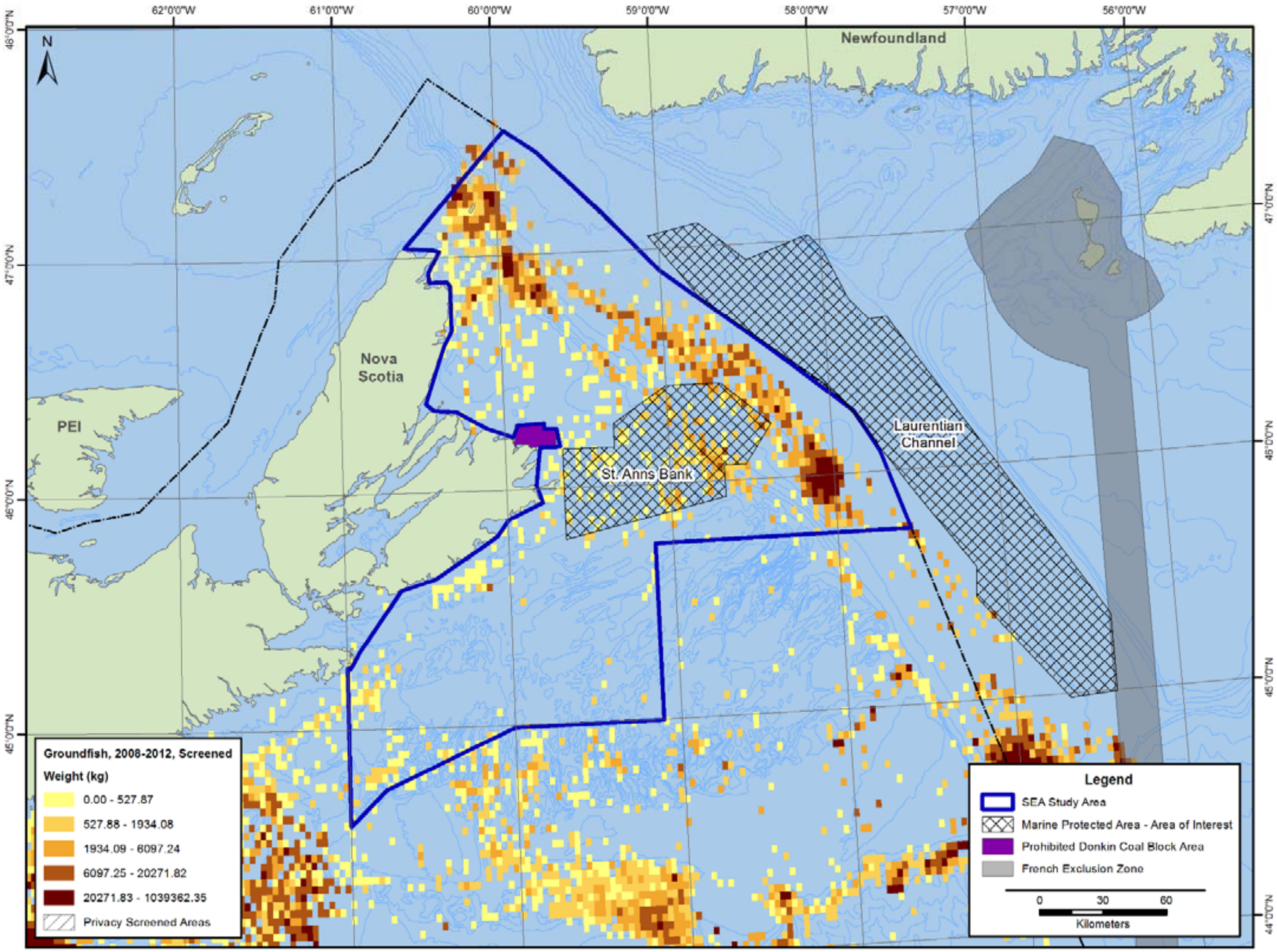


Figure 3-71. Hagfish Harvesting Areas

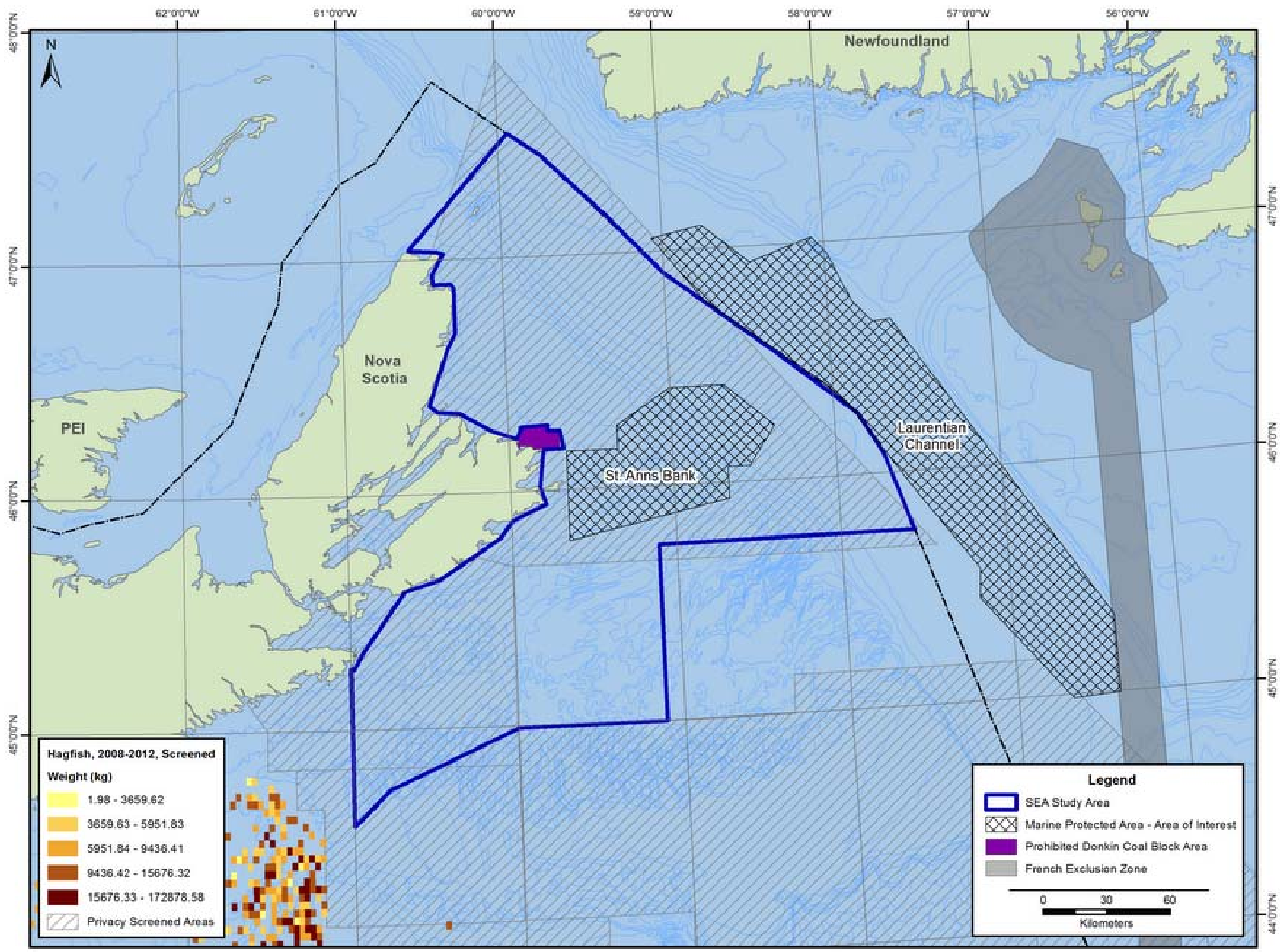


Figure 3-72. Herring Harvesting Areas

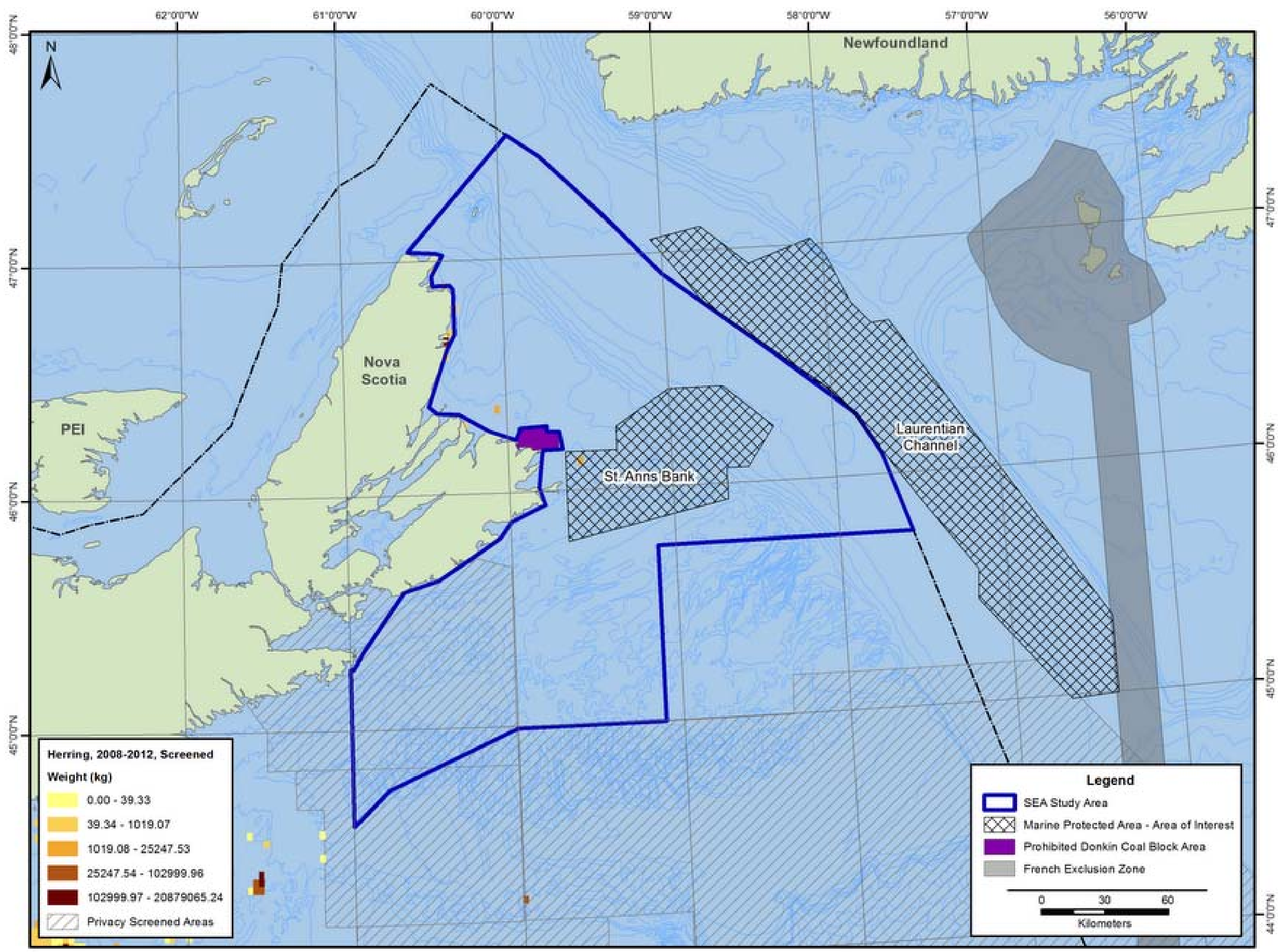


Figure 3-73. Large Pelagics Harvesting Areas

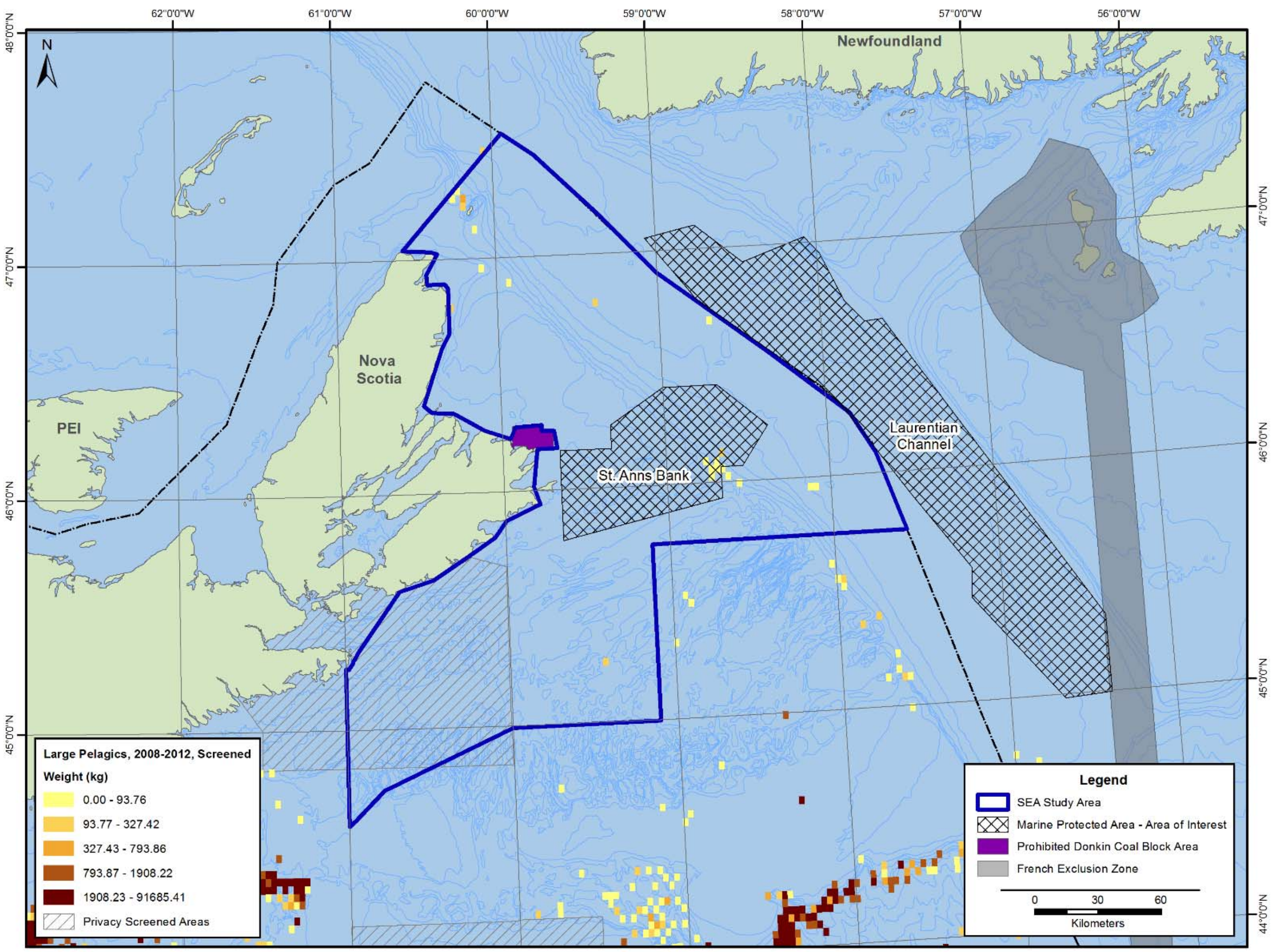


Figure 3-74. Mackeral Harvesting Areas

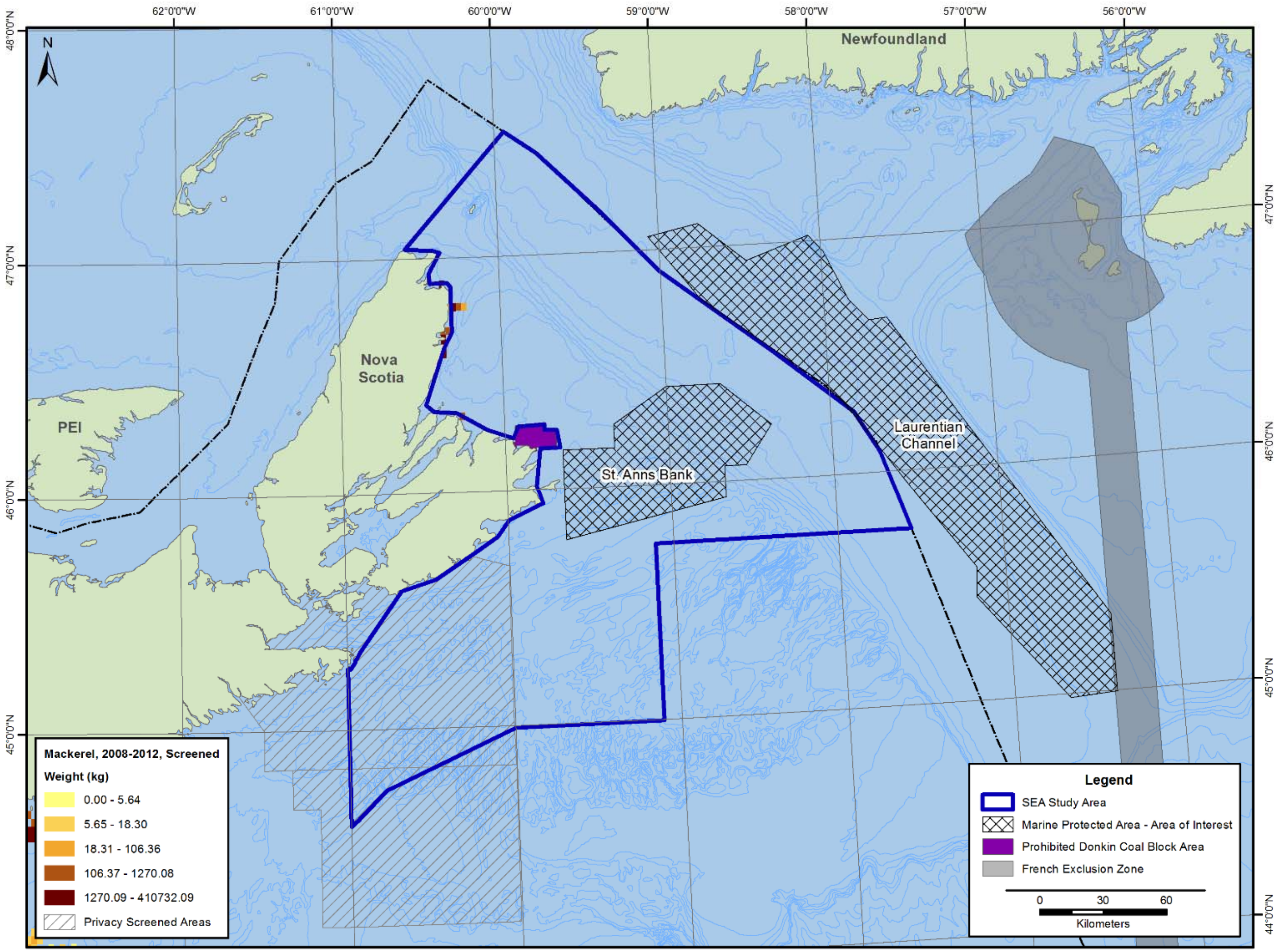


Figure 3-75. Monkfish Harvesting Areas

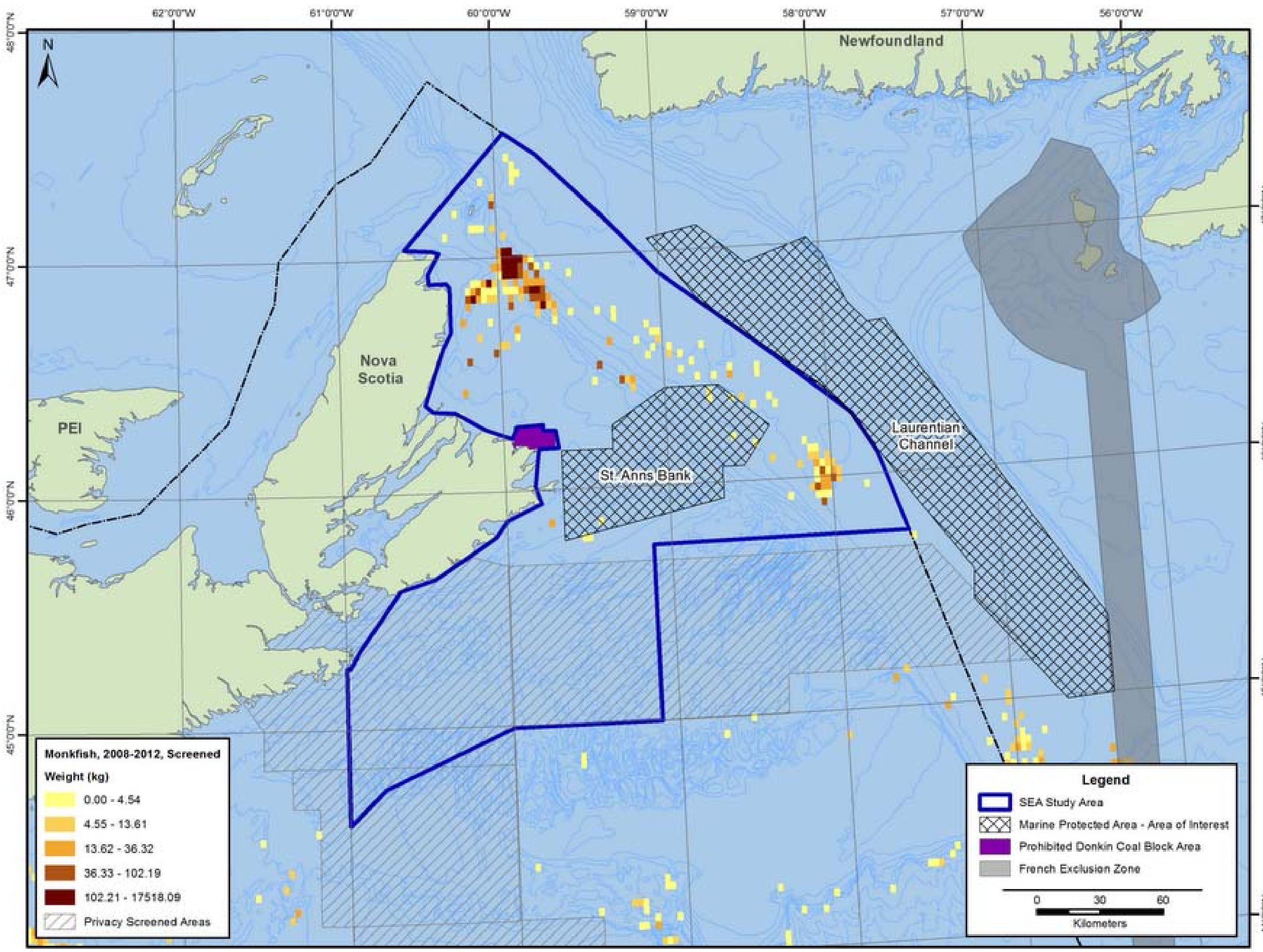


Figure 3-76. Other Crab (Rock) Harvesting Areas

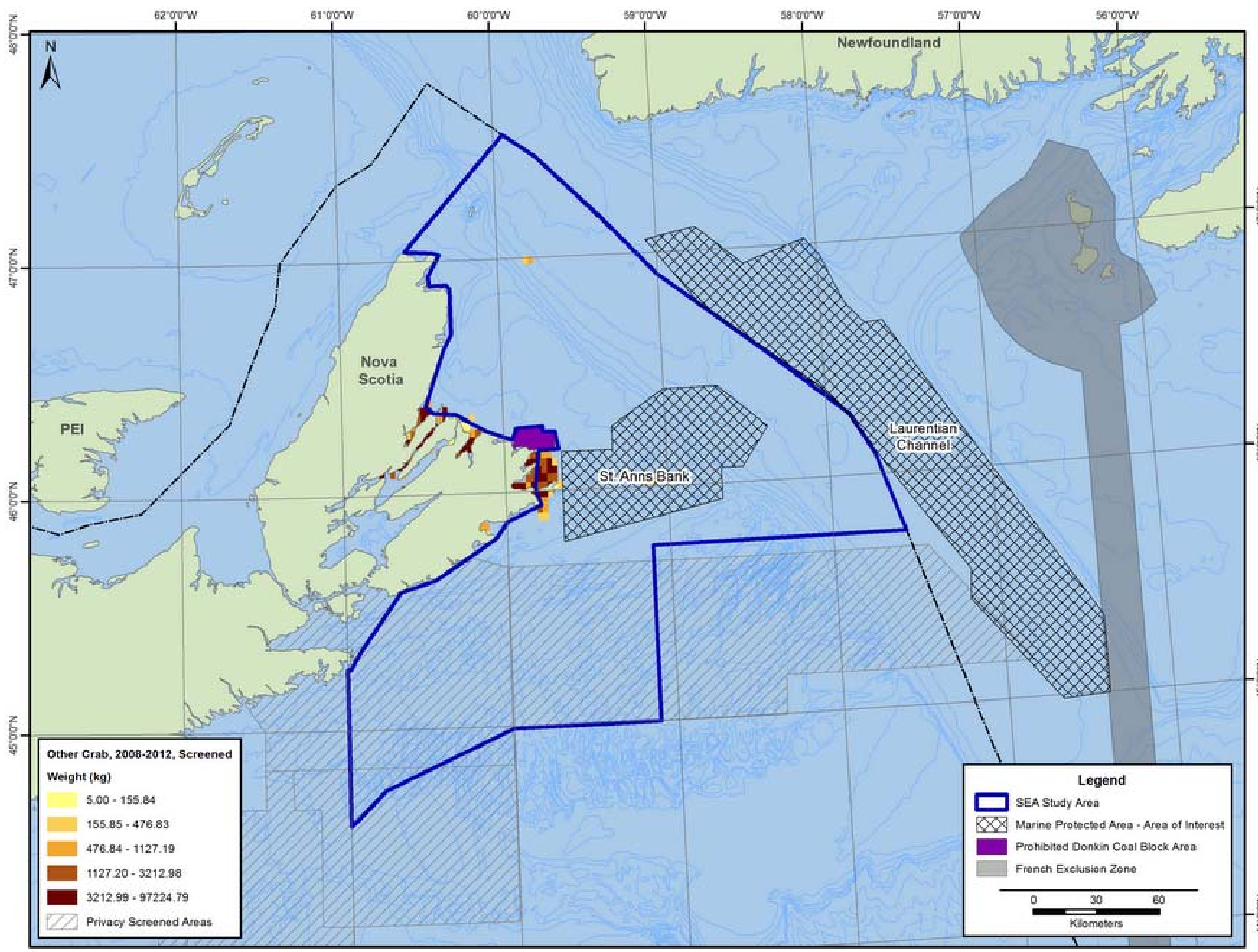


Figure 3-77. Redfish Harvesting Areas

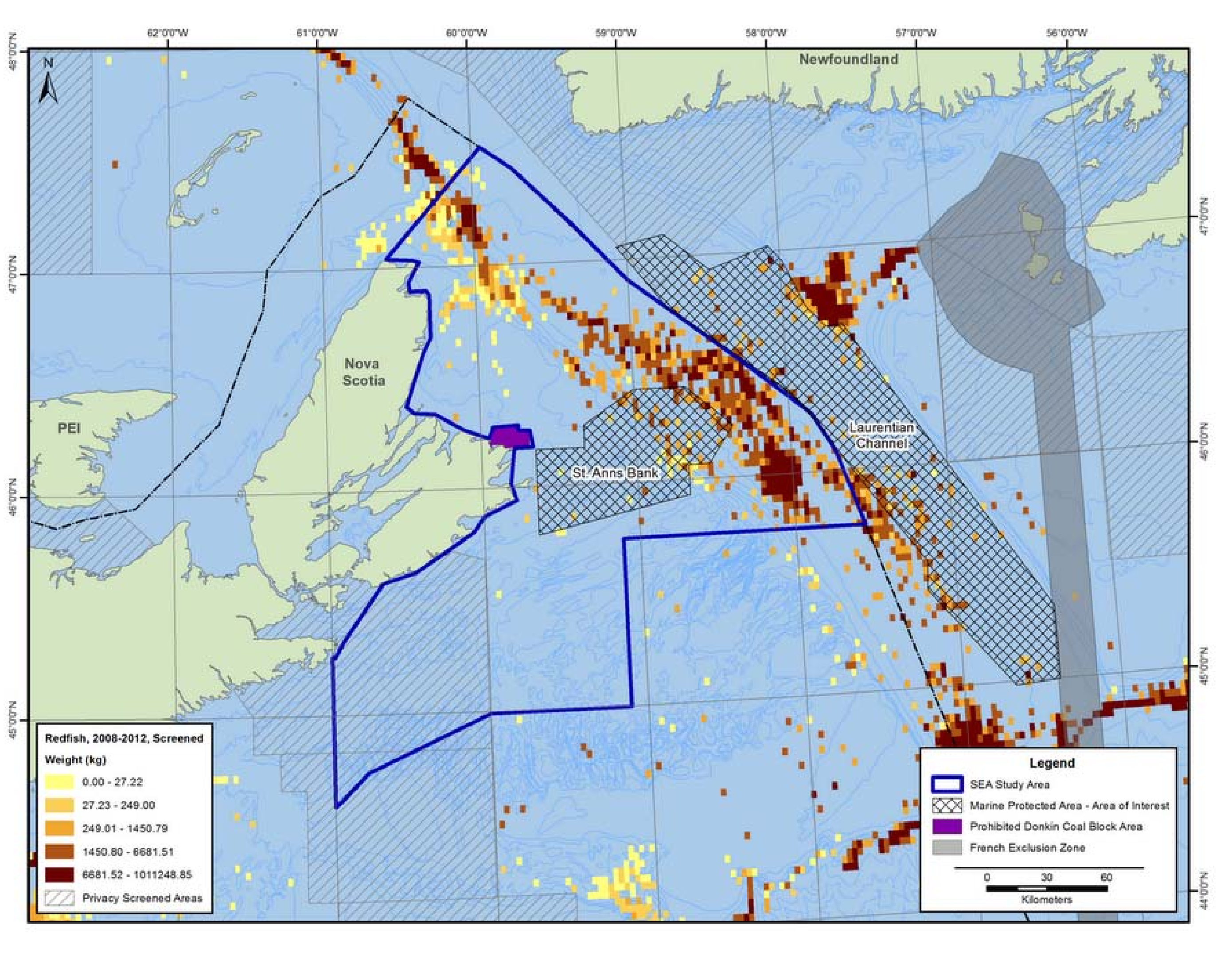


Figure 3-78. Scallop Harvesting Areas

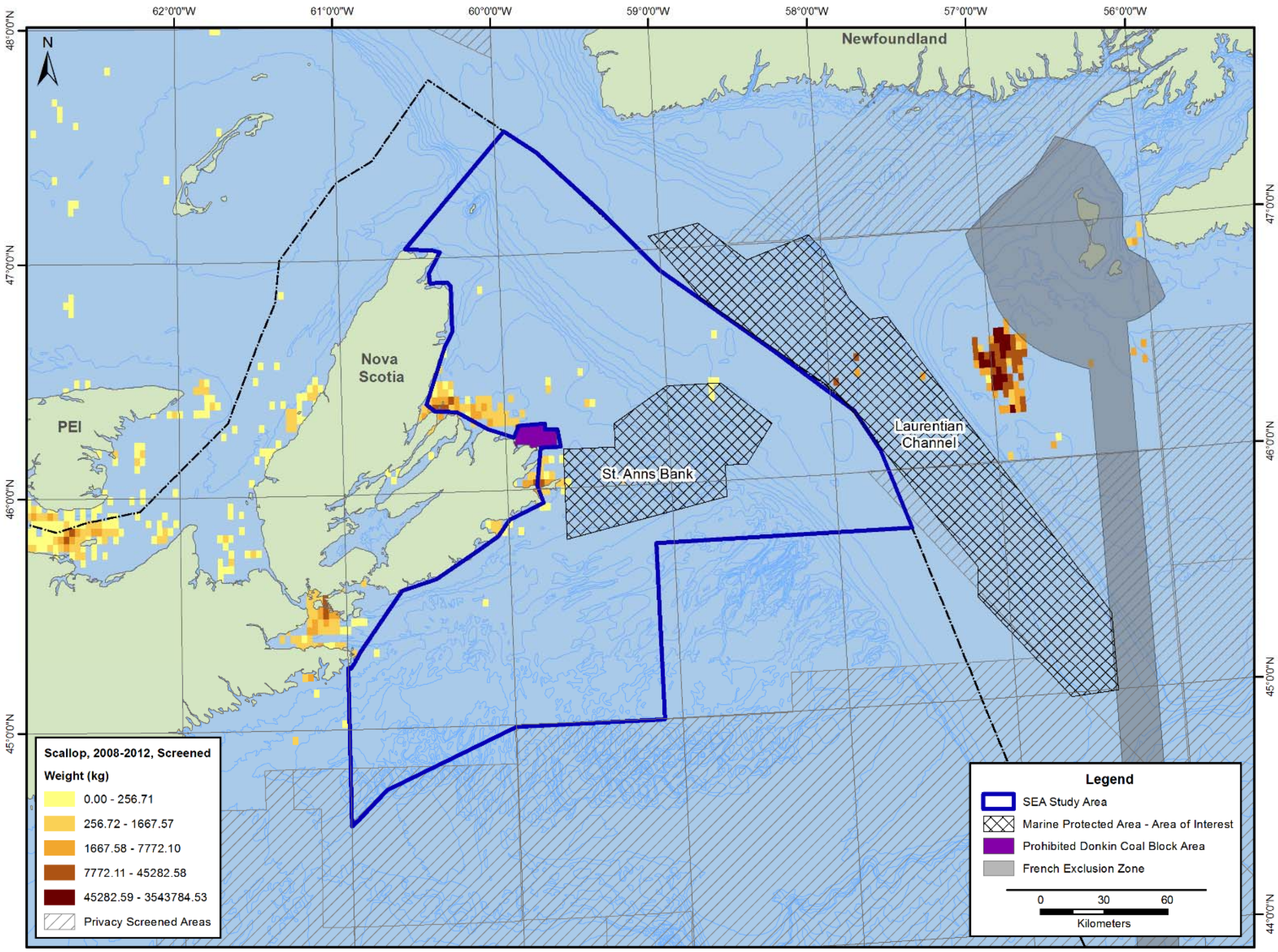


Figure 3-79. Shrimp Harvesting Areas

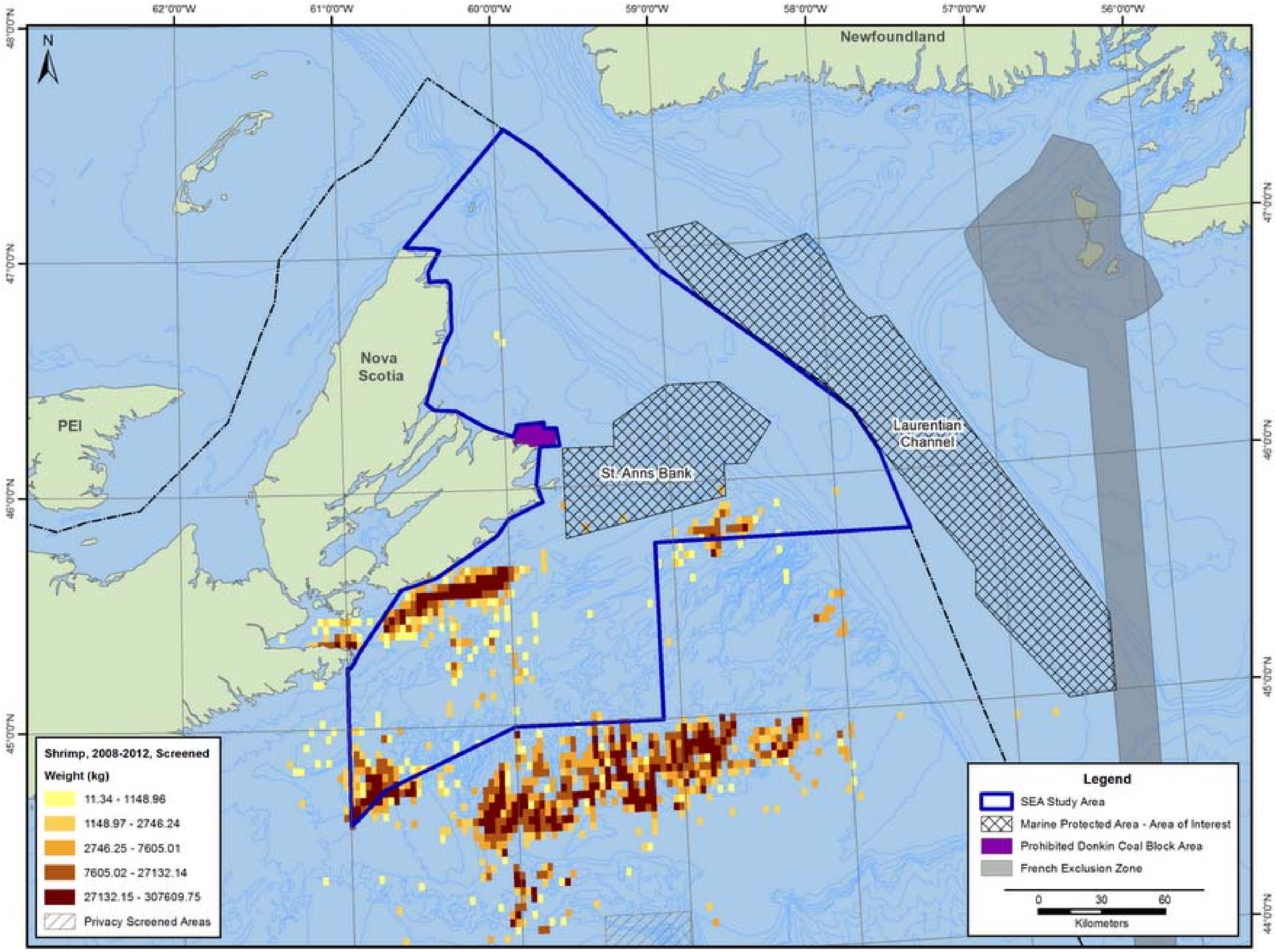


Figure 3-80. Silver Hake Harvesting Areas

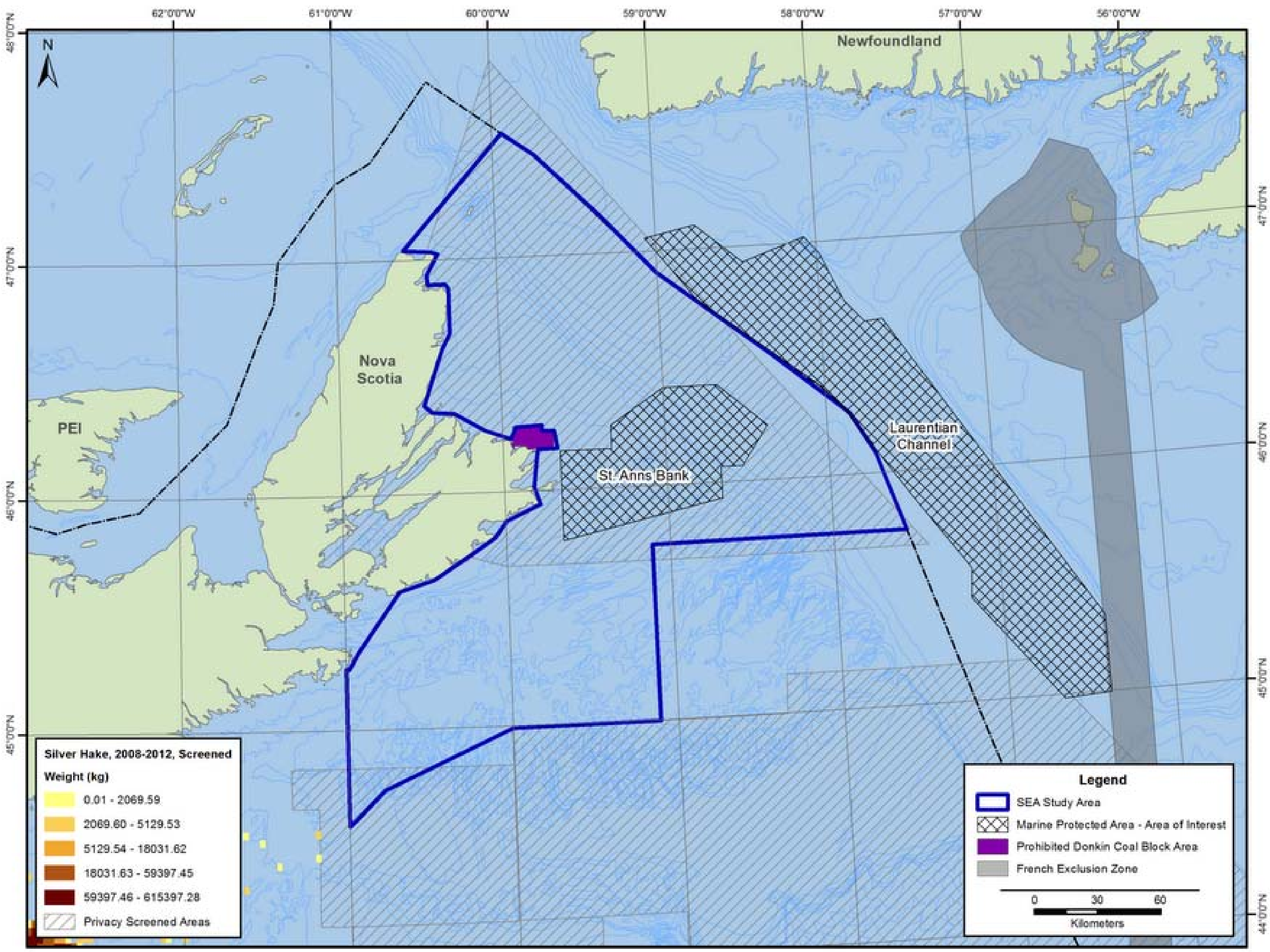


Figure 3-81. Snow Crab Harvesting Areas

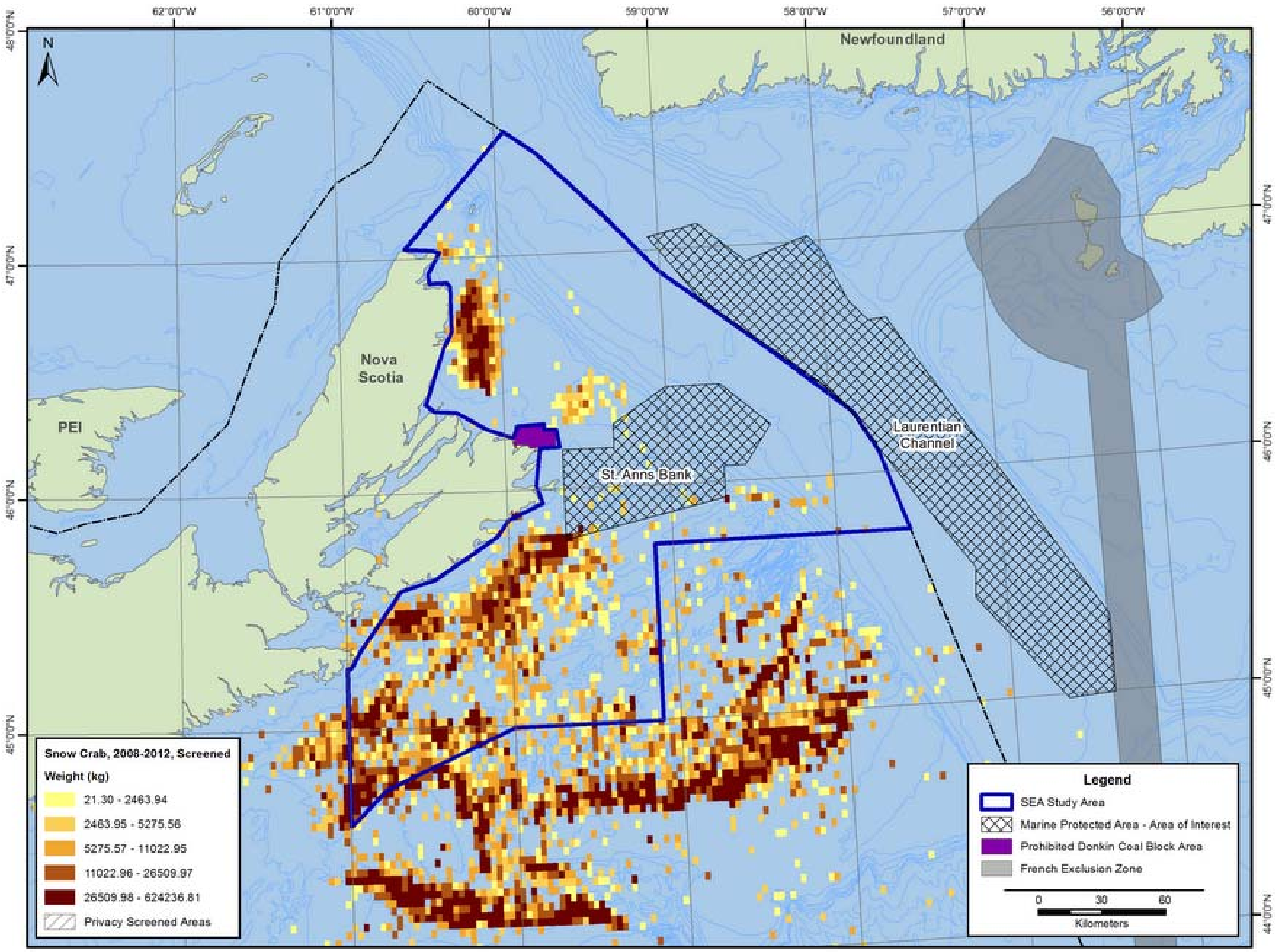


Figure 3-82. Squid Harvesting Areas

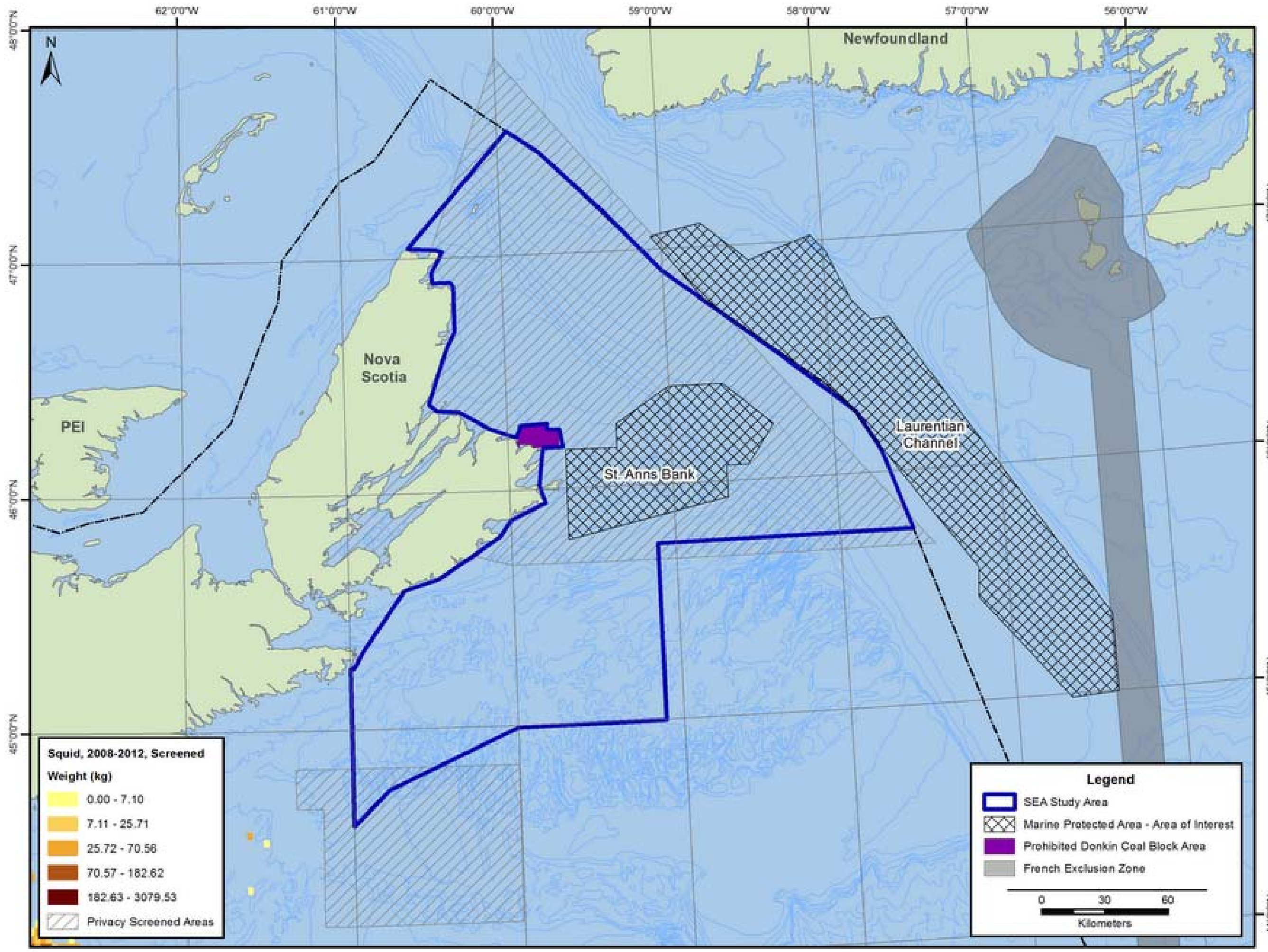


Figure 3-83. Swordfish Harvesting Areas

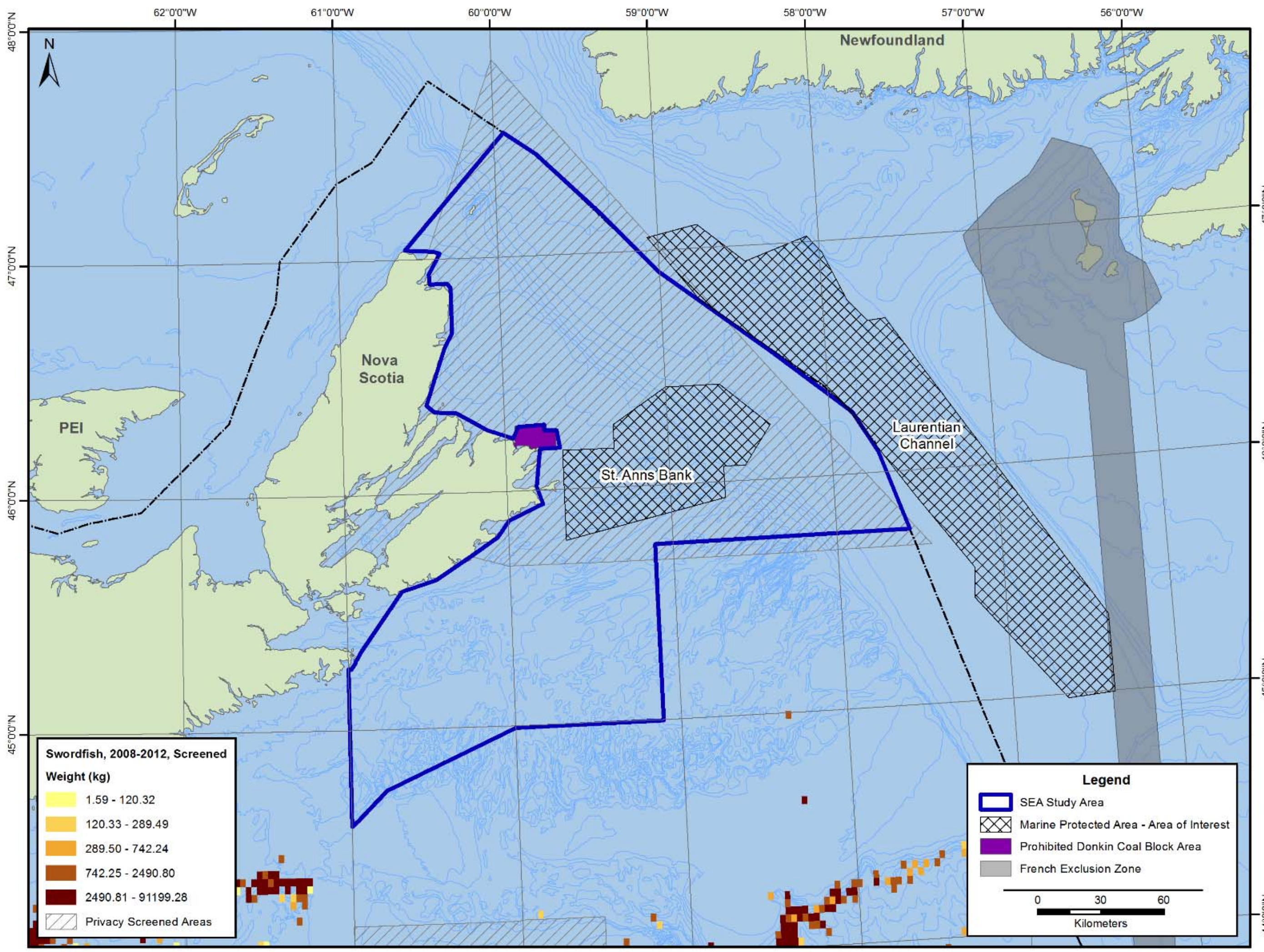


Figure 3-84. White Hake Harvesting Areas

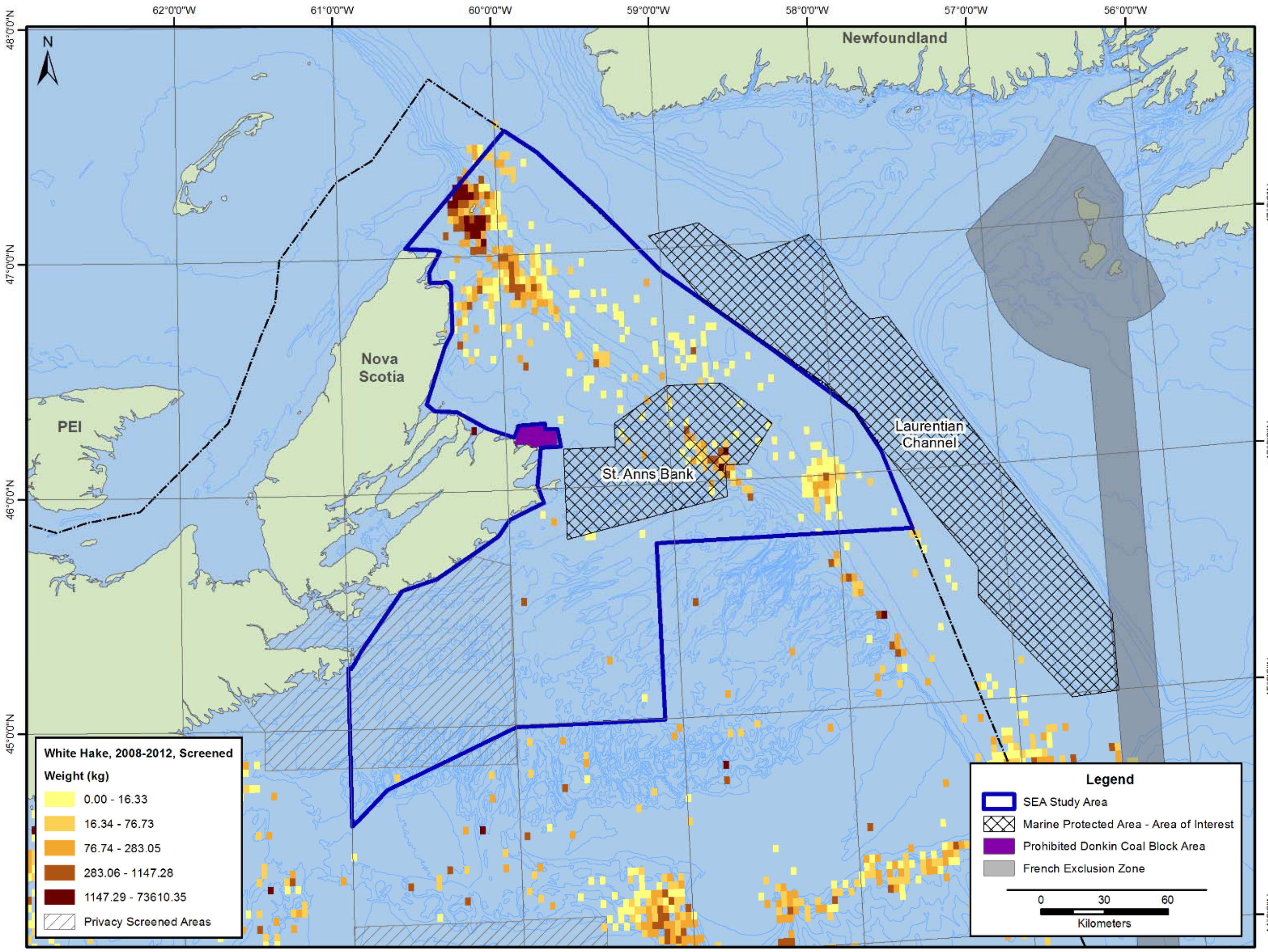
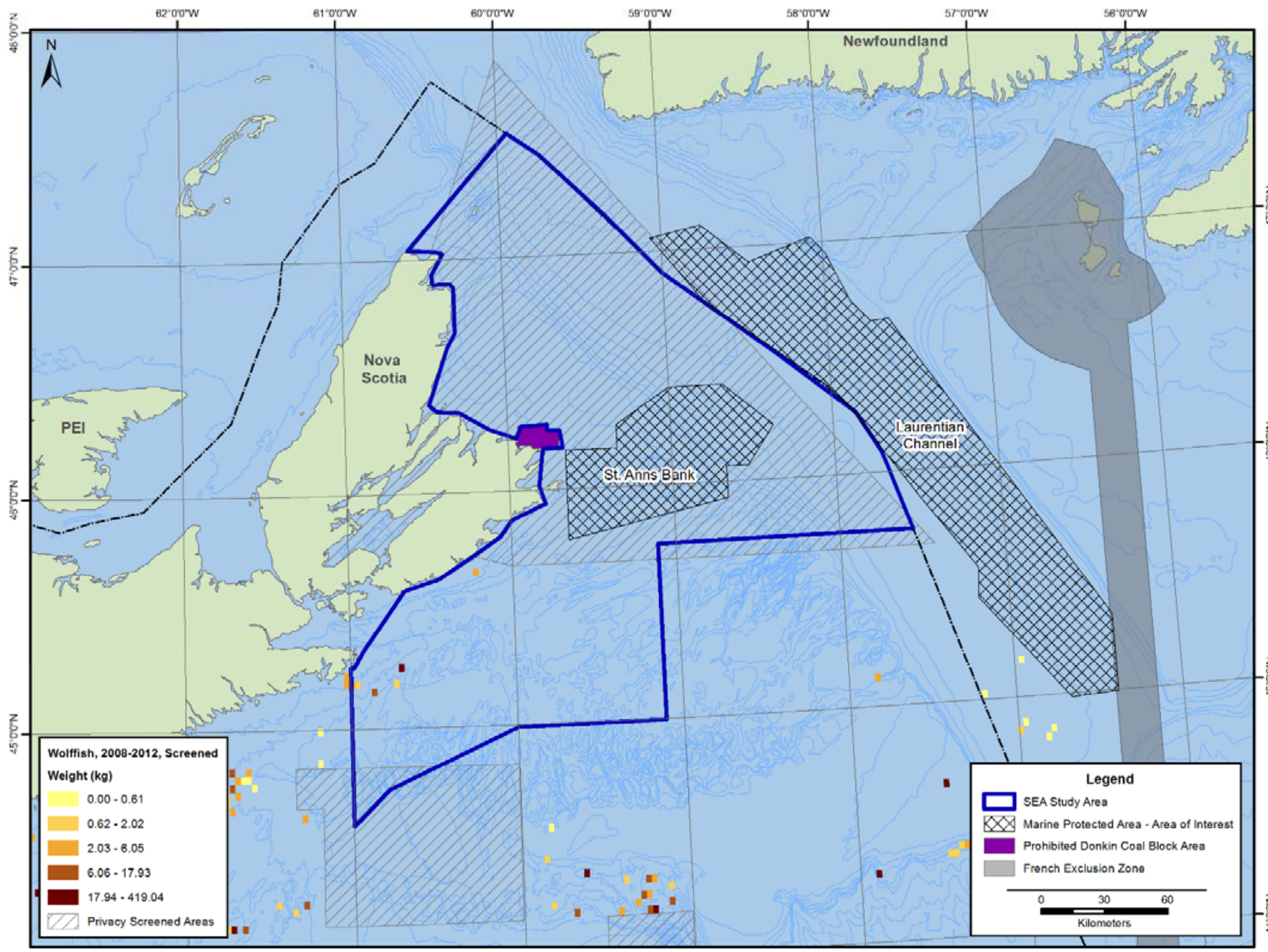


Figure 3-85. Wolffish Harvesting Areas



The geographically presentation of areas in which the majority landings are caught highlights the importance of the waters along the outer edge of the study area along the Laurentian Channel (Sydney Basin area) for groundfish, and the nearshore waters along the eastern coast of Cape Breton (Orpheus Graben area) for invertebrates (lobster, shrimp and snow crab). In general, there is a greater dependence on the inshore areas for lobster and scallop.

3.3.1.13 Community-level Fishermen's Organizations

The fish harvesters and fish processors have established local organizations to enhance the representation of their interests to federal and provincial regulators, and to increase the value of their industry through enhancement of harvesting methods, landings, and market potential. In addition, the Department of Fisheries and Oceans has implemented a Regional Advisory Process (RAP) which has contributed to the organization of fishers among species specific committees. The RAP was initiated in the Atlantic fishery in 1993 to provide peer reviewed information on the status of the fisheries and marine mammal resources in the region. The Maritimes RAP also undertakes the review of technical analysis relating to regional habitat and fisheries management issues. The principles of the process are:

- being timely, responsive and flexible to fishers' and processors' needs,
- employing the most appropriate and credible scientific methods,
- providing technical review on the full range of regional resource management issues,
- involving industry, stakeholders, and outside scientific experts in the review process,
- providing a visible and public document trail, and
- fostering interaction with the other regional RAPs, as well as facilitating the advancement of resource science through zonal and national meetings and workshops.

Table 3-44 lists the fishermen's organizations which are active in the Study Area.

Table 3-44 Fishermen's Organizations in Study Area

Organization	Representing
NS Federation of Inshore Seafood Harvesters	Multi-species fishermen
Area 24 Crab Fishermen's Association	Crab Fishermen
Area 23 Crab Fishermen's Association	Crab Fishermen
4VN Groundfish Management Board (4VN GMB).	
4V Hook & Line Association	Multi-species fishermen
Area 30 Fishermen's Association	Lobster fishermen
Canso Trawlermen's Co-op	Multi-species Groundfish fishermen (Mobile Gear)
East Cape Breton Fishers Association	Multi-species fishermen
CAW Local 1972	Multi-species fishermen
East Cape Breton Fisherman's Association	Multi-species fishermen
Eastern NS Mobile Gear Association	Multi-species Groundfish fishermen (mobile Gear)

Organization	Representing
Glace Bay Inshore Fishermen's Association	Multi-species fishermen
Groundfish Enterprise Allocation Council (GEAC)	Multi-species Groundfish (Enterprise Allocations)
Guysborough County Inshore Fishermen's Association	Multi-species fishermen
Inverness South Fishermen's Association	Multi-species fishermen
Little River Fishermen's Association	Multi-species fishermen
Maritime Fishermen's Union Local 6	Multi-species fishermen
North of Smokey Fishermen's Association	Multi-species fishermen
NS Swordfish Association	Large pelagics fishermen
Richmond County Inshore Fishermen's Association	Multi-species fishermen
Eskasoni Fish & Wildlife Commission	Multi-species fishermen (First Nation)
Native Council of Nova Scotia	Multi-species fishermen (Aboriginal)
Atlantic Policy Congress of First Nations Chiefs	Multi-species fishermen (First Nation)
Maritime Aboriginal Aquatic Resources (MAARS)	Multi-species fishermen (Aboriginal)

In addition to the above organizations, advisory committees have been established for the lobster, crab and shrimp management areas defined by DFO for the region (see Figures 3.36 to 3.40).

3.3.1.14 Fish Processors

Small Crafts Harbours are often the site of commercial fish processing plants. These private facilities provide a local market for fishers' catches, as well as employment in processing, shipping and business administration in the communities. There are 238 registered fish processors in Nova Scotia, 15 of which are located in the Study Area (NSFPA 2015). These enterprises are listed in Table 3-45.

Table 3-45 Licensed Fish Processors in Study Area

Company	Location
A & L Seafoods	Louisbourg, NS
Apaqtukewaq Fisheries Co-op	Chapel Island , NS
Aspy Bay Fisheries Limited	Dingwall , NS
Breakwater Fisheries Limited	Auld's Cove , NS
Cape Fisheries	Dominion , NS
Choice Atlantic Seafood Inc	Canso , NS
Crane Cove Fisheries	Eskasoni, NS
Dunphy's Oysters	Dingwall , NS
Farocan	Mulgrave, NS
Han Beck Sea Products	Louisbourg , NS
Ka'le Bay Seafoods Ltd	GLACE BAY NS Canada

Louisbourg Seafoods Ltd	Louisbourg , NS
Motor Vessel Osprey Ltd	North Sydney , NS
Pittman's Lobsters	Glace Bay , NS
Pleasant Bay Fish Co. Ltd	Cheticamp , NS
Victoria Co-operative Fisheries	Neils Harbour, NS

Many fish processors buy fish from ports throughout the province, not just their local port. Quota for Groundfish and Redfish is also held by a few enterprises from communities located outside the coastal communities in the Study Area. These enterprise allocations provide significant income and employment to the companies, and the communities in which they are located. Table 3-46 lists companies with Enterprise allocations within the Study Area:

Table 3-46 Companies with Enterprise allocations within the Study Are

Company	Location
Ivy Fisheries Ltd.	Sambro NS Canada
Sambro Fisheries Ltd	Halifax NS Canada
Clearwater Seafood Limited Partnership	Bedford NS Canada

3.3.1.15 Fishing Harbours

Over time, the fishery in the Study Area saw the evolution of fishing from multiple fishing wharfs and piers along the coast which were owned and maintained by individual fishers or families. The introduction of “Government Wharves” in the mid-20th century saw the consolidation of fishing effort to a few designated Small Crafts Harbours. The Department of Fisheries and Oceans operates and maintains a system of harbours from which commercial fish harvesters and other harbour users can safely operate (DFO 3015h).

Small Crafts Harbours provide fishers with a protected environment for their vessels and gear, and facilitates the transfer of catch to buyers at central locations, which increases the economic efficiency of operations. In addition to the economic and safety benefits of these harbours, there are non-economic benefits which are accrued to communities as a result of the centrality of wharves:

- They provide centers for activity and infrastructure that support a wide range of recreational activities such as swimming, scuba diving, water-skiing, kayaking, canoeing, cruising, sailing, sports fishing, and bird and whale watching. As such, the wharves contribute to the health and quality of life of a wide range of local citizens and visitors. In some instances these facilities contribute to a wider geographical area through commercial development of recreational tourism.
- Wharves are an integral part of waterfront development which enhances the attractiveness of the community and facilitates positive interaction between the general public and people involved in fisheries and marine industries. The facilities are the focus of community festivals where concerts, dances, picnics, boat tours, dory races and other activities are often held.

The location of Small Crafts Harbours within the Study Area are shown in Figure 3-87.

3.3.1.16 Aquaculture

Aquaculture is emerging as a significant provider of employment and income in coastal Nova Scotia. Global production of fish and other seafood through aquaculture is increasing and plays an important role in areas where there are declining capture fisheries. While Canadian aquaculture production is considerably lower than that in other nations, the emergence of local aquaculture companies is now putting greater emphasis on this coastal industry. This industry is viewed as an important source of future employment and food production, and considerable efforts are being made to improve the efficiency and environmental sustainability of aquaculture in Nova Scotia.

Table 3-47 provides an overview of Nova Scotia aquaculture production, while Table 3-48 provides an overview of employment levels in the Nova Scotia aquaculture industry. Information is not available for individual operations in the study area (for confidentiality reasons), however the provincial information demonstrates the relative importance of the industry to the local economy in terms of income and employment. Figure 3-86 illustrates the location of aquaculture operations in the Study Area.

Table 3-47 Nova Scotia Aquaculture Production (NSDFA 2015c)

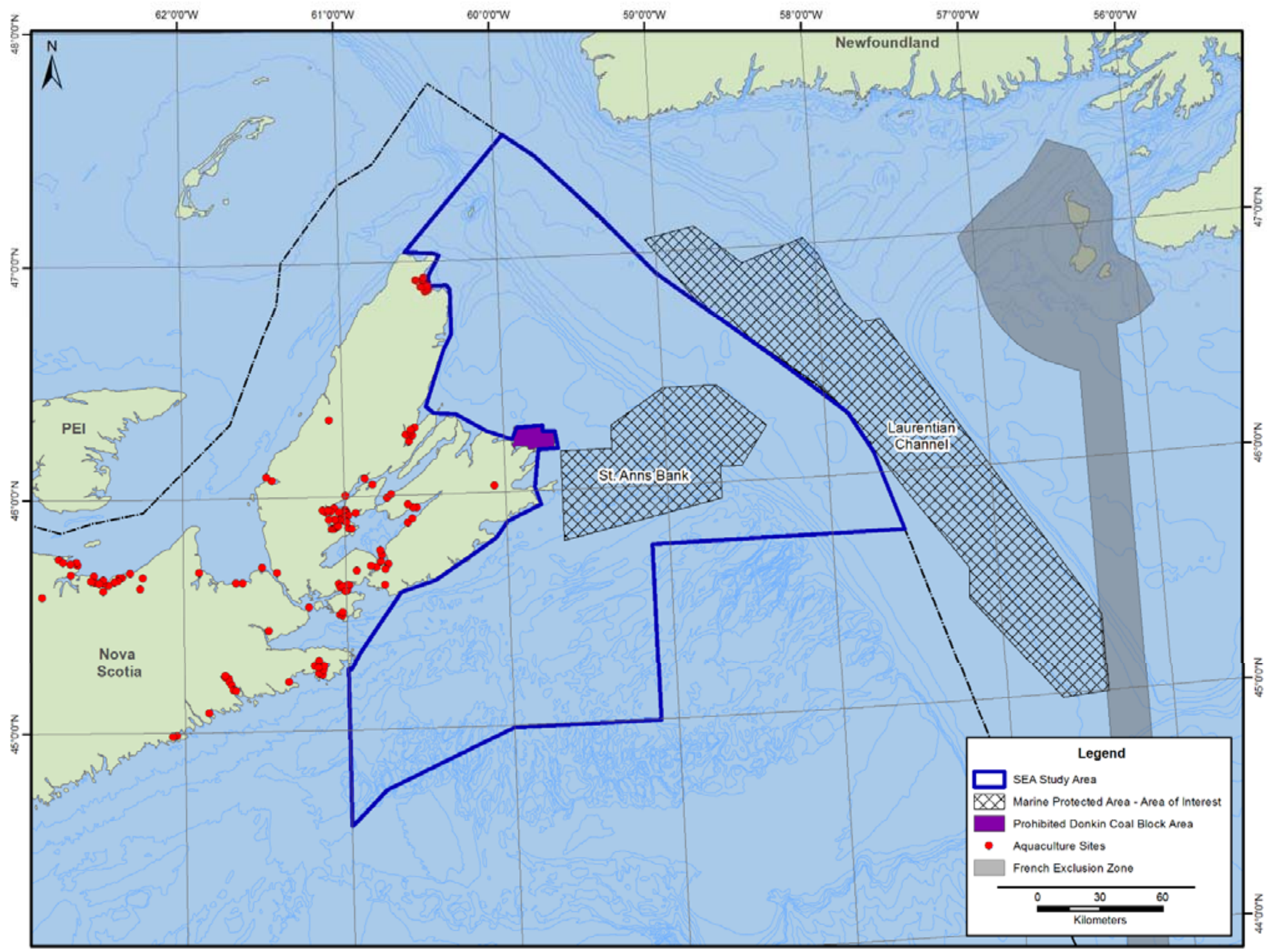
NOVA SCOTIA FISHERIES AND AQUACULTURE Aquaculture Production and Sales 2013				
SPECIES	**PRODUCTION (kg)**	**VALUE $**	**% OF TOTAL VALUE**	
Atlantic Salmon/Rainbow Trout (Marine)	6,404,917	$ 39,260,685	0.723340393	72.33%
Atlantic Salmon (Landbased, Hatchery, Nursery)	211,438	$ 2,695,318	0.049658644	4.97%
Rainbow Trout (Landbased, Hatchery, Nursery, U-Fish)	103,735	$ 1,041,964	0.019197185	1.92%
TOTAL FINFISH	**6,720,090**	**$ 42,997,967**	**0.7921962**	**79.22%**
Blue Mussels	1,051,235	$ 1,600,983	0.029496573	2.95%
American Oysters	356,000	$1,462,835	0.026951329	2.70%
Bay Quahogs, Clams, Giant Sea Scallops and Bay Scallops	357,858	$ 1,127,950	0.020781395	2.08%
TOTAL SHELLFISH	**1,765,093**	**$ 4,191,768**	**0.0772293**	**7.72%**
Other Species				
Marine Plants	*c*	*c*	*c*	*c*
Atlantic Halibut	*c*	*c*	*c*	*c*
Arctic Char	*c*	*c*	*c*	*c*
American Eels	*c*	*c*	*c*	*c*
Striped Bass	*c*	*c*	*c*	*c*
Brook Trout	*c*	*c*	*c*	*c*

Gilthead Seabream	*c*	*c*	*c*	*c*
TOTAL OTHER SPECIES	**263,127**	**$7,087,180**	**0.13057448**	**13.06%**
GRAND TOTAL	**8,748,310**	**$ 54,276,915**	**1.0000000**	**100%**
c – information has been by NSDFA withheld to protect the confidential information of individual ventures				

Table 3-48 Employment in Aquaculture (NSDFA 2015c)

Nova Scotia Department of Fisheries & Aquaculture EMPLOYMENT STATISTICS 2013				
	FULL TIME	**PART TIME < 6 months**	**PART TIME > 6 months**	**TOTAL**
FINFISH	159	39	25	**223**
SHELLFISH	112	173	60	**345**
OTHER	20	2	46	**68**
	291	**214**	**131**	**636**

Figure 3-86 Location of Aquaculture Operations



3.3.1.17 Recreational Fisheries

The provincial government is responsible for the management of freshwater recreational fisheries, also referred to as the sport fishery, through the Nova Scotia Department of Fisheries and Aquaculture. The coastal inter-tidal and internal waters of the study area are all contained in one NS Fishery Management Area (Zone 1).
Nova Scotia's streams, rivers, and lakes are considered a public resource and not private fishing areas, as is the case in other provinces. Nova Scotia's Angling Act is unique in that it allows anglers to cross uncultivated lands on foot to reach places for recreational fishing unlike other jurisdictions that have popular recreational fishing areas which are designated as private water and not accessible to the public.

The sport fishing season in Cape Breton is from April 1st to Sept 30th in intertidal waters and from April 15th to Sept 30th in lakes and rivers. There is no closed season for shad, eel or gaspereau in intertidal waters. The bag limits are as follows:

Table 3-49 Bag Limits for Sport Fish in Cape Breton

Species	Harvest Limit
Speckled (Brook) Trout, Brown Trout, Lake (Grey) Trout and Rainbow Trout	5 fish, of any one species or any combination of trout species
Smallmouth (Black) Bass	25 fish
White Perch, Yellow Perch, Brown Bullhead, Chain Pickerel, and White Sucker	25 fish
Lake Whitefish	8 fish
Shad	5 fish
Striped Bass	1 fish, with a minimum size limit, not less than 68 cm (26.8 inches) overall length
Gaspereau	20 fish
Smelt	60 maximum possession, not more than 30 of which may be harvested by dip net.
Eel	60 maximum possession, not more than 30 of which may be harvested by dip net.

The most recent survey of the recreational fishery was completed in 2010, at which time the industry was worth more than $56.4 million and 80,000 licensed anglers spent 1.1 million days fishing (NSDFA 2015b).

3.3.1.17.1 Salmon

The harvest of Atlantic salmon at sea has dropped 69 per cent over the last 42 years, from about 1.7 million in the mid-1970s to about 600,000 fish today. All commercial fisheries for Atlantic salmon in Atlantic Canada have remained closed since 1984. Since this time, Atlantic salmon harvesting has been restricted to two groups: Aboriginal peoples and recreational salmon anglers.

Recreational fishers must purchase a separate salmon license from the NS Department of Fisheries and Aquaculture. Nova Scotia's Salmon Season varies by area, in general the rivers of Cape Breton are open from June til October. Due to declining populations of wild Atlantic salmon, the federal Minister of Fisheries and Oceans announced that Anglers will not be allowed to keep any Atlantic salmon caught in the Maritimes in 2015 (CBC 2015).

Three provincial hatcheries stock over one million trout and Atlantic salmon annually to increase angling opportunities across the province. The Margaree Hatchery is primarily a salmon hatchery, but has recently been used to increase brook trout stocking initiatives to benefit angling in Cape Breton.

3.3.1.18 Aboriginal Fisheries

The Mi'kmaq have been harvesting many species of fish for food and social well-being (including trade) in the study area for millennia. This longstanding relationship has resulted in Supreme Court of Canada's recognition of the Mi'kmaq nation's Right to harvest for livelihood in 1999, the Marshall Decision, based on the Treaties of 1760 and 1761. This Decision affected 34 Mi'kmaq, Maliseet and Passamaquoddy First Nations throughout their traditional territories. In response to this Decision, the Government of Canada entered into bilateral fisheries Agreements with individual Bands (First Nation Communities) to extend the DFO management of fisheries to the communities. Under these Agreements, Bands gained financial support for the development of commercial fisheries operations in accordance with communal commercial licenses.

The majority of Mi'kmaq communities in Nova Scotia have fishing ventures (communal commercial licenses) that depend upon fisheries in the Study area. These First Nation allocations are harvested in accordance with the terms and conditions applied to Post-Marshall Fishing Agreements between the individual First Nations and the Government of Canada (DFO). As such, First Nations' allocations in the Study area are harvested under the same terms and conditions as other commercial fishing ventures in the area.

Communal commercial licenses are held under the name of the First Nations community and not under the name of a specific individual. the following Mi'kmaq communities in Nova Scotia have fishing licenses for groundfish, redfish, tuna, snow crab, lobster and shrimp in the study area (DFO Licensing Division, 2015:

- Acadia First Nation
- Afton (Paq'tnkek) First Nation
- Annapolis Valley First Nation
- Bear River First Nation
- Potlotek First Nation
- Eskasoni First Nation
- Fort Folly First Nation
- Glooscap First Nation
- Kingsclear First Nation
- Membertou First Nation
- Millbrook First Nation
- Oromocto First Nation
- Shubenacadie Band
- St. Mary's First Nation
- Tobique First Nation
- Wagmatcook First Nation
- Waycobah First Nation

In addition to the above First Nations, the following aboriginal organizations have communal commercial licenses active in the Study Area:

- Apaqtukewag Fishermans Co-Op (Potlotek)
- Mime 'J Seafoods Ltd (Native Council)
- NB Aboriginal Peoples Council

Table 3-50 provides an overview of the specific commercial fishing activities of these Bands in the Study Area. The landings for aboriginal communal commercial fishing are included in DFO landings reports. It should be noted that in addition to First Nation livelihood fishing, Mi'kmaq harvesters are active in a number of food social and ceremonial fisheries which is conducted in accordance with Mi'kmaq Treaty and Aboriginal Right. The specific location and harvest levels and associated socio-economic importance is significant. The specific details of this fishery is beyond the scope of an SEA and the subject of the Treaty relationship between the Mi'kmaq and Canada. Direct consultation between Canada and the Assembly of Nova Scotia Chiefs would be required to determine the specific nature and extent of the Food Social and Ceremonial fishery.

Table 3-50 First Nation and Aboriginal Fisheries in or near the Study Area (DFO Licensing Division 2015)

Band	Species	Licence Area	Licence Description
Acadia First Nation	Groundfish, Unspecified	Maritimes Region	Groundfish Itq
	Herring	Herring Fishing Area - 17-22	
	Herring	Herring Fishing Area - 17-22	
	Herring	Herring Fishing Area - 17-22	
	Herring	Herring Fishing Area - 17-22	

Band	Species	Licence Area	Licence Description
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Scallop, Sea	Scallop Fishing Area - 29	Inshore
	Scallop, Sea	Scallop Fishing Area - 29	Inshore
	Swordfish	Atlantic Waters	
	Tuna, Unspecified	Atlantic Waters	
	Tuna, Unspecified	Atlantic Waters	
Afton (Paq'tnkek) First Nation	Sea Urchins	Guysborough County - Exclusive Zone	
Annapolis Valley First Nation	Groundfish, Unspecified	Maritimes Region	Groundfish Itq
	Herring	Herring Fishing Area - 17-22	
Apaqtukewag Fishermans Co-Op	Crab, Snow	Crab Fishing Area - 24	
	Lobster	Lobster Fishing Area - 27	
	Mackerel	Maritimes Region	
	Sea Urchins	Richmond	
	Squid, Unspecified	Maritimes Region	
Bear River First Nation	Tuna, Unspecified	Atlantic Waters	
Chapel Island Band Council	Crab, Snow	Crab Fishing Area - 24	
	Crab, Snow	Crab Fishing Area - 24	
	Groundfish, Unspecified	Maritimes Region	Groundfish Itq
	Lobster	Lobster Fishing Area - 28	
	Lobster	Lobster Fishing Area - 29	
	Lobster	Lobster Fishing Area - 29	
	Sea Urchins	Richmond	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
Eskasoni First Nation	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	

Band	Species	Licence Area	Licence Description
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 24	
	Crab, Snow	Crab Fishing Area - 24	
	Crab, Snow	Crab Fishing Area - 24	
	Groundfish, Unspecified	Maritimes Region	Groundfish Itq
	Groundfish, Unspecified	Maritimes Region	Groundfish Itq
	Groundfish, Unspecified	NAFO Area - 4vn - 4vs - 4w	Fixed Gear Groundfish <45'
	Herring	Herring Fishing Area - 17-22	
	Lobster	Lobster Fishing Area - 28	
	Lobster	Lobster Fishing Area - 28	
	Lobster	Lobster Fishing Area - 28	
	Lobster	Lobster Fishing Area - 28	
	Lobster	Lobster Fishing Area - 28	
	Lobster	Lobster Fishing Area - 28	
	Lobster	Lobster Fishing Area - 29	
	Lobster	Lobster Fishing Area - 29	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Shrimp, *Pandalus*	Shrimp Fishing Area - 13-14-15	

Band	Species	Licence Area	Licence Description
	borealis		
Fort Folly First Nation	Groundfish, Unspecified	Maritimes Region	Groundfish Itq
	Swordfish	Atlantic Waters	
Glooscap First Nation	Groundfish, Unspecified	Maritimes Region	Groundfish Itq
	Groundfish, Unspecified	NAFO Area - 4vn	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Swordfish	Atlantic Waters	
	Tuna, Unspecified	Atlantic Waters	
Kingsclear First Nation	Herring	Herring Fishing Area - 17-22	
Membertou Band Council	Crab, Rock	Lobster Fishing Area - 27	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Groundfish, Unspecified	Maritimes Region	Groundfish Itq
	Groundfish, Unspecified	NAFO Area - 4t - 4vn	
	Herring	Herring Fishing Area - 17-22	
	Lobster	Lobster Fishing Area - 27	
	Lobster	Lobster Fishing Area - 27	
	Lobster	Lobster Fishing Area - 27	
	Lobster	Lobster Fishing Area - 27	
	Mackerel	Maritimes Region	
	Scallop, Sea	Scallop Fishing Area - 29	Inshore
	Sea Urchins	Cape Breton	
	Sea Urchins	Cape Breton	
	Shrimp, *Pandalus borealis*	Shrimp Fishing Area - 13-14-15	
	Swordfish	Atlantic Waters	
Millbrook First Nation	Crab, Jonah	Lobster Fishing Area - 32	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 24	
	Crab, Snow	Crab Fishing Area - 24	
	Crab, Snow	Crab Fishing Area - 24	
	Groundfish, Unspecified	Maritimes Region	Groundfish Itq

Band	Species	Licence Area	Licence Description
	Hagfish (Slime Eel)	NAFO Area - 4vn - 4vs - 4w	
	Herring	Herring Fishing Area - 17-22	
	Lobster	Lobster Fishing Area - 32	
	Lobster	Lobster Fishing Area - 32	
	Mackerel	Maritimes Region	
	Sea Urchins	Guysborough County - Exclusive Zone	
	Sea Urchins	Halifax County East Of Pennant Point	
	Swordfish	Atlantic Waters	
	Tuna, Unspecified	Atlantic Waters	
Mime 'J Seafoods Ltd	Crab, Snow	Crab Fishing Area - 24	
	Crab, Snow	Crab Fishing Area - 24	
	Crab, Snow	Crab Fishing Area - 24	
	Groundfish, Unspecified	NAFO Area - 4vn	Fixed Gear Groundfish <45'
	Groundfish, Unspecified	NAFO Area - 4vn - 4x - 5y	Fixed Gear Groundfish <45'
	Herring	Herring Fishing Area - 17-22	
	Herring	Herring Fishing Area - 17-22	
	Herring	Herring Fishing Area - 17-22	
	Herring	Herring Fishing Area - 17-22	
	Herring	Herring Fishing Area - 17-22	
	Herring	Herring Fishing Area - 17-22	
	Lobster	Lobster Fishing Area - 27	
	Lobster	Lobster Fishing Area - 29	
	Lobster	Lobster Fishing Area - 29	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Scallop, Sea	Scallop Fishing Area - 29	Inshore
	Squid, Unspecified	Maritimes Region	
	Squid, Unspecified	Maritimes Region	
	Swordfish	Atlantic Waters	
	Swordfish	Atlantic Waters	
	Swordfish	Atlantic Waters	

Band	Species	Licence Area	Licence Description
	Swordfish	Atlantic Waters	
NB Aboriginal Peoples Council	Herring	Herring Fishing Area - 17-22	
	Mackerel	Maritimes Region	
Oromocto First Nations	Herring	Herring Fishing Area - 17-22	
Shubenacadie Band	Crab, Snow	Crab Fishing Area - 24	
	Groundfish, Unspecified	Maritimes Region	Groundfish Itq
	Lobster	Lobster Fishing Area - 32	
	Sea Urchins (2)	Halifax County East Of Pennant Point	
	Sea Urchins	Halifax County East Of Pennant Point	
	Swordfish	Atlantic Waters	
St. Mary's First Nation	Herring	Herring Fishing Area - 17-22	
	Swordfish	Atlantic Waters	
Tobique First Nation	Herring	Herring Fishing Area - 17-22	
Wagmatcook First Nation	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Groundfish, Unspecified	Maritimes Region	Groundfish Itq
	Groundfish, Unspecified	NAFO Area - 4vn	Fixed Gear Groundfish <45'
	Groundfish, Unspecified	NAFO Area - 4vn	Fixed Gear Groundfish <45'
	Lobster	Lobster Fishing Area - 27	
	Lobster	Lobster Fishing Area - 27	
	Lobster	Lobster Fishing Area - 27	
	Lobster	Lobster Fishing Area - 27	
	Lobster	Lobster Fishing Area - 27	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Mackerel	Maritimes Region	
	Sea Urchins	Victoria South Of Cape North	
	Swordfish	Atlantic Waters	
Waycobah First Nation	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 23	
	Crab, Snow	Crab Fishing Area - 24	
	Groundfish, Unspecified	Maritimes Region	Groundfish Itq

Band	Species	Licence Area	Licence Description
	Groundfish, Unspecified	NAFO Area - 4vn	Fixed Gear Groundfish <45'
	Herring	Herring Fishing Area - 17-22	
	Lobster	Lobster Fishing Area - 27	
	Lobster	Lobster Fishing Area - 29	
	Mackerel	Maritimes Region	
	Sea Urchins	Victoria South Of Cape North	
	Sea Urchins	Victoria South Of Cape North	
	Shrimp, Pandalus borealis	Shrimp Fishing Area - 13-14-15	
	Swordfish	Atlantic Waters	
Woodstock First Nation	Swordfish	Atlantic Waters	

3.3.2 Tourism

The coastal communities along the Study area are the situated amongst some of Nova Scotia's most iconic tourism destinations. The Cabot Trail, and associated Highland's National Park and Parks Canada's Fortress Louisbourg are well known attraction that have built a foundation a diverse tourism sector. In 2104, 16% of tourists to the province visited Cape Breton with 66 thousand tourists visiting Fortress Louisbourg. Provincial and federal managed parks, wilderness areas and historic sites an important element of the tourism industry in Cape Breton. These are discussed in greater detail in sections 3.2.12.7 and 3.2.12.8. Figure 3.69 illustrated the extensive network of the parks and wilderness areas that have been effectively marketed to Canadian and international audiences. This industry has been expanding through Cruises ships, and new experience-based tourism activities such as dive tourism and whale watching among others.

The Industry Association, the Tourism Industry Association of Nova Scotia, is active in promoting the region's tourism opportunities in Canada and internationally. There has been a steady increase in arrivals over recent years with an increase of 1% from the US and 3% from overseas thus demonstrating that this is a growth industry for the region (TIANS 2015).

3.3.2.1 Cruise Ships

In recent years, cruise ship-based tourism has become an increasing important consideration in the operation and management of ports. There has been an increase in small cruise ship services within eastern North America, and many have included Cape Breton in their schedule. As a result, the Port of Sydney has seen increased business as a "Port of Call". Two cruise lines have included Sydney in the Eastern Canada tour with as many as 42 cruise ships visiting between May-October. This increased tourism traffic to the Sydney Port area by 70,000 visitors (NSTA 2015).

To accommodate the cruise tourism business, the City has constructed the Joan Harriss Pavilion at the Sydney waterfront. This facility provides an entertainment interface between the cruise ships and the community within walking distance of Sydney hotels, restaurants, shopping centers and boutiques.

While there has been a recent decline in Cruise ship visits to the region, due in part to declining global economic conditions, the Port representatives remain optimistic that there is potential in the growth of this aspect of the tourism industry.

3.3.2.2 Whale Watching

The Cabot Strait is an important area for the migration of for numerous species of marine mammals which travel between the Atlantic and major feeding ground in the St. Lawrence Estuary. Every year many cetaceans, including many large whales, migrate to the estuary to feed on the high concentrations of forage species such as krill and capelin and build up their energy reserves in preparation for the breeding season. As a result, the shores of Cape Breton and south coast Newfoundland provide tourists with seasonal whale watching opportunities.

A dozen marine mammal species are found in the Cabot Strait either regularly or occasionally, usually on a seasonal basis. Nearly half of them are considered to be endangered species according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

While whale watching is not as well established in the region as in other areas (Bay of Fundy and St. Lawrence Estuary) there is an increasing number of local operators who provide whale watching services (charter) to tourists who are visiting the respective regions (TIANS 2015).

Table 3-51 Whale Watch Tour Operators in the Study Area, by community

Community	Number of Whale Watching Tour Operators
Bay St. Lawrence	1
Capstick	1
Cheticamp	2
Englishtown	1
Ingonish	3
Niels Harbour	1
Pleasant Bay	5

3.3.2.3 Dive Tourism

Nova Scotia is gaining attention amongst the international dive tourist community. The province's 7500km of coastline boasts more than 4500 wrecks - one of the world's highest concentrations (Divernet 2015). The Cabot Strait contains some interesting marine historical sites, including St. Paul's Island, which has come to be referred to as the "Graveyard of the Gulf" since it contains many shipwrecks from the "age of sail". In addition to the sailing shipwrecks found in the region, there are famous 20th century wrecks of interest. On 25 November 1944 the HMCS Shawinigan was torpedoed and sunk with all hands on board by U-1228. The folklore and history of these particular historical wrecks has interested dive tourists. The region has been highlighted in dive magazines as a wreck-divers paradise, and work in underway to identify and catalogue wreck sites. Figure 3-89 illustrates the location of the known and catalogued ship wrecks in the Study Area.

3.3.2.4 Other Activity-based Tourism

Cape Breton boasts some of the most well used hiking trails in Nova Scotia, famous for the seascape vistas and rugged trail. Sea Kayaking has also become a popular activity with numerous small ventures along the coast. This industry has created seasonal jobs for local residents, and enhanced the economic benefit of the tourism industry.

Yachting has been a long standing activity in Cape Breton which has many marinas that provide services to tourists and the local recreational sailing community. This industry has attracted tourists and has provided seasonal employment in the communities in which marinas are located. Marinas on Cape Breton Island are located in (Cruise Cape Breton 2015a):

- Baddeck Marine
- Barra Strait Marina
- Ben Eoin Yacht Club and Marina
- Sydney - Dobson Yacht Club
- Georges River Boat Club
- South Ingonish Harbour - Ingonish Landing Marina
- Arichat - Isle Madame Boat Club
- D'Escousse - Lennox Passage Yacht Club
- Mira River - Mira Boat Club
- North Sydney - Northern Yacht Club
- Ross Ferry Marine Park
- St. Peter’s Marina
- Port Hawkesbury - Strait of Canso Yacht Club
- Whycocomagh Waterfront Centre - Marina

In addition to these facilities there are more than 63 public boat launches in Cape Breton where day-sailers and boaters can launch boats for recreational boating and fishing. 39 of these launches are located along the coast within the Study Area (Cruise Cape Breton 2015b).

3.3.3 Other Human Activities

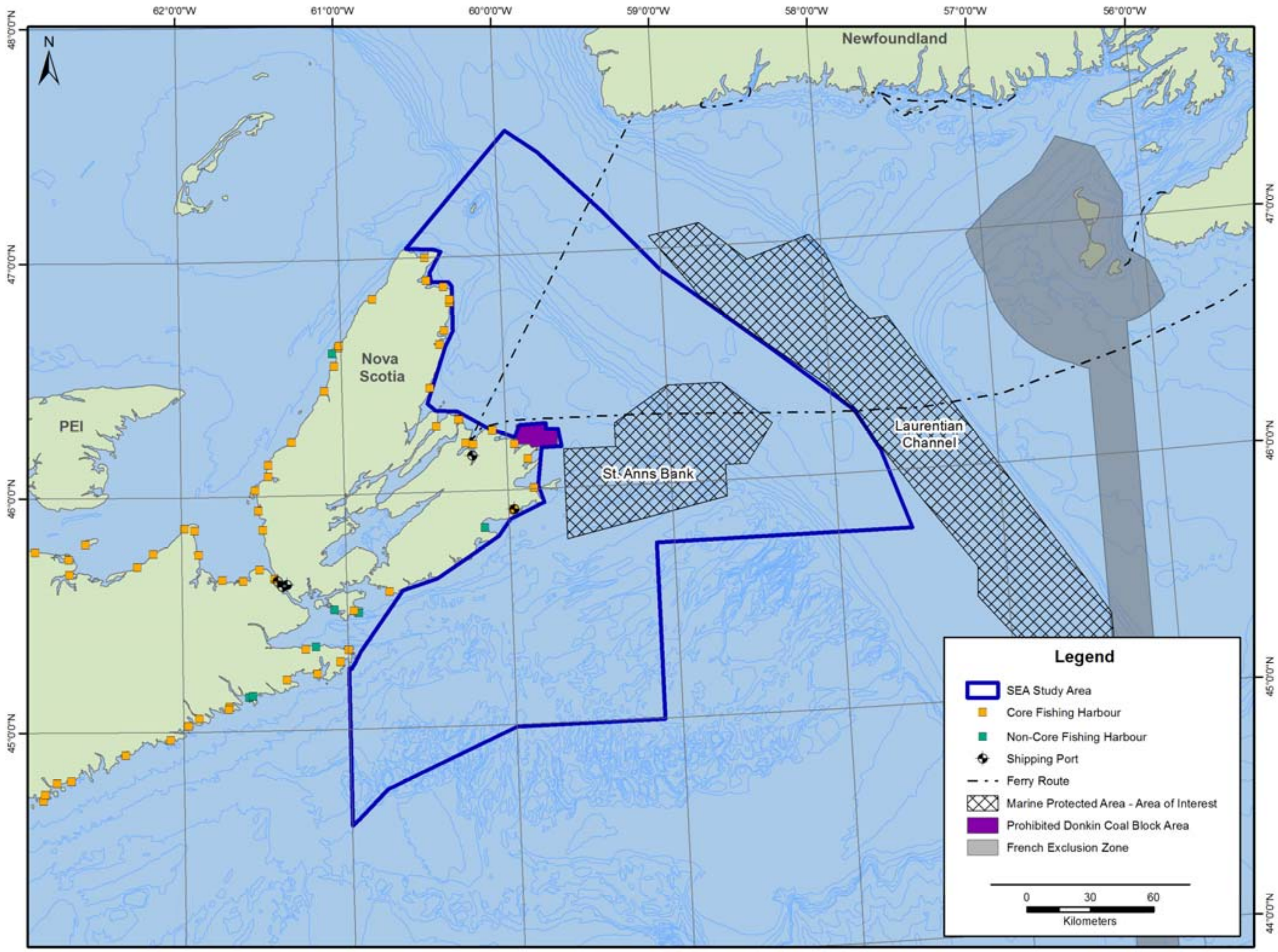
The following sections describe a number of other elements that exist, and activities that occur, within or near the marine environment, and which therefore have the potential to interact with, and be affected by, future offshore oil and gas activities. The overview focuses primarily upon the section of the Nova Scotia coastline that borders the Study Area, which includes major ports, small harbours, marine transportation routes and important tourism destinations.

Data and information were obtained from Canadian government agencies such as Statistics Canada, Canadian Coast Guard, National Defence Canada and Marine Atlantic Inc. Other sources include port corporations and operators of industrial facilities located in the Study Area.

3.3.3.1 Marine Shipping and Transportation

Marine activities have played an important historical role throughout Nova Scotia. Currently, marine shipping is limited mainly to sea ports with the required infrastructure and services to handle large vessels. Smaller harbours are maintained for fishing and recreational activities and ferry services operate inter-provincially to Newfoundland, New Brunswick and Prince Edward Island as well as to the State of Maine. The following sections describe these activities in the nearshore and offshore environments within or near the Study Area.

Figure 3-87 Ports, Harbours and Ferries in the Study Area



3.3.3.2 Shipping Ports

Two major marine shipping ports are located near the Study Area: Ports of Sydney and Strait of Canso Port (Table xx, Table xx and Figure xx). Ports of Sydney collectively refers to the various marine shipping facilities located within Sydney Harbour, which is a six kilometre waterway that offers a protected ice-free harbour (SPC 2015).

Table 3-52 Ports of Sydney

Port Facility	Description
Marine Atlantic, North Sydney	Provides ferry services from North Sydney to Port aux Basques and Argentia, Newfoundland
International Coal Pier, Sydney	Owned and operated by Logistec Stevedoring (Atlantic) to receive and store coal and petroleum coke. Has 180 m+ mooring dolphins, 240,000 MT of storage and direct access to rail service via the Sydney Coal Railway (SCR).
Sydport Industrial Park, Sydney	A 241 hectare industrial park with ocean access, SydPort wharf consists of a main jetty, an inner quay and an outer quay that together have 1,274 m of berthing space. Water depths range from 6.1-11 m at low tide. Lots are serviced with an accessible road, power and nearly half have sewer and water. Sydport is planning to provide service and fabrication for the offshore oil and gas industry.
Nova Scotia Lands (former Sysco Site), Sydney	Site of the former Sydney Steel Corporation plant. Now managed by Nova Scotia Lands, which is mandated to remediate and redevelop as a self-sufficient business property.
Sydney Marine Terminal, Sydney	Sydney Marine Terminal along with other harbour facilities, handles fuel for the entire Cape Breton Island. Receives more than 40 cruise ships each year and a newly constructed cruise pavilion is also used for meetings, receptions, conventions, tradeshows, performances and social events.
Proposed Container Terminal, Sydney	Currently owned by Cape Breton Regional Municipality. More than 200 hectares of land located at the terminus of the Cape Breton and Central Nova Scotia Railroad, which is capable of handling doublestack container trains. Railway connects with Canadian National Railway in Truro, Nova Scotia. Shipping channel has been dredged to 17 m depth to accommodate the largest container ships.

Sources: SPC 2015; SSC 2015; CSCB 2012

Strait of Canso Port is located on Chedabucto Bay which leads from the Atlantic Ocean to the Canso Causeway and the Gulf of St. Lawrence (Figure 3-87). The Strait of Canso has been a long time industrial area supporting materials extraction, paper production and power generation. The Strait of Canso Port includes two port facilities (Table 3-53).

Table 3-53 Strait of Canso Port

Port Facility	Description
Mulgrave Marine Terminal	The 2.8 hectare terminal positions itself to serve the offshore oil and gas industry, bulk and breakbulk cargo services requiring warehousing with lay down area at dockside and marine construction projects.
Port Hawkesbury Pier	Owned and operated by the Strait of Canso Superport Corporation, this pier offers 5 to 6 metre depths along the wharf face with berth space for pleasure crafts, small cruise ships, service vessels, fishing boats, tugs, barges and pilot boats.

Source: Superport 2015

Other industrial facilities maintain shipping operations related to their activities in the Strait of Canso (Table xx). A LNG plant and a large international shipping port are also proposed for Chedabucto Bay (CBP 2015; MT 2010).

Table 3-54 Other Industrial and Shipping Facilities

Operation	Description
Martin Marietta Materials, Porcupine Mountain Quarry, Aulds Cove	Extracting and shipping aggregates
Georgia Pacific, Port Hawkesbury	Gypsum wallboard plant and shipping facility idled since 2011
Stern Group, Port Hawkesbury Paper Mill, Port Hawkesbury	Production and shipping of high quality super-calendared paper for use in retail inserts, magazines and catalogs
Nova Scotia Power, Point Tupper Generating Station, Point Tupper	A 154 MW generating station originally commissioned as an oil-burning unit in 1973 and recommissioned as a coal fired facility in 1987.
Nustar Energy, Point Tupper	Storage and handling services for petroleum products, specialty chemicals, crude oil and other liquids. Crude oil storage tanks for storage and delivery. Terminal also provides pilotage, tug assistance, line handling, launching, emergency response and other ship services.
Maher Melford Terminal, Melford	Proposed 127 hectare container terminal with on-dock access to the CN Rail network. Ice-free and navigational water depth greater than 27 m (18 m at berth), will provide capability of handling world's largest current and forecasted containerships.
Liquefied Natural Gas Ltd., Bear Head LNG, Point Tupper	Proposed liquefied natural gas conversion plant and port-side shipping facility

Sources: CBP 2015; NSP 2015; SP 2014; CBP 2011; MT 2010; MMM No Date; NE No Date

Ships travelling to and from Sydney Harbour move through the Study Area. It is likely that some of those moving to and from Chedabucto Bay may also intersect the Study Area but specific vessel routes are unavailable. Ships crossing to and from the busy ports of Halifax and Montreal may also potentially traverse through the Study Area. Halifax is the largest port in Nova Scotia in terms of vessel movements and the only port on the east coast that can currently service fully laden post-Panamax container vessels. Montreal is the largest container port in eastern Canada and provides an important link between major European and Mediterranean ports and North American markets (MPA 2014; ACPA 2013).

3.3.3.3 International and Domestic Shipping

Marine transportation continues to play an important role in the Nova Scotia economy and a number of ports ship goods to and from international and domestic destinations. Goods are moved in and out of ports near the Study Area mainly through the busiest ports of Sydney, Mulgrave, Cape Porcupine and Port Hawkesbury (Figure 3-87). The latter three are all on the Strait of Canso, which is a heavy industry area.

Some of these ports are important in international trade from Nova Scotia. International shipping (by total tonnage) in ports near the Study Area was 79 percent of total international marine shipping conducted to and from Nova Scotia ports in 2011 (SC 2013). This is likely due to the large volumes shipped from Port Hawkesbury which handled 67 percent of international tonnage from ports near the Study Area in 2011. This high volume included shipments from the Stern Group's paper mill as well as gypsum wallboard from the currently idled Georgia Pacific plant which was still operational in 2011.

Four ports near the Study Area participate in domestic shipping as well as international shipping. Only 18 percent of Nova Scotia domestic shipping occurs in ports near the Study Area. Likewise, this area experiences fewer and smaller volumes of domestic shipping than international activity. The busiest domestic ports are Sydney, Mulgrave and Cape Porcupine (SC 2013). Port Hawkesbury, the busiest international port has the least number of domestic movements.

3.3.3.4 Small Craft Harbours

Fisheries and Oceans Canada (DFO) Small Craft Harbours (SCH) program oversees a system of harbours to provide commercial fishermen with safe and accessible facilities. SCH operates under the authority of the Fishing and Recreational Harbours Act and the Federal Real Property and Federal Immovables Act. Harbours are operated and maintained by Harbour Authorities, not-for-profit organizations responsible for the daily management of one or more public fishing harbours (DFO-SCH 2014).

In Nova Scotia, 153 Harbour Authorities operate a total of 180 harbours consisting of 156 core fishing harbours, which are central to the fishing and aquaculture industries, as well as 24 non-core harbours. Table 3-55 presents the 20 small craft harbours that are located along the coast within 10 km of the Study Area (Figure 3-87). Nineteen are core fishing harbours and one is non-core (DFO-SCH 2014). All harbours may also be used for recreational boating and marine tourism activities.

Table 3-55 Harbour Authorities and Harbours

Harbour Authority	Harbour	Category
Alder Point Harbour Authority	Alder Point	Core Fishing
Bay St. Lawrence Harbour Authority	Bay St. Lawrence	Core Fishing
Big Bras d'Or Harbour Authority	Big Bras d'Or	Core Fishing
Canso Harbour Authority	Canso	Core Fishing
Glace Bay Harbour Authority	Glace Bay	Core Fishing
Little Dover Harbour Authority	Dover (Little Dover)	Core Fishing
Little Harbour (Richmond Co.) Harbour Authority	Little Harbour (l'Ardoise)	Core Fishing
Little River (Victoria Co.) Harbour Authority	Little River (Victoria County)	Core Fishing
Louisbourg Harbour Authority	Louisbourg	Core Fishing
Main-A-Dieu Harbour Authority	Main-à-Dieu	Core Fishing
New Waterford Harbour Authority	New Waterford	Core Fishing
North Victoria Six Ports Harbour Authority	Dingwall	Core Fishing
	Ingonish (MacLeods Point)	Core Fishing
	Ingonish Ferry (South Ingonish)	Core Fishing
	Neils Harbour	Core Fishing
	New Haven	Core Fishing
	White Point	Core Fishing
Point Aconi Harbour Authority	Point Aconi (McCreadyville)	Core Fishing

Port Morien Harbour Authority	Port Morien	Core Fishing
NA	Gabarus	Non-Core Fishing

Source: DFO-SCH 2014

3.3.3.5 Ferries in the Study Area

In coastal areas of Canada, marine ferries deliver people and goods between provinces and to communities. In the Study Area, Marine Atlantic provides a daily ferry service between North Sydney, NS and Port aux Basques, NL (96 nautical miles) year round and a seasonal service to Argentia, NL (280 nautical miles) (Figure xx). In 2015, the Port aux Basques ferry is providing twice daily service in each direction, year round. The Argentia ferry is operating twice per week in each direction from early June to mid-September in 2015 (MAI 2015). In the 2013-14 fiscal year, Marine Atlantic moved approximately 325,000 passengers, 115,000 passenger vehicles and 97,000 commercial vehicles through these ports (MAI 2014).

3.3.3.6 Marine Cables

Marine cables are laid on the seabed between land-based stations to carry telecommunication signals across stretches of ocean. In the Atlantic Ocean, a number of such cables use one or more lines to connect sites in Eastern Canada and the United States and locations in the Greenland, Ireland, the United Kingdom and elsewhere in Europe.

A number of marine cable networks cross through the Study Area but most of these are considered abandoned (DFO 2015). As presented in Table 3-56, one system with two cables is currently active in the Study Area (Figure 3-88).

Table 3-56 Active Marine Cables in the Study Area

Cable	Landings	Cable Length	In Service	# Lines in Study Area
Persona (owned by East Link)	New Victoria, NS to Rose Blanche, NL	800 km (2 lines)	2008	2

Sources: ICPC 2015; DFO 2015

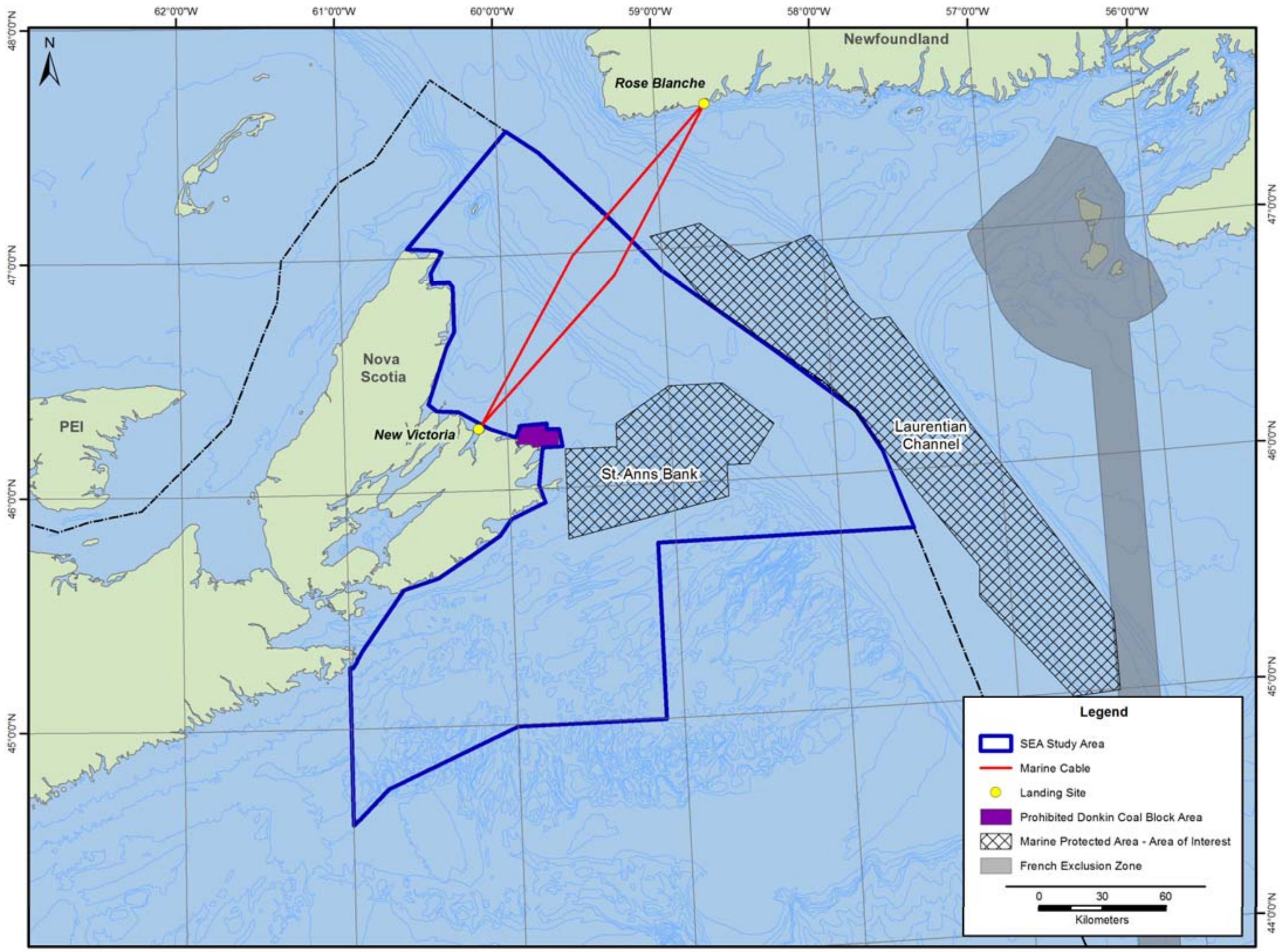
3.3.3.7 Military Activities

Under the National Defence Act, National Defence Canada (DND) is responsible for protection of Canada and its interests, and contributing to international peace and security. Canada has been a member of the North Atlantic Treaty Organization (NATO) since its founding in 1949 and since that time the Canadian Armed Forces has been engaged in NATO security and peacekeeping missions throughout the world. The Canadian Armed Forces (CAF) is involved in training and operations to prepare for international missions and disaster responses. CAF is also engaged in protecting national interests through coastal and aerial surveillance, leading search and rescue missions and assisting civil rescue authorities with domestic disaster relief (DND 2015; FAIT 2015).

Canada is a maritime country with security and economic interests in three oceans and the sea has been a vital component in the development of its economy especially in coastal areas. The Royal Canadian Navy (RCN) operates in Canada's oceans to guard the coast, detect suspicious and illegal activities and to respond to emergencies and disasters. To achieve this in the Atlantic Ocean, Maritime Forces Atlantic (MARLANT) is based in Halifax, Nova Scotia. In addition, Canadian Forces Base Halifax, the Canadian Fleet Atlantic, Fleet Maintenance Facility Cape Scott and Canadian Forces Base St. John's are all located in the Atlantic region (RCN 2014).

While exact locations of some activities may not be disclosed, Canada's Royal Navy and Air Force operate military, training, surveillance, monitoring and rescue operations throughout Atlantic Canadian waters. For example in August 2014, five Canadian vessels worked with two American military ships in a Halifax-based two-week NATO training exercise including manoeuvering, helicopter operations, weaponry and other activities (RCN 2014). Thus aircraft or marine patrols may operate in the Study Area or travel through it to and from operations in Canada and internationally.

Figure 3-88 Marine Cables in the Study Area



3.3.3.8 Unexploded Explosive Ordnances

Unexploded ordnance (UXO) are explosives that were intentionally left undetonated or did not explode as intended. Potential UXO sites in the ocean include sunken ships and submarines as well as munitions dump sites. Wartime action along Canada's coasts and incidents involving ships, planes or vehicles carrying ammunition and explosives have resulted in the potential presence of UXOs in the marine environment.

Many locations on land and sea in Canada have been used for military operations, training, weapons testing and disposal. The Government of Canada recognizes the potential danger of UXOs and has developed the UXO and Legacy Sites Program to maintain a database of potential sites, assess identified sites and conduct remediation measures as appropriate. Under this program, a UXO legacy site is described as any property that was owned, leased or used by DND but no longer resides within its inventory and for which there exists a UXO risk associated with past Departmental activities (DND 2013).

Through the UXO Program, DND has identified nearly 850 UXO legacy sites that are confirmed or in assessment at locations throughout Canada. Nova Scotia has three confirmed sites and 129 under investigation. Further, the marine waters of the east coast of Canada has four confirmed sites and 30 in assessment (DND 2013). Two explosive dumpsites, four DND Legacy Sites and 69 shipwrecks are identified as being within the Study Area (Table 3-57 and Figure 3-89) (Giffin 2015).

Table 3-57 UXOs (Explosive Dumpsites, Legacy Sites and Shipwrecks of Concern) in the Study Area

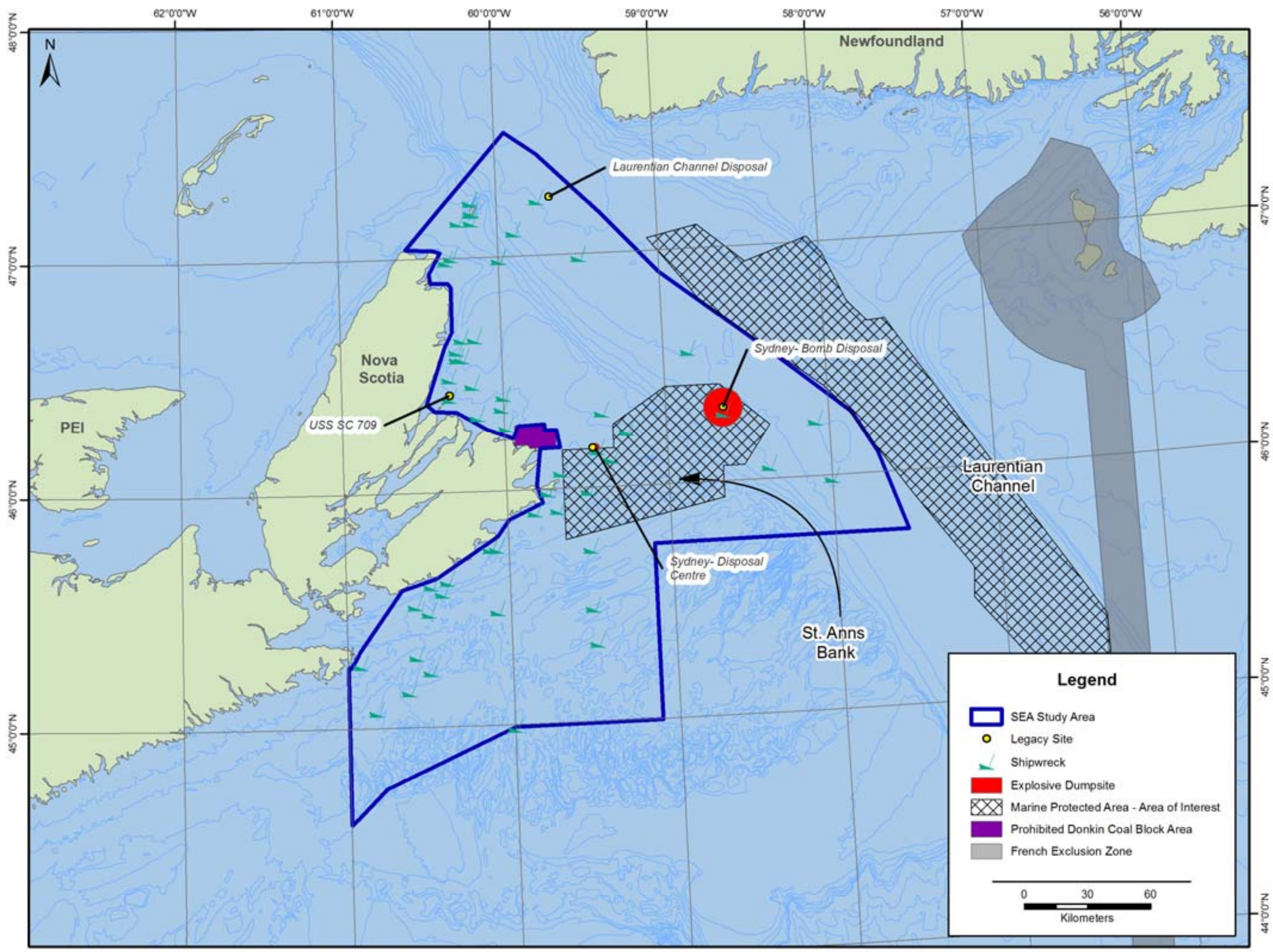
Site Name	Type
Danger Unexploded Explosives	Explosive Dumpsite
Explosives Dumping Ground	Explosive Dumpsite
USS SC 709	Legacy Site
Laurentian Channel Disposal	Legacy Site
Sydney - Bomb Disposal	Legacy Site
Sydney - Disposal Centre	Legacy Site
Waterton	Shipwreck
Eva U. Colp	Shipwreck
Ferdinand Bol	Shipwreck
Randy & Rebecca	Shipwreck
Sydney (unexploded bombs)	Shipwreck
Lake Allen	Shipwreck
Livingston	Shipwreck
Sydney (disposal area)	Shipwreck
SC 709	Shipwreck
Musquash	Shipwreck
Adriatic	Shipwreck
Afghan Prince	Shipwreck
Aguadilla	Shipwreck
Alfred Tailor	Shipwreck
Aviso	Shipwreck
C. Andrews	Shipwreck
Cape Breton	Shipwreck
Carol Joyce	Shipwreck
Carolyn A.	Shipwreck

Site Name	Type
Chelson	Shipwreck
Chelston	Shipwreck
Cienfuegos	Shipwreck
Ciss	Shipwreck
Cissay	Shipwreck
Clydie E.	Shipwreck
Curlew	Shipwreck
Dantzic	Shipwreck
Donzella	Shipwreck
Elliott	Shipwreck
Elsie M. Walters	Shipwreck
Emmy	Shipwreck
Empress of Fort William	Shipwreck
Enterprise	Shipwreck
Erdine Mae	Shipwreck
Essie M.L.	Shipwreck
F.L.B. 101	Shipwreck
Fannie Hartigan	Shipwreck
Floriston	Shipwreck
Frances G. Rowe	Shipwreck
Garnish Queen	Shipwreck
Harlaw	Shipwreck
Harold C. Beacher	Shipwreck
Heather H.	Shipwreck
Howard Stanley	Shipwreck
Imogene	Shipwreck
James G. Courtney	Shipwreck
Joan Eileen	Shipwreck
Judique	Shipwreck
Lenarfish	Shipwreck
Liberator	Shipwreck
Lidonna	Shipwreck
Linda Diane	Shipwreck
Luksefjell	Shipwreck
M. K. Smith	Shipwreck
Mary E. O'Hara	Shipwreck
Max C.	Shipwreck
MCNO #28	Shipwreck
Melissa Jean II	Shipwreck
Monica Walters	Shipwreck
Nellie Dixon	Shipwreck
Nickerson	Shipwreck
Octavian	Shipwreck
Percy F. Russell	Shipwreck
Sadie & Eva	Shipwreck
St. Eloi	Shipwreck
Susie Bernetta	Shipwreck
Truls	Shipwreck

Site Name	Type
Tuscarora	Shipwreck
Western Glen	Shipwreck

Source: Giffin 2015

Figure 3-89 UXOs (Explosive Dumpsites, Legacy Sites and Shipwrecks of Concern) in the Study Area



This Chapter defines and describes the scope of the SEA analysis, including the spatial and temporal boundaries of the assessment and the environmental components, issues and potential interactions upon which it is focussed. In doing so, it also describes and summarizes the nature and findings of the public and stakeholder consultation processes that have been or will be undertaken as part of the SEA, which have had a key influence on the scoping exercise.

The Chapter then goes on to identify the VECs upon which the SEA is focussed and the rationale for their selection. It concludes with an overview of the approach and methods used to conduct the SEA and its associated analyses.

4 STRATEGIC ENVIRONMENTAL ASSESSMENT SCOPE AND APPROACH

This Chapter defines and describes the scope of the SEA analysis, including the spatial and temporal boundaries of the assessment and the environmental components, issues and potential interactions upon which it is focussed. In doing so, it also describes and summarizes the nature and findings of the public and stakeholder consultation processes that have been or will be undertaken as part of the SEA, which have had a key influence on the scoping exercise.

The Chapter then goes on to identify the VECs upon which the SEA is focussed and the rationale for their selection. It concludes with an overview of the approach and methods used to conduct the SEA and its associated analyses.

4.1 Spatial and Temporal Boundaries

This SEA focuses on describing the environmental setting and associated environmental considerations within the Study Area that has been established for the assessment, the spatial boundaries of which are illustrated in Figure 4-1. These have been defined based on consideration of the geographic extent of the CNSOPB's jurisdiction (as defined by the northeastern edge of the Nova Scotia Offshore Area), as well as the limits of the study areas for previous SEAs undertaken by the CNSOPB and others for various parts of the Eastern Scotian Shelf and Slope (NS Offshore Area) and the Laurentian Subbasin (NL Offshore Area).

The Study Area includes lands that could be included in any potential future Call for Bids or resulting Exploration Licences in this area. The spatial boundaries of the SEA and associated analysis also reflect consideration of the nature and scale of any offshore oil and gas (particularly, exploration) activities that may occur in relation to future Exploration Licences that may be issued in this region, as well as the potential environmental zones of influence of any such activities and their associated disturbances in the marine environment.

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

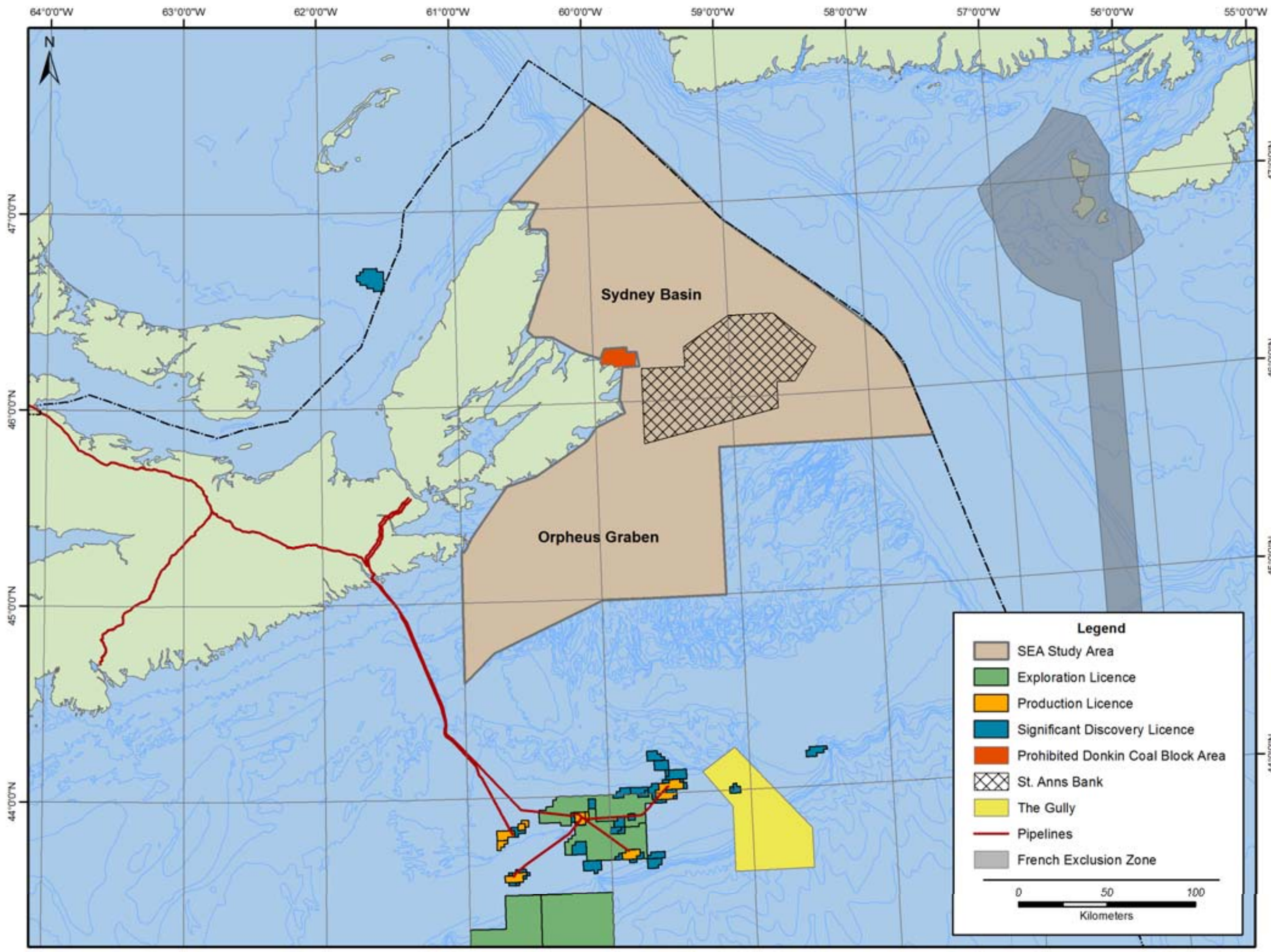
The geographic scope of the SEA information and analysis therefore recognize and consider the nature, key characteristics and spatial distribution (including movements) of the various environmental components under consideration (Chapter 3). For the biophysical environment, this includes the associated life histories, ranges, habitat preferences, movement patterns and other key requirements and activities of key species that are known or likely to be present either year-round or seasonally. It also considers the overall location, size and extent of any special areas that overlap in whole or part with the Study Area, as well as the overall geographic distributions of the ecological and/or socio-cultural components and processes that have been relevant to the identification and overall integrity and value of these areas. For the human environment, the SEA includes consideration of the overall geographic extent and distribution of key human activities (such as fishing, recreation, tourism) within and adjacent to the Study Area.

Therefore, although the SEA has a primary focus on the Sydney Basin and Orpheus Graben Areas themselves (approximately 37,280 km^2), the analysis has not been confined to the Study Area. Rather, the assessment also considers the overall areas within which the environmental components that could potentially be affected by potential oil and gas related activities (including accidental events) are located.

In terms of temporal boundaries, the SEA focuses upon an overall time horizon of approximately 10 years, which would generally correspond to the temporal duration of any additional Exploration Licences that could be issued in the area upon completion of the SEA. In conducting the assessment, particular consideration has been given to the overall timing and seasonality of the presence of marine biota and relevant marine activities within the Study Area, including any particularly important or sensitive time periods.

As has been the CNSOPB's practice in completing SEAs, this assessment will be reviewed within a five year period to determine whether an update is required.

Figure 4-1 Sydney Basin and Orpheus Graben Areas - Study Area



4.2 SEA Scoping Document and the Associated "Strategic Decision"

The planning and preparation of the SEA has been informed and guided by a Scoping Document, which outlines the factors to be considered, the scope of those factors and other guidelines for preparing the SEA Report.

A Draft SEA Scoping Document was initially prepared by CNSOPB staff and the SEA Study Team and subsequently released and announced publicly by the Board on May 7, 2015. Following review and input by a number of the Board's advisory agencies and organizations, the Scoping Document was subsequently finalized in June 2015 and has since guided the SEA's planning and completion.

The Scoping Document sets out the key purpose and objectives of the SEA, which include that it will:

- Provide an overview of the existing environment;
- Generally describe typical offshore oil and gas exploration activities;
- Describe and evaluate potential environmental effects associated with offshore oil and gas exploration;
- Identify knowledge and data gaps;
- Identify any species at risk and special areas that may interact with exploration activities;
- Make recommendations for general mitigative measures that may be employed during any potential offshore petroleum exploration activities in the region;
- Identify, where appropriate, activities / areas that may require additional or enhanced levels of mitigation, and identify, if feasible, the type and level of enhanced mitigation required;
- Identify follow-up (environmental effects monitoring) measures, as appropriate, that may be required to verify EA predictions and/or the effectiveness of mitigation related to future offshore petroleum exploration activities; and
- Assist the Board in its determination in respect to the potential issuance of future exploration rights within the SEA Study Area.

The SEA Scoping Document also specifies that the SEA will describe and consider all potential and reasonably foreseeable offshore oil and gas exploration activities that may occur in the Study Area if one or more Exploration Licences are eventually issued. These include potential exploratory and delineation drilling, seismic survey activities (2D, 3D, wide angle azimuth surveying, vertical seismic profiling, geohazard surveys), geotechnical surveys, and eventual wellsite abandonment. It also states that the focus of the SEA will be on offshore exploration activities (and their potential interactions with the environment) which fall under the jurisdiction of the CNSOPB. The Scoping Document goes onto to identify and highlight a number of other information requirements and issues which are to be considered and addressed in the SEA.

The specific "strategic decision" that the SEA is intended to inform is whether further exploration rights should be issued in whole, in part, or at all in the Sydney Basin and Orpheus Graben Areas, and if so, to identify any environmental components and issues which should be considered in taking these future decisions and actions.

4.3 Consultation Activities and Initiatives

The CNSOPB's approach to planning and conducting its SEAs is an inherently open and consultative one, which includes various mechanisms for relevant organizations and individuals to receive and review information, and as well as to provide information and perspectives that are relevant to the SEA and its scope. This includes opportunities to identify questions, concerns and issues which require consideration in the SEA and which may be relevant to associated licencing decisions by the Board.

As referenced above, a number of government departments and agencies (Environment Canada, DFO, DND) and stakeholder groups, including the CNSOPB's Fisheries Advisory Committee and others, were involved in the review and finalization of the SEA Scoping Document that has guided its planning and preparation.

This draft SEA report is available for comment during the stated public review period. Any and all comments received will be considered by the CNSOPB in revising and finalizing the SEA Report, with the final SEA documents anticipated to be published in the fall of 2015.

Another important and integral component of the review of the Draft SEA will be a program of public and stakeholder engagement. This is currently planned to include a series of public open houses and other stakeholder meetings in communities throughout the SEA Study Area in the September 2015 time period. Full details on these sessions, their attendance, and key findings will be included in the Final SEA Report.

4.4 Identification of Valued Environmental Components

It is generally acknowledged that an EA should identify and focus on those components of the environment that have the potential to be significantly or materially affected by the proposed project, program, plan or policy in question, including those which are particularly important ecologically, valued by society or which can serve as recipients, pathways and indicators of environmental change. In an EA context, these are known as Valued Environmental Components (VECs), and may include both biophysical and socioeconomic elements of the environment.

The above sections have generally described a number of issues scoping activities and initiatives that have helped to identify the environmental components, issues and interactions that may be relevant to possible future oil and gas activity in the Study Area and which require consideration in the SEA. These have included the Scoping Document prepared and issued by the CNOPB and the continuous provision of information, updates and opportunities to provide input through the Board's website and other means. In addition to these past, on-going and planned consultation activities, the scoping exercise for the SEA has also included consideration of the nature of past and potential future oil and gas activities in the Sydney Basin and Orpheus Graben Areas (Chapter 2), and the existing biophysical and human environments of the region (Chapter 3), in order to identify key potential environmental interactions and issues (Chapter 5). Other SEAs undertaken in relation to offshore petroleum exploration and development in Nova Scotia and elsewhere were also reviewed and considered, as well as project-specific EAs conducted in relation to individual seismic surveys, exploration drilling programs and production projects. The results of these previous assessments and studies were considered as part of the scoping exercise, as appropriate, with due consideration of differences between their environmental settings and study areas and that for this SEA.

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

1) Species of Special Status
2) Special Areas
3) Fisheries, and
4) Other Ocean Users

A further definition of these VECs and the rationale for the selection is provided below:

Species of Special Status: A number of marine fish, bird, mammal and reptile species that are known or likely to occur in the Study Area have been designated as being at risk, and have varying degrees of formal protection under the federal *Species at Risk Act*, the *Migratory Birds Convention Act*, and/or other legislation. This includes several species of marine and anadromous fish, as well as marine, coastal and land birds and a number of whales and sea turtles. Other species have also been identified as being of conservation concern or regionally rare by relevant organizations such as the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or others.

Special Areas: Several locations within or adjacent to the Study Area have been identified (and in some cases, designated) as special areas under provincial, federal and/or other legislation and processes, due to their ecological, historical and/or socio-cultural characteristics and importance. Some other locations have been identified as being especially sensitive to possible environmental disturbances, including some that are important ecologically and/or for associated human activities and values. Fisheries and Oceans Canada has, for example, selected St. Anns Bank, an area east of Cape Breton on the Eastern Scotian Shelf, as an Area of Interest (AOI) for possible establishment as a Marine Protected Area under the *Oceans Act*. There is also a Migratory Bird Sanctuary, the Big Glace Bay Lake Migratory Bird Sanctuary, and a number of Important Bird Areas (IBAs), including Bird Islands IBA, and various other island and coastal locations in the general area. There are also several existing or proposed Ecologically or Biologically Significant Marine Areas (EBSAs) in the region, as well as Cape Breton Highlands National Park and various provincial parks and protected areas which border the Study Area. These areas, and the potential for interactions and effects resulting from future oil and gas activities on them, are given particular emphasis in the SEA.

Fisheries: Fisheries are an important and integral component of the socioeconomic environment of Nova Scotia and other parts of Canada, including the various communities and regions that extend along the coastline adjacent to the Study Area and elsewhere. Commercial harvesting is conducted throughout the area through core licences or developmental fisheries permits / licences, and involves fishers from Nova Scotia and other provinces which are represented by a number of organizations. Consideration will be given to recreational fisheries, Aboriginal communal commercial fisheries, and Food, Social and Ceremonial fisheries as well. The main fish species currently targeted by commercial fisheries include, but is not limited to, important invertebrate species such as American lobster, snow crab, sea scallop, red crab and rock crab, as well as finfish such as Atlantic herring, bluefin tuna, Atlantic cod, Greenland halibut, haddock, mackerel, pollock, redfish and swordfish and other species. Some harvesting of gray and harp seals may also occur in the area. Aboriginal fisheries include all of these species, with special emphasis on lobster, halibut and flounder. Fisheries have the potential to be affected both directly (through possible interactions between offshore oil and gas operations and fishing activity and gear) and indirectly (due to any negative changes in the size, distribution and health of fish populations or habitat) by offshore petroleum activities. Ensuring adequate and appropriate planning and mitigative (especially, communicative) measures to avoid potential interactions between offshore oil and gas exploration equipment and fishing vessels and equipment is a key priority for both industries.

Other Ocean Users: A number of other human activities and components also occur within or near the marine environment, and therefore have the potential to interact with, and be affected by, any future offshore oil and gas activities in the Study Area. These include general vessel traffic to, from and through the area, as well as whale and sea bird tours and other commercial and recreational marine pursuits.

These VECs represent the main environmental components which are assessed in this SEA. This assessment therefore focuses on those environmental components and potential interactions which are of primary concern, and thus, which have the most relevance to strategic planning and decision-making related to possible future oil and gas activities in the Sydney Basin and Orpheus Graben Areas.

A number of environmental components, including physical components such as air and water quality as well as marine fish, birds, mammals and reptiles that do not currently have special status (as defined above) and/or which are not subject to fishing activity or other human uses are not included as VECs for the assessment and are therefore are not given similarly detailed and separate treatment in the assessment. These components are considered to be relatively abundant and healthy in the Study Area at present, and/or they are not currently fished or otherwise used for commercial, recreational and/or Aboriginal purposes. Any resulting mitigation measures will also, however, serve to avoid or reduce potential effects upon these or other environmental components as well, including marine species and aspects of the human environment in the area.

4.5 SEA Analysis: Approach and Methodology

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

4.5.1 Environmental Setting

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

This description of the existing environment in the Study Area does not focus exclusively upon the identified VECs, but rather also includes other aspects of the physical, biological and socioeconomic environments which are relevant and/or have been specified in the Scoping Document for the SEA. It is intended that the SEA Report will eventually be viewed as an a important source of environmental information on the Sydney Basin and Orpheus Graben Areas, and will be used as such in the planning and EA review of any future projects and activities that may eventually be proposed in the region.

4.5.2 Potential Environmental Interactions and Effects

At the early stages of strategic planning processes (e.g., exploration licencing) there is typically little or no information available regarding the specific nature, timing and location of projects and activities as these have yet to be defined, designed and proposed. Whereas an EA of a proposed offshore exploration program, for example, would consider particular project characteristics and activities (e.g., survey areas, drilling locations) and predict specific environmental effects (e.g., area covered by sound attenuation or released drill cuttings, spill probability and behaviour), SEAs usually describe potential environmental issues and effects in relatively broad terms. SEAs therefore usually focus on providing a general and regional-scale description of the overall environmental setting, and on identifying and attempting to address environmental issues through appropriate strategic planning and decision-making.

This SEA includes the identification of general environmental issues and effects which may be associated with offshore oil and gas activities in the Sydney Basin and Orpheus Graben Areas. The analysis for each of the identified VECs includes consideration of the components and activities which are typically associated with offshore oil and gas activity (Chapter 2) and the region's existing environment (Chapter 3), in order to identify potential interactions between them (Chapter 5). This analysis has been generally informed by the available literature and other existing information on the effects of offshore oil and gas activities and their associated environmental interactions on each of the VECs. These sections of the SEA Report include a general identification and overview of the known and likely environmental issues and interactions associated with petroleum exploration activities, as background and context for identifying key issues and associated environmental planning considerations.

4.5.3 Environmental Mitigation Measures and Planning Considerations

These sections initially provide a summary overview of typical / standard mitigation measures which are often implemented during offshore oil and gas exploration activities in the Nova Scotia Offshore Area and elsewhere to avoid or reduce potential environmental effects. Environmental monitoring and follow-up programs which are typically required are also discussed, as applicable.

Based on the overview of the existing environmental setting of Sydney Basin and Orpheus Graben Areas and the potential environmental interactions and issues and typical mitigations identified through the above, the SEA also then identifies key environmental considerations to help guide future planning and decision-making. In doing so, this section highlights relevant aspects of the existing environmental setting of the area (e.g., particularly important areas and times). Key planning and management considerations that may help to inform future licencing discussions are identified and described here, as well as any other activity, issue, site or time-specific measures which may help to avoid or reduce potential environmental effects.

4.5.4 Cumulative Environmental Effects

Cumulative effects which may result from future offshore oil and gas activities in the Sydney Basin and Orpheus Graben Areas are also assessed as part of the analyses, to the degree possible given that their specific number, characteristics, locations and timing is not known at this stage.

The SEA also considers the potential cumulative effects of offshore oil and gas activities in the Study Area in combination with other projects and activities in the region (such as general marine vessel traffic, fisheries).The overall objective at the SEA stage is to generally identify and evaluate potential issues with regard to possible cumulative effects, at an early and relatively broad scale of analysis, for general consideration in licencing decisions, but also, for planning and assessing any future associated oil and gas projects to avoid or reduce such effects.

4.5.5 Information Availability, Requirements and Opportunities

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

5 POTENTIAL ENVIRONMENTAL INTERACTIONS, MITIGATION AND PLANNING CONSIDERATIONS

This Chapter provides an identification and analysis of potential environmental issues and interactions, mitigation measures and planning considerations related to possible future offshore oil and gas activities in the Sydney Basin and Orpheus Graben Areas. The analysis and discussion that follows is focused upon the four VECs that have been identified for the SEA:

1) Species of Special Status;
2) Special Areas;
3) Fisheries; and
4) Other Marine Components, Activities and Ocean Users

5.1 Oil and Gas Exploration Activities: Components, Activities, Environmental Interactions

As described previously in Chapter 2, key aspects of potential oil and gas related activities that may occur in the Study Area (should Exploration Licences be issued) include:

- Seismic surveying;
- Seabed surveying (such as geophysical and geotechnical data collection);
- Vertical seismic profiles (VSPs);
- Exploratory / delineation drilling (mobile offshore drilling unit - semi-submersible or drill ship) and well abandonment; and
- Vessel traffic (including supply and support vessels, aircraft).

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

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

- Potential accidental spills or the loss of material / equipment into the marine environment.

5.2 Species of Special Status

A number of marine fish, bird, mammal and reptile species that are known or likely to occur in the Study Area have been designated as being at risk, and have varying degrees of formal protection under the federal *Species at Risk Act*, the *Migratory Birds Convention Act*, and/or other legislation. This includes several species of fish, as well as marine, coastal and land birds, and a number of whales and sea turtles. Other species have also been identified as being of conservation concern or regionally rare by relevant organizations such as the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or others. Species of Special Status occurring in the Study Area are discussed in detail in Section 3.2.11.

5.2.1 Potential Environmental Emissions and Interactions

A wide range of environmental interactions have the potential to occur between offshore oil & gas activities and marine species and their habitats. These interactions may be both direct and indirect in nature, and can include the following:

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

Potential impacts of various phases or components of offshore oil and gas exploration and production are discussed with respect to marine fish, birds, marine mammals, and sea turtles in the following subsections.

5.2.1.1 Seismic and Seabed Surveys

A description of the methods and equipment used in conducting seismic and seabed surveys is provided in Chapter 2. Potential impacts of seismic surveys on fish, birds, marine mammals and sea turtles are discussed below.

5.2.1.1.1 Potential Impacts to Fish, including Species of Special Status

The effects of sounds on fishes are not well studied and are poorly understood. The general structure of the fish inner ear is similar to that of other vertebrates (Ladich and Popper 2004), and fish are known to be able to detect and respond to a wide range of sounds. The ability of fish and invertebrate species to detect sound varies considerably. Hearing sensitivities of finfish were reviewed by Popper and Carlson (1998) and Popper *et al.* (2003). Species differ in the range of frequencies (bandwidth) and in the lowest sound pressure level (SPL) threshold that they are able to detect. A recent review of the anthropogenic effects of sound on fishes stated that the majority of species detect sounds from below 50 Hz up to 500–1500 Hz (Popper and Hastings 2009). Most fish species are considered to be 'hearing generalists' (Popper and Hastings 2009). Generalists include cod, salmonids, cichlids, tunas and numerous other species (see Popper *et al.* 2003). Cod, salmon, American plaice and herring have hearing sensitivities between 80 and 200 Hz, with a sensitivity threshold at 80 to 100 dB re to 1μPa (Mitson 1995).

A smaller number of fish species can detect sounds to over 3 kHz, while a very few species can detect sounds to well over 100 kHz. These species are considered 'hearing specialists" (*e.g.*, Popper *et al.* 2003). Fish considered to be hearing specialists usually have specialized anatomical structures that enhance hearing sensitivity and bandwidth (see Ladich and Popper 2004, Popper *et al.* 2003). Specialists include all Cyprinid and Clupeiform fishes and some scattered representatives in a wide range of other taxa. The fishes known to have the widest hearing frequency bandwidth are members of the Clupeiformes, or herrings (Popper *et al.* 2003). Some fish species, such as Atlantic salmon (*Salmo salar*), a hearing generalist, are known to detect particle motion, rather than sound pressure (Hawkins, and Johnstone 1978).

Many fish species and invertebrates area also capable of emitting sounds at frequencies similar to seismic noise (Myrberg 1980, Turnpenny and Nedwell 1994, Engen and Folstad 1999, Hawkins and Amorin 2000, Slabbekoorn *et al.* 2010). Some fish species use acoustic communication during communication, navigation and sensing of prey and predators (Myrberg 1980, Zelick *et al.* 1999, Bass and Ladich 2008, Slabbekoorn *et al.* 2010). Some fish are also able to distinguish and interpret competing sounds (MMS 2004). Radford *et al.* (2014) recently reviewed the effects of anthropogenic noise on fish communication. They highlight that communication plays an important role in the ecology of many fish (*e.g.* territorial disputes, mating, predatory attacks, aggregating for spawning) and masking these sounds could affect survival and reproductive success. Furthermore, non-masking sounds have the potential to stress fish and/or reduce performance of many activities. These authors emphasize that there remains relatively little empirical data regarding seismic effects on fish, particularly given the vast number of species involved and that such effects varies across fish taxa, based on their physiology, ecology and adaptation.

Marine invertebrates typically lack organs that detect sound pressure waves but some, such as crabs, have structures known as statocysts that are capable of detecting sound via particle motion (Popper *et al.* 2001, Morley *et al.* 2014). Organisms that rely exclusively on particle motion (most invertebrates) to detect sound tend to be less affected by anthropogenic noise exposure (Morley *et al.* 2014). Laboratory studies have shown that some crustaceans (*e.g.* Norway lobster) respond to sounds that are within the frequency range of sounds generated by seismic surveys (Goodall *et al. et al.* 1990).

In general, deep water species and those lacking swim bladders may be less vulnerable to effects from seismic survey activities (Boertmann and Mosbech 2011).

5.2.1.1.1.1 Behavioural Impacts

When exposed to an operating seismic array, mobile marine fish may exhibit a variety of responses, including alarm responses and temporary avoidance of the area (*e.g*. McCauley *et al.* 2000a, 2000b). When exposed to an operating seismic air source arrays, mobile marine fish may swim deeper, mill in compact schools or become more active (eg, Slotte *et al.* 2004). Given the opportunity, fish will generally avoid areas where noise levels exceed their threshold of hearing by 30 dB or more (ICES 1995).

Indeed, behavioural reactions to exposure to seismic noise have been widely documented in marine organisms (DFO 2004).There are well documented observations of fish and invertebrates exhibiting behaviours that appeared to be in response to exposure to active seismic air source array noise levels. These include startle responses, changes in swimming direction and speed, or changes in vertical distribution (Blaxter *et al.* 1981, Schwartz and Greer 1984, Pearson *et al.* 1992, McCauley *et al.* 2000a, 2000b, Wardle *et al.* 2001, Hassel *et al.* 2003). Gadoids, for example, have been shown to leave the area during seismic surveys (Skalski *et al.* 1992, Løkkeborg and Soldal 1993, Engås *et al.* 1996, Slotte *et al.* 2004, Parry and Gason 2006). Species such as cod, rockfish and whiting (*Merlangius merlangus*) have been reported to change depth in response to seismic noise (Pearson *et al.* 1992; Wardle *et al.* 2001).

Other studies have found that many species of fish dive to avoid intense sound (Protasov 1966, Schwartz and Greer 1984, Knudsen *et al.* 1992). McCauley *et al.* (2000 a, b) describe a more intense "generic" fish alarm startle response of seeking shelter in tight schools and moving near the bottom. Anthropogenic noise appears to have a more pronounced effect on larger fish (Engås *et al.* 1996) and invertebrates (Wale *et al.* 2013) than smaller individuals. In contrast, other studies indicate that fish do not change behaviour when exposed to an active seismic air source array (*e.g.,* Pickett *et al.* 1994, Wardle *et al.* 2001, Andriguetto-Filho *et al.* 2005). Wardle *et al.* (2001), for example, report that neither finfish nor invertebrates showed signs of moving away from a reef on the west coast of Scotland after four days of seismic air source array firing. Similarly, Pena *et al. et al.* (2013) indicated that feeding herring were undeterred by seismic acquisition activity as they approached to within 2 km of seismic survey operations. Snow crab located 50 m from a seismic source did not exhibit alarm responses, changes in physiology (Christian *et al.* 2004), nor did they show evidence for effects on egg hatch time (Payne *et al.* 2008). Hawkins and Popper (2014) illustrate that seemingly similar species respond differently to the same anthropogenic noise source. They also indicate that the response can differ within a species depending on the time of day and other factors.

Some studies indicate that any behavioural changes that do occur are very temporary while others imply that marine animals might not resume pre-seismic behaviours or distributions for several days (Engås *et al.* 1996, Løkkeborg 1991, Skalski *et al.* 1992). Most available literature (Blaxter *et al.* 1981, Dalen and Raknes 1985, Pearson *et al.* 1992, Davis *et al.* 1998, McCauley *et al.* 2000a, 2000b) indicates that the effects of noise on fish are brief and if the effects are short-lived and outside a critical period, they are expected not to translate into biological or physical effects. However, Slabbekoorn *et al.* (2010) and Hawkins *et al.* (2014b) emphasize that the understanding of anthropogenic noise effects on fish remains incomplete.

5.2.1.1.1.2 Physical Impacts

The impacts of sound on fish and invertebrates has received considerable study, with varying results. A variety of studies have investigated potential injury to fish as a result of seismic air source arrays, such as damage to hearing structures (*e.g.* Popper *et al.* 2005) and/or mortality of fish, fish eggs or larvae (*e.g.* Parry and Gason 2006). No mass fish kills associated with the operation of airguns have been recorded (Payne 2004). The majority of studies have found that stationary fish affected by seismic surveys had to be located very close to the seismic array (usually, caged close to the source and subjected to multiple passes of the array) to be affected (see McCauley *et al.* 2003 and Turnpenny and Nedwell 1994 for reviews). Turnpenny and Nedwell's 1994 study concluded that, depending on source noise level, water depth, and distance of the fish relative to the sound source, damage to fish such as eye and internal organ injuries would only occur within a few tens of metres, with lesser symptoms such as hearing damage possible out to several hundred metres. Studies using caged fish have also noted that the response of the fish is usually a strong attempt to move away from the sound (*e.g.* McCauley *et al.* 2003). Under natural conditions, fish would presumably respond to disturbing sounds and swim away before the onset on injuries. The effects of seismic surveys on marine phytoplankton, zooplankton and the planktonic life stages of various marine fish species have also been investigated (see, for example, Dalen *et al.* 2007 for a review). Mortality of fish, fish eggs, and larvae has been observed only within a few metres of seismic air source arrays (Kostyuchenko 1973,Dalen and Knutsen 1987, Kosheleva 1992, Matishov 1992, Holiday *et al.* in Turnpenny and Nedwell 1994, Parry and Gason 2006) and immediate mortality is unlikely (Worcester 2006). High intensity seismic noise can have lethal or sublethal effects on plankton at short range (less than 5 m; Ostby *et al.* 2003, in Boertmann and Mosbech 2011).

Davis *et al.* (1998) estimated up to one percent of the ichthyoplankton in the top 50 m of the water column within close proximity to the sound source could be killed during 3-D seismic survey off Nova Scotia. Kenchington *et al.* (2001) estimated a plankton mortality rate of six percent if they were concentrated in the upper 10 m in close proximity to the sound source. In Norway, it was estimated that 0.45 percent of planktonic organisms in the top 10 m of water could be killed by high intensity seismic noise (Sætre and Ona 1996). In this study, mortality of fish eggs caused by exposure to seismic array noise was very low compared to natural mortality and was not considered to significantly impact fish recruitment (Sætre and Ona 1996). Payne *et al.* (2008) indicated there was no evidence for delayed mortality or egg loss in snow crab exposed under the conditions of an actual seismic program in deep waters off Cape Breton. In snow crab, over a period of days to several months, there were no effects of delayed mortality or damage to mechanosensory systems associated with animal equilibrium and posture. There was also no evidence of leg loss or other appendages (Payne *et al.* 2008). A caged snow crab test group exposed to seismic sound showed elevated bruising of their hepatopancreas; bruising of ovaries, and dilated oocytes with detached chorions (DFO 2004).

The timing and location of seismic activity and proximity to the air gun array is a key factor in the likelihood and potential degree of effect. Seismic air source arrays operating in areas and times of strong seasonal stratifications or upwelling may affect more planktonic material because of their high densities in these areas (Boudreau *et al.* 2001).

Although it is evident that fish often respond to sounds emitted from seismic air source arrays (see below), little direct physical damage to fish occurs at distances greater than a few meters from the source. Due to the avoidance behaviour by free-swimming fish, they typically do not suffer physical damage from seismic surveys (Gausland 1993). Indeed, there are no documented cases of fish mortality under exposure to seismic sound under field operating conditions (DFO 2004, Payne 2004), nor have FLOs or other seismic ship's personnel reported observing dead fish around survey operations. Overall, exposure to seismic sound is considered unlikely to result in direct fish mortality (DFO 2004).

Caged snow crab exposed to air guns did not exhibit any signs of external damage, and survival of the embryos and locomotion of the resulting larvae after hatch were unaffected; and gills, antennae and statocysts were soiled in the test group, but were found free of sediment five months later (Christian *et al.* 2004, DFO 2004c). Internally, less definitive results were significant differences between test and control groups related to bruising of the hepatopancreas; bruising of ovaries; dilated oocytes with detached chorions; one test group had delayed embryo hatch and larvae were slightly smaller; and orientation as a function of being turned over (DFO 2004c).

5.2.1.1.1.3 Sound Levels that may affect Fish and Invertebrates

Studies of fish reactions to anthropogenic noise in the marine environment have produced a range of results across different sound levels and between species. For context, container shipping and oil platform production can reach levels of 198 dB (Ross 1976). Subtle behavioural changes of rockfish exposed to seismic sounds, for example, commenced at 149 dB and alarm response became significant at 168 dB (Pearson *et al.* 1992). Eastern striped grunter displayed persistent C-turn startle responses at 182 – 195 dB (McCauley *et al.* 2000a, b), whereas various fish showed startle responses to noises ranging from 183 - 207dB (Wardle *et al.* 2001). The onset of 'alarm' behaviours typically begin at 156 – 161 168 dB (McCauley *et al.* 2000 a,b) Blaxter *et al.* (1981) found that schooling herring changed direction with a sudden noise level of 144 dB re 1 µPa. Turnpenny and Nedwell (1994) found air source signals ranging from 160 to 186 dB re 1 µPa resulted in avoidance behaviour. Lokkeborg and Soldal

(1993) estimated that avoidance behaviour in fish occurs between 160 and 171 dB re 1 µPa. Engåas *et al.* (1996) noted that mild behavioural effects can extend 3 to 10 to tens of kilometres from the seismic source. This is supported by DNV Energy (2007, in Hurley 2009) which states that scare effects have been demonstrated in a radius of more than 30 km from the seismic sound source. The spatial range of response in fish can also vary greatly with changes in the physical environment in which the sounds are emitted. Fish species may be unaffected by sound but may move away if the sound source drives their prey out of an area.

- Some select examples of studies which have investigated the physical damage to fish are a result of exposure to different levels of seismic sound are provided below. It is noteworthy that many of these studies were conducted in the laboratory and therefore may not always reflect effects experienced by free ranging organisms in the wild.
- Turnpenny and Nedwell (1994) determined that blindness can occur in fish exposed to air sleeve blasts of approximately 214 dB. Auditory damage begins at 180 dB, with transient stunning and internal injuries occurring at 192 dB and at 220 dB, respectively.
- Cod eggs exposed to seismic shots (202 – 220 dB) showed no signs of injury (Dalen and Knutsen 1987).
- Matishov (1992) showed that five day old cod experienced delimitation of retina at 250 dB.
- Cod larvae (exposed to 220 dB) and fry (exposed to 234 dB) were shown to experience immediate mortality, but eggs showed no signs of injury (Dalen and Knutsen 1987).
- Pollock eggs (242 dB) show delayed mortality (Booman *et al.* 1996).
- No injury to red mullet eggs occurred at 210d B but eight percent were injured at 230 dB (Kostyuchenko 1973).
- Swimbladders of anchovy larvae were ruptured at 238 dB (Holiday *et al.* in Turnpenny and Nedwell 1994).
- Kostyuchenko (1973) reported more than 75 percent survival of fish eggs at 0.5 m from the source (233 db at 1 m) and more than 90 percent survival at 10 m from the source.
- Kosheleva (1992) reported no obvious physiological effects of fish beyond 1 m from a source of 220 to 240 dB.
- Hastings (1990) reported that lethal threshold for fish occurs at 229 dB and a stunning effect in the 192 to 198 dB range.
- Matishov (1992) observed shell damage in Iceland scallops while urchins lost 15 percent of their spines when exposed to 217 dB.
- No detectable differences were observed in mussels, crustaceans or periwinkles within 30 days after exposure to 229 dB seismic arrays (Kosheleva 1992).
- At 231.dB, length of molt intervals and long-term survival of Dungeness crab larvae molt times and long term survival was were not affected (Pearson *et al.* 1994).
- Brown shrimp exposed to 190 dB showed no injury (Webb and Kempf 1998).
- Caged cephalopods (squid and cuttlefish) exposed to sound from a single 20-inch airgun exhibited startle responses such as firing their ink sacs, moving away from the airgun, and increasing swimming speeds (McCauley *et al.* 2000a).

- Norway lobster (*Nephrops norvegicus*) showed postural responses to sound frequencies of 20 to 180 Hz in the lab (Goodall *et al.* 1990).
- Preliminary investigations by Christian *et al.* (2004) on fertilized snow crab eggs 2 m form a sound source found that mortality was 1.6% higher in exposed eggs than controls. However, the authors concluded the effect was likely confounded by the use of one pool of control eggs and one pool of exposed eggs, and further investigation is required.
- No statistically significant differences between the exposed and unexposed larvae were observed with respect to immediate and long-term survival and time to molt, even for those exposed larvae within 1 m of the seismic source (Pearson *et al.* 1994).
- Hawkins *et al.* (2014a) studied the response of mackerel and sprat schools to repeated impulsive sounds. Incidence of response increased with sound levels but responses were different across species (mackerel changed depth while sprat dispersed). The sound level where 50 percent of fish schools responded was 163.2 and 163.3 dB re 1mPa2 (peak to peak) and 135 and 142dB re 1mPa2 for single strike for sprat and mackerel respectively.

5.2.1.1.1.4 Impacts on Commercial Fishing

A number of studies have documented changes in fishing success rates during and immediately after seismic survey activity within the general area. Skalski *et al.* (1992), for example, cited seismic activity as a contributing factor for decreased fish abundance, and Lokkeborg (1991) observed reduced catches in fish for days following 2D/3D seismic survey exposure as a result of changes in fish behaviour. Similarly, Engås *et al.* (1996) documented reduced catches within several kilometres that continued for days after seismic activity stopped, though Gausland (2003) pointed out that the catch rates were not statistically different than normal variation in catch rates. Catches for some species / gear types (such as gillnet catches of orange rockfish and halibut) have actually increased during seismic activity, whereas others (such as longline catches of haddock) have been observed to decrease. At larger scales, regions with seismic survey activity had decreased catches for only a few species for certain gear types (eg, saithe and haddock with gill nets; Vold *et al.* 2009). Parry and Gason (2006) found no evidence of seismic noise effects on catch rates of Australian rock lobster.

The potential effects of seismic survey activity on fish catch rates therefore appear to vary by species and gear type (Hirst and Rodhouse 2000, Worcester 2006, Lokkeborg *et al.* 2012, Vold *et al.* 2012), but in general remain poorly understood.

5.2.1.1.2 Potential Impacts on Marine Birds

Many species of birds utilize habitats within the Study Area (Section 3.2.8). Marine and migratory birds are protected by legislation (*Migratory Birds Convention Act* and the *Species at Risk Act* and thus, are a regulatory concern. However, very little information on the effects of underwater noise on bird species exists in the scientific literature. There are currently no data suggesting that underwater sounds have adverse impacts on birds.

5.2.1.1.2.1 Behavioural Impacts

There have been no known studies that have tested the levels of sound that cause injury to marine birds, although temporary hearing impairment (aka temporary threshold shift (TTS) temporary hearing impairment can occur in avifauna that are exposed to sound in air (Saunders and Dooling 1974). Corwin and Cotanche (1988) have shown that the auditory system of birds is able to recover from TTS. The available evidence suggests that avian hearing underwater is poorer than in air, given that the avian middle ear constricts under the increased pressure associated with diving (Dooling and Therrien 2012). Unlike some other marine animals, seabirds do not communicate vocally underwater, and a heightened auditory sensitivity in water is thus unlikely to have developed.

A number of sources also indicate that there is no evidence of negative behavioural effects on various bird species resulting from seismic sound (see Davis *et al.* 1998, MMS 2004). Stemp (1985) found no evidence of seismic survey related effects on marine bird mortality or distributions in the Davis Strait, and Parsons (1980, in Stemp 1985) reported that shearwaters were observed within 30 m of seismic source array with their heads underwater and demonstrating no response. Research in the Irish Sea also indicated no evidence that seabirds were attracted to or repelled by offshore seismic survey activity (Evans *et al.* 1993), and Lacroix *et al.* (2003) studied moulting Long-tailed Ducks (*Clangula hyemalis*) in the Beaufort Sea and found no changes in movements or diving behaviour during seismic surveys. Turnpenny and Nedwell (1994) also refer to other data in which trained observers reported no behavioural effects on guillemot, fulmar and kittiwake species that were monitored during seismic surveys.

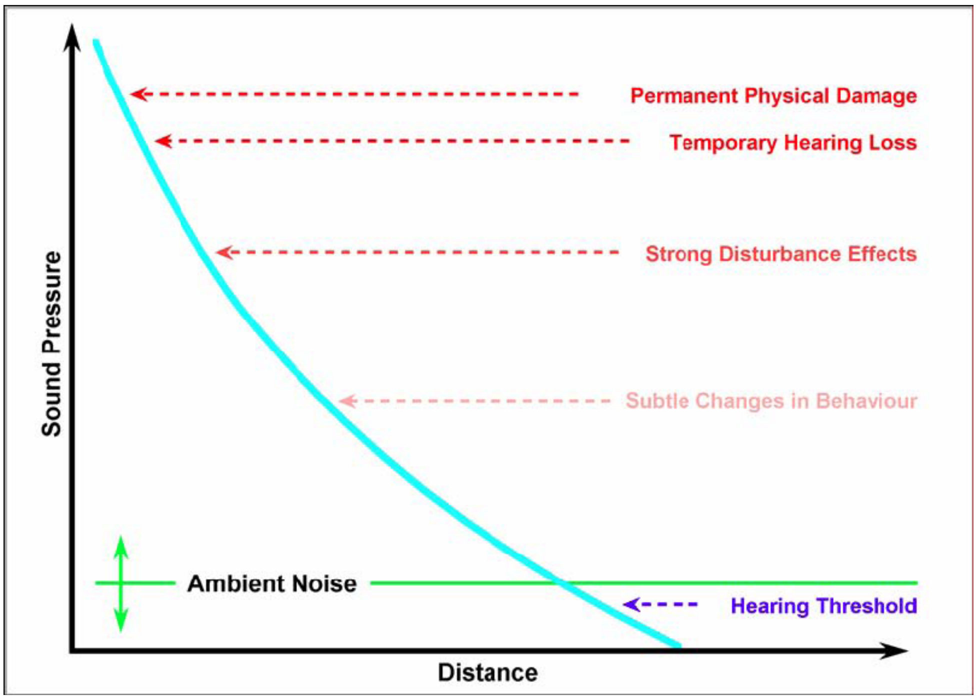
Deep-diving birds (such as murres, dovekies,and puffins) and other bird species that spend considerable amount of time underwater, swimming or plunge diving for food may be at somewhat higher risk of injury or disruption due to exposure to underwater noise during seismic exploration. These species dive from a resting position on the water in search of small fish and invertebrates, and are capable of reaching great depths (20 to 60 m) and spending considerable time (25 to 40 seconds) underwater (Gaston and Jones 1998). Unlike fish or marine mammals, diving birds typically place their heads under the water suddenly in pursuit of prey, and could therefore potentially be exposed to high noise levels without the benefit of a steady gradient or associated ramp up procedures. Consequently, they would find it difficult to predict or avoid excessively high sound levels in the water column. This interaction may be further accentuated by the known attraction of many bird species to offshore vessels.

Birds are not known to use sound to communicate with each other underwater, so communication masking is not predicted to be an issue.

5.2.1.1.3 Potential Impacts to Marine Mammals

Underwater sound has a range of potential impacts on marine mammals. Figure 5.1 provides a graphical representation of the apparent zones of potential effects associated with anthropogenic sounds on marine mammals. These potential effects are discussed in more detail in the following subsections.

Figure 5-1 Schematic Representation of Zones of Potential Effects Associated with Anthropogenic Sounds on Marine Mammals. (Source: Turnpenny and Nedwell 1994). Note that vertical distances between various effects are not drawn to scale



5.2.1.1.3.1 <u>Hearing Ability</u>

The majority of marine mammals have auditory adaptations which allow them to hear well underwater (Au *et al.* 2000). However, these adaptions result in their ears being sensitive to pressure fluctuations in the water, increasing the risk of damage from exposure to strong waterborne sound and pressure-shock waves (Wursig and Richardson 2002). Much of the impact of seismic pulses have been inferred or assumed by implication rather than observed, and there have been no reported instances of deaths, physical injuries or auditory effects on marine mammals from seismic surveys (MMS 2004). Two reports provide good reviews of the current knowledge of anthropogenic noise effects on marine mammals (Richardson *et al.* 1995, Nowacek *et al.* 2007)).

5.2.1.1.3.2 <u>Behavioural Effects</u>

Seismic noise in the marine environment has been shown to have a variety of effects on marine mammals, particularly in the case of relatively intense sounds at close ranges. These may be physical (injury) or and/or behavioural (avoidance or other changes in distribution or activities) in nature.

The National Research Council (2003) has stated that a broadband-received sound pressure level of 160 dB re 1 µPa (rms) or greater is currently the best estimate available to cause disruption of behavioural patterns (considered Level B Harassment) to marine mammals. Behavioural effects may also occur as a result of marine seismic survey activity and these have been documented in a variety of species and situations. Such interactions occur when animals are affected by intense noise, including the possibility that the sounds emitted and/or used by these animals may be interfered with. Other, indirect effects may also occur when underwater noise results in changes in the location or abundance of food sources.

Behavioural responses of marine mammals to noise are highly variable and dependent on many internal and external factors (NRC 2003b). Internal factors include:

- individual hearing sensitivity, activity pattern and motivational and behavioural state at time of exposure;
- past exposure of the animal to the noise, which may have led to habituation or sensitization;
- individual noise tolerance; and
- factors such as age, sex and presence of dependent offspring.

External factors include:

- non-acoustic characteristics of the sound source, such as whether it is stationary or moving;
- environmental factors that influence sound transmission;
- habitat characteristics, such as being in a confined area; and
- location, such as proximity to a shoreline.

Some of the behavioural effects that underwater noise sources have been observed to have on marine mammals include:

- changes in vocalizations (Parks *et al.* 2007; Holt *et al.* 2009; Miller *et al.* 2000, 2009; Di Iorio and Clark 2010; Risch *et al.* 2012);
- respiration, swim speed, diving, and foraging behaviour (Stone and Tasker 2006);
- displacement and avoidance (Castellote *et al.* 2012, Weir 2008); and
- shifts in migration paths, stress and immune depression (Romano *et al.* 2004; Rao *et al.* 2012).

Migrating humpback, grey, and bowhead whales have reacted to sound pulses from marine seismic exploration by deviating from their normal migration route and/or interrupting their feeding and moving away (*e.g.*, Malme *et al.* 1984, 1985, 1988, Richardson *et al.* 1986, 1995, Ljungblad *et al.* 1988, Richardson and Malme 1993, McCauley *et al.* 1998, 2000a, b, Miller *et al.* 1999). In contrast, toothed whales such as dolphins and porpoises have been reported bow riding active seismic vessels (*e.g.*, Duncan 1985, Arnold 1996, Stone 2003). Other studies have shown localized (~one kilometre) avoidance (Goold 1996a, Calambokidis and Osmek 1998).

Very little information exists on the reactions of pinnipeds to sounds from seismic exploration in open water (Richardson and Malme 1995). One study (Harris *et al.* 2001) found that seismic operations caused few if any seals to depart the operational area. Another study (Miller *et al.* 1999) found seals were further away during airgun operations one summer, while the reverse was true the following summer. Seals are known to habituate quickly to novel sounds (Richardson *et al.* 1995), and have been observed to avoid underwater sounds by swimming with theirs heads out of the water (Mate and Harvey 1987). Some authors (Moulton *et al.* 2005) showed that ringed seal density around an artificial island drilling site during breeding season did not change once development began, even though above and underwater sounds were audible to seals up to 5 km away. However, some telemetry research (Thompson *et al.* 1998) suggests that reactions may be stronger than has been evident from visual studies.

Some marine mammal species utilize underwater sounds to communicate and for other uses and activities (LGL 2013, Lawson *et al.* 2000). These sounds may be “masked” or interfered with by seismic sounds in the marine environment particularly where these are at similar frequencies (Richardson *et al.* 1995). Several recent studies have indicated that marine mammal communications can be affected by operating seismic source arrays (Gedamke 2011, Nieukirk *et al.* 2012, Blackwell *et al.* 2013), particularly low-frequency species such as baleen whales (Clark *et al.* 2009). Some whales are known to continue calling in the presence of seismic pulses (*e.g.*, Richardson *et al.* 1986, McDonald *et al.* 1995, Greene and McLennan 2000). (Madsen *et al.* 2002a, Jochens and Biggs 2003, though there have been a few reports of whales ceasing to call when exposed to pulses from a very distant seismic ship (*e.g.* Bowles *et al.* 1994).

There is also evidence that some toothed whales can shift the dominant frequencies of their echolocation signals from a frequency range with much ambient sound toward frequencies with less sound (Au *et al.* 1974, 1985, Moore and Pawloski 1990, Thomas and Turl 1990, Romanenko and Kitain 1992, Lesage *et al.* 1999). A few marine mammal species are known to increase volume of their calls in the presence of elevated sound levels (Dahlheim 1987, Au 1993, Lesage *et al.* 1999, Terhune 1999).

The behavioural responses of marine mammals to seismic sound have been shown to be highly variable between species and other factors and conditions (Weilgart 2007; Miller *et al.* 2009), and generalizations about marine mammal behavioural reactions are therefore difficult to make as they can vary considerably based on such factors (Wood *et al.* 2012). For example, some cetaceans have been known to utilize seismic surveys for foraging (*e.g.* bottlenose dolphins; Barry *et al.* 2012), whereas others have been shown to avoid operating seismic source arrays, although these zones of influence are quite variable (as reviewed by LGL 2005). Some recent studies have, however, shown avoidance or other disturbances up to several hundred kilometres away from seismic airguns source arrays, and well after the survey is completed (Nieukirk *et al.* 2004, 2012; Risch *et al.* 2012; Castellote *et al.* 2012). Wood *et al.* (2012) for example, describe relatively high levels of behavioural reactions to seismic noise at relatively low intensity (*e.g.*, 120−140 dB re: 1 µPa rms), although some species (such as minke whales) have been observed in close proximity (less than 100 m) to operating seismic source arrays (Boertmann and Mosbech 2011).The zones of influence for marine noise appear to be much larger for low frequency cetaceans compared to high frequency cetaceans (Laws 2012). Of particular concern is the potential for marine mammals disturbance associated with seismic surveys to interfere with species at risk and other rare species and small populations, particularly any associated disruption of animal movements, communication or other activities during key periods such as reproduction (Croll *et al.* 2002; Beauchamp *et al.* 2009). Seals have been observed to react behaviourally to seismic surveys and other human-induced noise in the marine environment, although if it occurs any such disturbance is usually localized in extent and short-term in duration (Richardson *et al.* 1995).

In recent research, Cerchio *et al.* (2014) used marine autonomous recording units to track numbers of singing humpback whales. They determined that the number of singing whales was reduced considerably during times of seismic noise. It was suggested that seismic surveys could disrupt breeding behaviours of these animals. Robertson (2014) determined that response of bowhead whales to seismic activity was context dependent (i.e. dependent on the whale's circumstance and activity). This author also determined that bowhead whales spend less time at the surface, and are more difficult to observe and count when exposed to seismic activity. When accounting for these behavioural changes, it was suggested that seismic activity did not displace bowheads to the degree previously thought but rather primarily altered their dive behaviour. Pirotta *et al.* (2014) used passive acoustic loggers to monitor vocalizations in harbour porpoises in an area where there had been no evidence of broad scale displacement of animals from seismic activity. The authors determined that such vocalizations declined by 15 percent in the seismic area and that the further animals were away from activity, the greater the likelihood of vocalizations. This paper also documents evidence of sub-lethal effects of seismic airguns on harbour porpoises and suggests that exposure to seismic activity could influence energy budgets through reduced foraging performance.

5.2.1.1.3.3 Physical Effects

Although permanent hearing damage can result in some instances (Nowacek *et al.* 2007), hearing deterioration due to prolonged or repeated exposure to high levels of noise (also referred to as temporary threshold shift, or TTS) can also occur. Extended periods of moderate noise levels under water can cause a temporary threshold shift (TTS) in some marine mammals, resulting in a reduction in hearing sensitivity (Au *et al.* 1999; Kastak *et al.* 1999; Schlundt *et al.* 2000) and a small degree of permanent loss (Kastak *et al.* 2005). The degree and duration of which TTS is may be influenced by such factors such as the individual or species involved and the magnitude and duration of exposure (Richardson *et al.* 1995; Davis *et al.* 1998). Several previous studies have investigated this phenomenon (*e.g.*, Finneran *et al.* 2000, 2002, 2010; Southall *et al.* 2007; Lucke *et al.* 2009; Gedamke *et al.* 2011). Studies related to potential TTS resulting from offshore seismic surveys have cited distances from less than 100 m from the sound source (Ridgway *et al.* 1997), to several hundred meters (as described in LGL Limited 2005) to one km or more (Madsen *et al.* 2006; Gedamke *et al.* 2011). Richardson *et al.* (1995) hypothesized that permanent hearing impairment of marine mammals would not likely occur unless prolonged exposure to continuous anthropogenic sounds exceeding 200 dB re 1 µPa-m was experienced.

Exposure to high-intensity pulsed sound can cause other, non-auditory physical effects such as stress, neurological effects, bubble formation, resonance effects and other types of organ or tissue damage in marine mammals ((DFO 2004), LGL Limited 2009, Ferndandez *et al.* 2005, Jepson *et al.* 2013)), though data suggest that if these effects do occur, they would only occur in close proximity to the sound sources. Therefore, species that show behavioural avoidance of seismic vessels, including most baleen whales, some toothed whales and some pinnipeds, would not likely experience threshold shifts or other physical effects (LGL Limited 2009). NMFS policy is under review and currently states that cetaceans and pinnipeds should not be exposed to pulsed sounds exceeding 180 and 190 dB re 1 µPa (rms), respectively (NMFS 2000).

5.2.1.1.4 Potential Impacts on Sea Turtles

As species which spend the vast majority of their time in the water, sea turtles will be exposed to seismic noise. Maximum hearing sensitivity in sea turtles has been observed in the 100 to 700 Hz range (Ridgeway *et al.* 1969, Davis *et al.* 1998, Saetre and Ona 1996).

5.2.1.1.4.1 Physical Effects

Seismic noise in the marine environment has been shown to have a variety of effects on sea turtles, particularly in the case of relatively intense sounds at close ranges. These may be physical and/or behavioural (avoidance or other changes in distribution or activities) in nature.

Although permanent hearing damage can result in some instances (Nowacek *et al.* 2007), hearing deterioration due to prolonged or repeated exposure to high levels of noise (also referred to as temporary threshold shift, or TTS) can also occur. Moein *et al.* (1994) observed TTS in loggerhead turtles exposed to a few hundred air source pulses approximately 65 m away, but unfortunately did not describe the received sound levels or size of the air source used. McCauley *et al.* (2000) reported erratic behaviour ("alarm response") of caged loggerhead and green turtles at received sound levels of 175 dB re µPa(rms) (or 185 dB re 1 µPa(0-p)) while received sound levels of 166 dB re µPa(rms) (or 176 dB re 1µPa(0-p)) triggered avoidance behaviour. Although a reduction in hearing capability was evident, the effect was temporary and returned to normal within a short period of time (McCauley *et al.* 2000). The degree and duration of which TTS may be influenced by factors such as the individual or species involved and the magnitude and duration of exposure (Richardson *et al.* 1995; Davis *et al.* 1998).

Seismic exploration activities are not expected to affect the distribution or abundance of marine turtle prey such as jellyfish.

5.2.1.1.4.2 Behavioural Effects

Much research on sound impacts on sea turtles has focused on seismic exploration. For example, studies showed that sea turtles increase their movements after airgun shots and do not return to the depth where they usually rest (Lenhart 1994). Behavioural effects may also occur as a result of marine seismic survey activity and these have been documented in a variety of species and situations. Such interactions occur when animals are disturbed or otherwise affected by intense noise, including the possibility that the sounds emitted and/or used by these animals may be interfered with. Other, indirect effects may also occur when underwater noise results in changes in the location or abundance of food sources. Behavioural responses of marine mammals to noise are highly variable and dependent on many internal and external factors (NRC 2003b).

Sea turtles have also been shown to exhibit short-term physical, physiological and behavioural effects as a result of noise-related disturbances (McCauley *et al.* 2000). The loggerhead turtle's hearing range overlaps with the sound frequencies produced by seismic activities (Martin *et al.* 2012), as does that of leatherback turtles (Dow Piniak *et al.* 2012). Temporary hearing loss has been reported in some instances (Moein *et al.* 1994), as has a strong initial avoidance response to seismic air-gun operations (O'Hara and Wilcox 1990; McCauley *et al.* 2000, Holst *et al.* 2005). McCauley *et al.* (2000) stated that marine turtles are expected to display behavioural changes at around two kilometres and avoidance around one kilometre from the seismic array in 100 to 120 m water depth.

5.2.1.2 Exploratory Drilling

Exploration and delineation wells are drilled to confirm the presence, or define the extent, of oil and gas resources at particular locations. These activities are described in detail in Chapter 2. Potential impacts of various activities related to exploratory drilling on marine fish, birds, marine mammals and sea turtles are discussed below.

5.2.1.2.1 Potential Interactions with Fish

5.2.1.2.1.1 <u>Presence of Structures, Drilling, Lights, Noise, Other Activities and Disturbances</u>

The presence of a petroleum installation in marine waters will often attract some fish and invertebrate species, which is often referred to as a "reef effect" (Picken and McIntyre 1989; LGL Limited *et al.* 2000). Lights from drill units and support vessels may also attract some species. Less of a reef effect typically occurs around exploratory drilling units than production rigs, as the amount of subsurface structure is less and the duration of the interaction is much shorter (LGL Limited *et al.* 2000). Operational safety zones associated with offshore oil and gas platforms are excluded from fishing activity and can therefore serve as refugia from fishing-related mortality.

Noise from marine structures or activities may cause avoidance by some species, with short term and low frequency noises appearing to elicit temporary avoidance due to startling effects with longer-term avoidance if the noise is higher frequency or continuous (Misund *et al.* 1996; Wilson and Dill 2002).

5.2.1.2.1.2 <u>Routine Discharges (sewage, deck drainage, bilge/cooling water, wash fluids and other waste).</u>

Research indicates that the response of the benthic community to drill cuttings discharges can be dependent on the types of drilling fluid used (Netto *et al.* 2008). Oil-based drilling muds (which are regulated) can affect benthic habitat and communities well away from the drill site (>6km; Breuer *et al.* 2008). It is noted that as per the OWTG, under no circumstances should oil base fluid or whole mud containing oil base fluid be discharged to the sea. Biological effects of water-based muds are not normally found beyond about 250-500 m from a drilling platform (Hurley and Ellis 2004, Schaaning *et al.* 2008, Jorissena *et al.* 2009, Santosa *et al.* 2009). The accumulation of drill cuttings can cause reduced abundances and differences in community composition (Schaanning *et al.* 2008; Neff *et al.* 2000). Water-based muds can affect macrofauna due to, for example, associated elevation of oxygen demand that can initiate eutrophication responses (*e.g.* Trannum *et al.* 2010). Water-based muds are thought to be dispersed in the water column where they could affect pelagic organisms (Jensen *et al.* 2006). Laboratory studies also show potential for particles from water-based muds to affect fish and bivalves (Bechmann *et al.* 2006).

A general recovery in terms of abundance, species richness and diversity has been observed for the benthic communities one year after drilling (Husky Energy 2000; Netto *et al.* 2008; Manoukian *et al.* 2010). The rate of recovery will, however, depend on site-specific environmental characteristics and processes, and the associated rate of recruitment and recolonization by the benthic fauna characteristics of the area (Neff *et al.* 2000). Offshore oil and gas activities may affect deep sea corals through physical damage of the coral or dislodgement of organisms from anchoring and/or mooring of floating vessels, increased turbidity, smothering from drill cuttings, and any release of hydrocarbons into the marine environment (Campbell and Simms 2009).

5.2.1.2.1.3 <u>Other Seabed and Coastal Disturbances (excavations, equipment installation)</u>

Impacts to marine fish from other activities such as excavations and equipment installation are expected to be similar to effects discussed in Section 5.2.1.2.1.1.

5.2.1.2.2 Potential Interactions with Marine Birds

Marine birds are abundant in the Study Area and will be subject to interactions with oil and gas activities. The main potential interactions are discussed in the following subsections.

5.2.1.2.2.1 <u>Presence of Structures, Drilling, Lights, Flaring, Noise, Other Activities and Disturbances</u>

In Atlantic Canada, nocturnal migrants and night-flying seabirds (*e.g.* storm-petrels) are most likely to be attracted to lights and flares. Attraction to lights at night or in poor visibility conditions during the day may result in collision with lit structures or their support structures, or with other migratory birds. Disoriented migratory birds are prone to circling light sources and may deplete their energy reserves and either die of exhaustion or be forced to land where they are at risk of depredation.

Although there is a known association of birds with oil platforms (Baird 1990, Wiesse and Montevecchi 2000), the nature, degree, timing and extent of any associated mortality is generally unknown (Montevecchi *et al.* 1999). Birds that are attracted to oil and gas installations may experience mortality due to direct collisions with equipment and infrastructure or by coming into contact with flares or other components, particularly at night and/or during periods of fog or other times of reduced visibility (Gauthreaux and Beleser 2006, Montevecchi 2006). Other health effects may also occur due to altered behaviours (disorientation), which can lead to energy consumption, delayed foraging or migration, increased susceptibility to predation, and others (Wiesse *et al.* 2001, Jones and Francis 2003).

Possible disturbance effects of aircraft overflights on birds include: temporary loss of useable habitat, increased energy expenditure of birds due to escape reactions, lower food intake due to interruptions and other interactions (Ellis *et al.* 1991, Komenda-Zehnder *et al.* 2003).

5.2.1.2.2.2 Routine Discharges (sewage, deck drainage, bilge / cooling water, wash fluids other waste)

Operational discharges such as sheens of crude oil and other substances may alter the feather weight and microstructure of pelagic seabirds (O'Hara and Morandin 2010). Any effects to the fish species upon which avifauna depend may also indirectly affect birds.

5.2.1.2.3 Potential Interactions with Marine Mammals and Sea Turtles

Marine Mammals and Sea Turtles are abundant in the Study Area and may be subject to interactions with oil and gas activities. The main potential interactions with the presence of structures are listed below and discussed in the following subsection.

- Presence of Structures, Drilling, Lights, Flaring, Noise, Other Activities and Disturbances
- Routine Discharges (sewage, deck drainage, bilge / cooling water, wash fluids, and other waste)
- Other Seabed and Coastal Disturbances (excavations, equipment installation)

Marine mammals have been observed to both move away from and toward offshore drill rigs, and this has been found to vary between different species and types of drilling installations (Richardson *et al.* 1995, LGL Limited *et al.* 2000). These changes may range from tens of meters to several kilometres, but is considered highly reversible with animals expected to return to an area once the noise source is removed (Davis *et al.* 1998). Continuous noise, associated with drilling rigs and ships propellers, has been shown to be a masking agent for beluga and killer whales (Foote *et al.* 2004, Scheifele *et al.* 2005).

Marine mammal reactions to aircraft are variable due to differences in aircraft type, altitude, and flight pattern (e.g., straight-line overflight, circling, or hovering). Possible responses include: diving immediately, changing movement patterns, leaving the area or no change at all (Richardson et al. 1995).

5.2.1.3 Vessel Traffic

During offshore exploration activities supply vessels and possibly aircraft are used to transport personnel, equipment and materials to and from vessels and/or the drilling rig. Supply vessels typically make several round trips per week to the drilling unit throughout a drilling program, and a dedicated stand-by vessel also usually attends the rig throughout the drilling program. Personnel are also often transported to and from the survey area by helicopter, according to work schedules and rotations, workforce numbers, distances and the type of aircraft being used. During an offshore seismic survey program, standby or guard vessel(s) are also typically used to scout for hazards and for interacting and communicating with any other marine users in the survey area.

A summary overview of some of the existing and available literature on the potential environmental effects of marine vessel traffic (including that which is typically associated with offshore exploration activities) on marine fish, birds, mammals, and reptiles is provided in the following subsections.

5.2.1.3.1 Potential Interactions with Marine Fish

Noise generated by vessel traffic can be transmitted through water, causing avoidance by some species. Physiological and reproductive effects have been reported when fish are continually exposed to noise (Clark *et al.* 1996). Given the opportunity, fish will generally avoid areas where noise levels exceed their threshold of hearing by 30 dB or more (ICES 1995).

Vessels and their associated activities (such as bilge dumping) can lead to the potential introduction and spread of aquatic invasive species and resulting habitat degradation (Morris *et al.* 2010).

5.2.1.3.2 Potential Interactions with Marine Birds

The possible effects of marine vessel traffic on marine birds include: behavioural changes that may have energetic consequences (Schummer and Eddleman 2003), and a loss of suitable habitat as vessel traffic can reduce bird use of vessel disturbed areas (Bramford *et al.* 1990). Cumulative effects of chronic small scale oil discharge from seagoing vessels results in important mortality of seabirds in Newfoundland and Labrador (Wiese and Roberston 2004). Organic wastes discharged from ships may attract gull species which may in turn lead to increased predation on a number of smaller bird species (maceration is required as per the OWTG to avoid this). Birds may also be attracted to vessel lighting at night, and birds such as storm-petrels, may fly into vessel lights and other equipment. Possible disturbance effects of aircraft overflights on birds include: temporary loss of useable habitat, increased energy expenditure of birds due to escape reactions, lower food intake due to interruptions and other interactions (Ellis *et al.* 1991, Komenda-Zehnder *et al.* 2003). It is noted that helicopter pilots tend to avoid birds as much as possible for safety reasons.

5.2.1.3.3 Potential Interactions with Marine Mammals and Sea Turtles

Shipping is likely the main source of anthropogenic noise in the marine environment (Wright *et al.* 2007), and masking has been identified as the primary auditory effect of vessel noise on marine animals (Southall 2005). The reactions of cetaceans to ships may be avoidance, approach, or indifference (Richardson *et al.* 1995), as well as other behavioural effects such as changes in vocalizations (Clark *et al.* 2009). Although cetacean species are susceptible to mortality or injury from vessel collisions (Williams and O'Hara 2010), they can often habituate to ships following a consistent course or which are frequently present in the area (Richardson *et al.* 1995). Pinnipeds appear to show little reaction to vessels in open water (Richardson and Malme 1993). Vessel traffic and associated low frequency noise can be a source of chronic stress for marine mammal populations (Rolland *et al.* 2012, Rao *et al.* 2012). Marine mammal reactions to aircraft are variable due to differences in aircraft type, altitude, and flight pattern (*e.g.*, straight-line overflight, circling, or hovering). Possible responses include: diving immediately, changing movement patterns, leaving the area or no change at all (Richardson *et al.* 1995).

5.2.1.4 Well Abandonment/Decommissioning

Once drilling and any associated well testing is completed, offshore wells are typically then abandoned. Cement mixtures or mechanical devices are used to plug the well, the casing is cut and removed just below the surface of the seafloor and all equipment is removed. Wellheads are removed from the seafloor, often using a mechanical casing / wellhead cutting device. In the event that this device fails, operators often use a chemical / directed explosive method to detach the wellhead. A remotely operated vehicle (ROV) or other equipment is used to inspect the seabed to ensure that no equipment or obstructions remain in place.

Potential interactions and/or impacts of decommissioning and abandonment on marine fish, mammals, and sea turtles are similar to the potential effects of the exploration and construction phases. These are outlined in Section 5.2.1.2.

5.2.1.5 Accidental Spills

While unlikely, due to standard operating procedures and environmental mitigation measures, an accidental event or malfunction such as an oil spill could potentially occur during the life of an offshore oil and gas exploration project. Types of incidents potentially affecting the local environment include potential blowouts (subsea and/or surface), as well as spills of hydrocarbons or other substances from a drill rig and/or other associated vessel activities. Potential incidents vary considerably in their nature, scale, frequency, duration, and potential environmental effects. The use, storage, and transportation of fuels, drilling fluids, and other chemicals can also potentially result in accidental spills into the marine environment. Most offshore wells are drilled without incident, and a significant and environmentally damaging spill occurring during oil and gas activity in the Study Area is unlikely, based on available statistics (refer to CNSOPB website). Regulatory review and approval processes and the requirements and guidelines that apply to oil and gas activities in the NS offshore area are extremely detailed, rigorous, and stringent, and Operators must demonstrate that they have the ability and capacity to undertake such activities in a safe and environmentally responsible manner. Operators must prove they meet these requirements in terms of both appropriate spill prevention as well as response procedures and resources, should a spill occur.

A summary overview of some of the existing and available literature on the potential environmental effects of offshore oil spills and other possible accidental events on marine fish, birds, mammals and sea turtles is provided in the following subsections.

5.2.1.5.1 Potential Interactions with Marine Fish

A great deal of research has also been undertaken regarding the effects of exposure of oil on marine fish and habitat. A review by Teal and Howarth (1984) examined the effects of numerous oil spills. These included death of fish eggs and larvae, decreases in fish spawning, death of adult fish, decreased growth in fish and shellfish, contamination of fish and shellfish, decreased recruitment and decreased catches. Contamination of shellfish was found to be common, but contamination of finfish occurred in only about half the cases (Teal and Howarth 1984). In most cases, effects persisted for less than a year, although effects on one species (flatfish) persisted for up to 8 years.

Spill effects depend on a variety of factors, including: the amount and type of oil, environmental conditions, species and life stage, lifestyle, fish condition, degree of confinement of experimental subjects and others (LGL Limited 2005). Macroalgae are considered to be at risk from oil spills due to toxic effects and smothering (NOAA 2010; Boertmann and Mosbech 2011). Finfish may be affected through direct physical effects (*e.g.*, coating of gills and suffocation) or more subtle physiological effects (*e.g.*, abnormal gill function, decreased growth, altered enzymatic activity, immunotoxic responses or organ damage) (for a review, see LGL Limited 2005, Barron 2012, Jung *et al.* 2012). Oil spill dispersants can also impair physiological function of fish (Milinkovitch *et al.* 2013).

Exposure to spilled oil can alter genomic expression of finfish (Whitehead *et al.* 2012). Recent studies have shown that exposure to oil can affect fish embryo development and survival (Murakamia *et al.* 2008, Frantzen *et al.* 2012, Incardona *et al.* 2012, Ingvarsdottir *et al.* 2012). Species with buoyant eggs are particularly vulnerable (Boertmann and Mosbech 2011). Thomson *et al.* (2000) stated that the sensitivity of fish larvae to an oil spill varies depends on the type of oil (*e.g.*, crude, light condensate, etc.) as well as the yolk sac stage and feeding conditions. Eggs and larvae exposed to oil generally exhibit morphological malformations, genetic damage and reduced growth (Thomson *et al.* 2000).

Possible behavioural effects on fish include avoidance of the contaminated area or altered natural behaviours related to predator avoidance or feeding (LGL Limited 2005). Juvenile and adult fish have been known to leave an area after a spill (Roth and Baltz 2009). However, fish may not show avoidance behaviour, depending on such factors as migration impulse or concentrations of toxic components (Rice 1985, cited in LGL Limited *et al.* 2000).

Oil exposure can lower the density of invertebrate populations (Andersen *et al.* 2008), and can cause a notable change in the composition and abundance of the benthic fauna (Pérez del Olmo *et al.* 2007). Benthic fauna such as crabs and molluscs in shallow areas can be greatly affected by oil spills (McCay *et al.* 2003a, 2003b) but effects on deeper benthic communities have also been observed from deepwater blowouts (Schrope 2011, White *et al.* 2012, Montagna *et al.* 2013). Habitat-forming organisms such as sponges filter immense volumes of water, leading to concerns that they could bioaccumulate toxins related to oil spills (NAFO 2013b). Deep water corals can show stress from oiling when they are exposed to spill plumes (i.e. deepwater blowouts; White *et al.* 2012).

Zooplankton effects from oil spills include die-offs and contamination, and these can persist in excess of 70 days (Teal and Howarth 1984). Species that occur at the surface layers of the water column are considered to be most at risk (Boertmann and Mosbech 2011). In some cases phytoplankton biomass can increase during an oil spill due to the negative effects experienced by zooplankton predators and the nutrient release caused by other dying organisms (Teal and Howarth 1984). Phytoplankton and zooplankton communities exposed to dispersants and oil were more affected than by oil alone (Jung *et al.* 2012). Bivalves such as mussels showed cytotoxicological and gentoxicological effects (Barsiene *et al.* 2012). Saltmarsh arthropods (terrestrial and marine) can be suppressed by oil exposure but have been shown to recover after a year (McCall and Penning 2012).

Coastal areas are amongst the most vulnerable to oiling (NOAA 2010). Consequently, some fish life histories (*e.g.* anadromous fish such as salmon and beach spawners like capelin) may be particularly vulnerable to oiling in coastal areas (Boertmann and Mosbech 2011).

The degree of effect and recovery times are habitat specific (Boertmann and Mosbech 2011) but structurally complex coastal habitats (*e.g.* salt marshes and coastal wetlands) are amongst the most sensitive (Lin and Mendelssohn 2012; Mendelssohn *et al.* 2012; Boertmann and Mosbech 2011). In addition, ecotoxological effects of oil spills on invertebrate and fish communities can be amplified when combined with natural stressors (Whitehead 2013).

Oil in coastal areas can persist for decades in crevices and sediments protected in interstitial spaces of boulders (Teal and Howarth 1984; NOAA 2010; Boertmann and Mosbech 2011). Recovery of protected coastal areas generally takes longer than from more exposed areas (Joydas *et al.* 2012, Mendelssohn *et al.* 2012). Salt marsh habitats can experience reductions in biomass, show signs of stress (Mishra *et al.* 2012) and have reduced photosynthesis (Wu *et al.* 2012). Impacts to long-lived communities should be expected to persist for greater durations (Boertmann and Mosbech 2011). Such communities include coastal benthos and deepwater communities.

Microbial activity is key to degrading spilled oil, but the level of activity varies with type of oil and environmental conditions (Mendelssohn *et al.* 2012). Clean-up efforts in coastal areas can actually be more damaging than the actual oil spill and may delay recovery (Peterson *et al.* 2003).

5.2.1.5.2 Potential Interactions with Marine Birds

Marine birds are amongst the biota most at risk from oil spills and blowouts, as they spend much of their time upon the surface of the ocean (LGL Limited 2005; Barron 2012; Boertmann and Mosbech 2011). In the event of a spill, and depending upon project and area specific factors, coastal birds may also be at risk on beaches and in intertidal zones.

An accidental release of hydrocarbons can expose birds to oil by breathing contaminated air, through skin contact, through eating contaminated prey items (Davies and Bell 1984), or by ingesting contaminants while preening contaminated plumage can result in the direct physical exposure of birds to oil within the affected area (Stout 1993). The possible physical effects oil exposure on birds include changes in thermoregulatory capability (hypothermia) and buoyancy (drowning) due to feather matting resulting from oil contamination (Wiese 1999, MMS 2004, Clark 1984, Hartung 1995, Montevecchi *et al.* 1999), as well as oil ingestion from excessive preening (Hartung 1995, Stout 1993).

Ingested oil can cause lethal and sublethal effects (McEwan and Whitehead 1980); including damage to the liver (Khan and Ryan 1991), pneumonia (Hartung and Hunt 1966), brain damage (Lawler *et al.* 1978), immunotoxic effects (Barron 2012) and starvation due to increased energy needs to compensate for heat loss resulting from oiling and loss of insulation (Peakall *et al.* 1980, 1982, MMS 2001, MMS 2004). Nesting seabirds that survive oil exposure often exhibit decreased reproductive success (LGL 2005), although oiled birds treated quickly have reduced risk (Barham *et al.* 2007).

The likely effects of oil exposure on birds varies between species, as well as with different types of oil (Gorsline *et al.* 1981), weather conditions, times of year, migratory patterns and other activities (Wiese *et al.* 2001 Montevecchi *et al.* 2012). Birds at greatest risk are those that spend a considerable time resting or foraging on the water surface (Wiese and Roberston 2004, Boertmann and Mosbech 2011). Species which feed on organisms from high risk areas (*e.g.* benthos) are also at heightened risk of contamination (Engelhardt 1983). The long-lived nature of many bird species also suggests that oil-related reductions in population growth can have longer term population effects (Wiese and Roberston 2004).

There is apparently no direct relationship between the volume of oil spilled and bird mortality. The timing and location of a spill appear to have more influence on mortality rates (Weisse *et al.* 2001). The effects of oiled areas may also be transferred away from the affected site due to the migratory nature of some avifauna (Henkel *et al.* 2012).

5.2.1.5.3 Potential Interactions with Marine Mammals and Sea Turtles

Oil spills may affect marine mammals and sea turtles through direct exposure and associated health effects, as well as by changing the availability and quality of their food sources and habitats. Spilled oil may affect marine mammals and turtles through dermal contact, inhalation, ingestion and, in the case of baleen whales, fouling of baleen plates.

Marine mammals and sea turtles will likely avoid or move out of areas affect by oil spills, and have been observed to detect and thus avoid spills (Matkin *et al.* 1994, Smultea and Würsig 1995, Ackleh *et al.* 2012).

When marine mammals have come into contact with oil, effects on their skin appear to be minor and of little relevance to the animal's overall health (Geraci 1990). Additionally, ingestion and inhalation of oil have been found to involve only trace amounts (Bence and Burns 1995).

Exposure to oil through ingestion or dermal contact is considered to be harmful and possibly fatal to sea turtles (Howard 2012).

Although some studies indicate that no clear evidence exists to link oil spills with mortality of cetaceans (Geraci 1990, Dahlheim and Matkin 1994), others report that the long-term effects of oil exposure include an inability for marine mammals to rebound to pre-spill numbers (Matkin *et al.* 2008, Monson *et al.* 2011).

It has been estimated, for example, that more than 5,000 individuals died as a result of the Deepwater Horizon incident in the Gulf of Mexico (Gero *et al.* 2011).

5.2.2 Environmental Mitigation Measures

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

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

- Geophysical and Geological Programs in the Nova Scotia Offshore Area - Guidelines for Work Programs, Authorizations and Reports (January 2015)
- Drilling and Production Guidelines (March 2011)
- Environmental Protection Plan Guidelines (March 2011)
- Offshore Physical Environmental Guidelines (September 2008)
- Offshore Waste Treatment Guidelines (December 2010)
- Offshore Chemical Selection Guidelines for Drilling & Production Activities on Frontier Lands April (2009)
- Safety Plan Guidelines (March 2011)
- Incident Reporting and Investigation Guidelines (November 2012)

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

Table 5-1 Summary of Standard Environmental Mitigation Measures and Their Applicability

Mitigation Measures	Applicability				
	Seismic and Seabed Surveys	Exploration Drilling	Vessel Traffic	Well Abandonment	Accidental Spills
Adherence to the Statement of Practice	●				
Avoidance of known species at risk and/or sensitive species and areas and/or times where possible in the planning and conduct of oil and gas activities	●	●	●		
Reduction of airgun source levels in the design and implementation of offshore seismic programs to the minimum level practical for the survey, including the amount and frequency of energy used and its likely horizontal propagation	●	●			
The use of a gradual "ramp-up" procedure over a minimum 20 minute period to allow mobile marine animals to move away from the area if they are disturbed by the underwater sound levels associated with a seismic survey	●	●			
Establishment of a safety zone around the seismic air source array (with a radius of at least 500 m), which is monitored by a qualified Marine Mammal Observer (or through Passive Acoustic Monitoring in low visibility conditions) and specific protocols regarding observation requirements and times and shut-down as required	●	●			
Shut-down of seismic sound source(s) during line changes and maintenance activities with associated monitoring and ramp-up provisions	●	●			
Minimizing the amount of associated vessel and aircraft traffic, and the use of existing and common travel routes where possible and the avoidance of low-level aircraft operations wherever possible	●	●	●		

Mitigation Measures	Applicability				
	Seismic and Seabed Surveys	**Exploration Drilling**	**Vessel Traffic**	**Well Abandonment**	**Accidental Spills**
Minimizing environmental discharges and emissions from planned operations and activities, including compliance with relevant regulations and standards	•	•	•	•	
The installation and use of oil water separators to treat contained deck drainage, with collected oil stored and disposed of properly	•	•	•	•	
Selection of non-toxic drilling fluids, including the use of WBMs wherever possible and technically feasible		•			
Treatment of operational discharges (such as sewage, deck drainage, bilge / cooling water, wash fluids other waste) prior to release in compliance with the *Offshore Waste Treatment Guidelines* and other applicable regulations and standards	•	•	•	•	
Minimizing the use of artificial lighting on offshore vessels and installation, where possible with due regard to safety and associated operational requirements	•	•	•	•	
Programs and protocols for the collection and release of marine birds that become stranded on offshore installations, including associated regulatory guidance and permit requirements	•	•	•	•	•
Inspections of ship hulls, drilling rigs and equipment for alien invasive species and associated follow-up maintenance Maximizing use of local vessels, drill rigs and equipment to reduce the spread of alien invasive species	•	•	•	•	
All foreign vessels operating in Canadian jurisdiction to comply with the *Ballast Water Control and Management Regulations* of the *Canada Shipping Act* (2001) during ballasting and de-ballasting activities.	•	•	•	•	

Mitigation Measures	Applicability				
	Seismic and Seabed Surveys	Exploration Drilling	Vessel Traffic	Well Abandonment	Accidental Spills
Avoiding or minimizing flaring, and the use of high efficiency burners		•			
Appropriate handling, storage, transportation and on-shore disposal of solid and hazardous wastes	•	•	•	•	•
Water contaminated with hydrocarbons generated during flow testing (within certain tolerances), can be atomized in the flare (using high efficiency burners) or shipped on-shore for disposal		•			
Selection and screening of chemicals under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands*	•	•	•	•	•
The use of mechanical procedures during well completion and abandonment activities where possible, including the proactive design of well structures to facilitate this				•	•
Should blasting be required (such as in well abandonment), appropriate scheduling of these activities to avoid sensitive times, as well as setting of charges below the sediment surface, minimizing the amount of explosives utilized the use of high velocity explosives and staggering of individual blasts				•	
Pre-drilling surveys of the sea bed to assess the potential presence of sensitive benthic micro-habitats (such as corals and sponges)		•			
Use of turtle guards to minimize potential for turtle entanglement	•				
Spill prevention plans and procedures, with associated and effective spill preparedness and response plans in place					•

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

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

5.2.3 Environmental Planning Considerations

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

5.2.3.1 Marine Fish Species of Special Status

Marine fish are present in the Study Area throughout the year, with many species moving in and out of the area at different times according to their life histories, habitat preferences and seasonal activities. An overview of the distribution and seasonal occurrence of key marine fish species in and near the region is presented in Section 3.2.7.

A number of fish species that are designated as being at risk (and which are formally protected) under the Canadian *Species at Risk Act* (*SARA*) and/or the Nova Scotia *Endangered Species Act* (*NS ESA*) are known or likely to occur in the Study Area, including several species of wolfish as well as the white shark (see Table 3-29).

The Northern wolffish has been designated as threatened, given that the number of this large, slow-growing, long-lived, solitary, nest-building fish have declined over 95 percent in recent years, and the number of areas where the fish is found has likewise decreased. Spotted wolffish were also designated for similar reasons, as its populations have declined over 90 percent in three generations, and the number of locations where this species is found has also decreased. Another species, the Atlantic wolffish, was assessed by COSEWIC as being of "special concern", suggesting that it is particularly sensitive to human activities or natural events, but it is not formally designated as protected at this time. Specific threats to these species of wolffish identified by COSEWIC include by-catch mortality in commercial fisheries and habitat alteration by trawling gear. The last assessments for the three species were completed in 2000 (Atlantic) and 2001 (Northern, Spotted) and there is no indication that their status is changing. There is, however, a recovery strategy outlined in Kulka *et al.* (2007) to help increase the population levels and distributions of these wolffish species.

Section 3.2.7 presents the results of recent DFO surveys that overlap with the Study Area, and which found all three wolffish species (Atlantic, Striped, and Spotted) in the region (Figure 3-29 Figure 3-30). Spotted wolffish were found in two areas within the Study Area, along the Laurentian Channel slope. Northern wolffish were caught in three locations within the SEA and were not limited to the edge of the Slope.

Although the range of the white shark extends to the Canadian waters of the North Atlantic, it is considered to be quite rare (only 32 records over 132 years for Atlantic Canada; COSEWIC 2006b). Its numbers have been estimated to have declined by about 80 percent over 14 years (less than one generation) in areas of the northwest Atlantic Ocean outside of Canadian waters. This species was assessed in 2006 as being endangered under Schedule 1 of *SARA*, with no update since that time.

Several other species in the Study Area have also been evaluated and designated by COSEWIC, but are not currently protected under *SARA*. In many cases, these species occur in expected habitat zones during some seasons and/or have somewhat predictable migrations. For example, significant aggregations of a given Atlantic salmon population can occur near natal estuaries when smolt leave rivers for marine migrations (spring) and as adults return for spawning migrations (summer). Various other COSEWIC-listed species aggregate for migration and spawning (*e.g.* Atlantic cod) or are restricted to limited areas).

5.2.3.1.1 Summary of Important Areas and Times for Fish Species of Special Status

A wide range of marine finfish species also occur within the Study Area, occupying different habitats at different times throughout the year. A number of areas and times are of particular importance and relevance in the Study Area, including:

- Generally, the shallower regions of the Study Area are more important as habitat during the warm water season. Deep channels and slopes serve as habitat for species year-round but are particularly important in cold water seasons when many finfish species move to these areas for refuge and/or spawning;

- Estuaries are often extremely productive and serve as important feeding, staging and nursery habitat for a variety of vertebrate and invertebrate species;

- There are areas in and along the slopes of the Laurentian Channels that are important in the life cycle components of many demersal and pelagic fish in terms of migration, refuge, and feeding (DFO 2007); and

- The particular timing and locations of spawning and sensitive periods for key species (as outlined in Table 3-17**.**

A number of other important locations within the Study Area were identified through the available literature. Fisheries and Oceans Canada recently undertook an exercise to identify and designate selected areas around Nova Scotia that are of ecological and biological significance to marine life (Hastings *et al.* 2014, DFO 2014). Several of these areas were identified wholly or partly due to their significance to marine fish species, including SAR species. EBSAs are discussed in further detail in Section 3.2.12.

The 2014 DFO document outlining offshore EBSAs lists several EBSAs as being of significance to marine fish Species of Special Status. These include the following areas:

- **Laurentian Channel Slope**,
  - A known overwintering area for groundfish SAR species such as Atlantic Cod, redfish, White Hake)
  - A breeding ground for redfish.
  - Also a migratory route for many groundfish species, including SAR.

- **St. Anns Bank**
  - Important for groundfish SAR (used by 3 populations of Atlantic Cod, Atlantic Wolffish),
  - Located on a migratory route for groundfish SAR (Atlantic Cod, Atlantic Wolffish)

- **Canso Bank and Canso Basin**
  - Important for groundfish SAR (American Plaice)

- **Misaine Bank**
  - Important for groundfish SAR species (Atlantic Cod, American Plaice, Thorny Skate)

- **Middle Bank**
  - Important for groundfish SAR (Atlantic Cod spawning and nursery area),

Coastal EBSAs off Nova Scotia were identified by Hastings *et al.* (2014). Several of these are stated as being of significant importance to marine and anadromous fish SAR. These include:

- **Cabot Strait** (between Cape North and St. Paul Island)
  - Provides important summer habitat for Atlantic Cod (Endangered – COSEWIC), American Plaice (Threatened – COSEWIC), redfish (Endangered/Threatened – COSEWIC), Atlantic Wolffish (Special Concern – SARA), White Hake (Threatened – COSEWIC) and Witch Flounder.
  - Larvae of several SAR species such as American Plaice (Threatened – COSEWIC), Atlantic Cod (Endangered – COSEWIC), and redfish species (Endangered/Threatened – COSEWIC)

- **Western Sydney Bight**
  - Important summer habitat for groundfish SAR species (Atlantic Cod (Endangered – COSEWIC), American Plaice (Threatened – COSEWIC), Smooth Skate (Special Concern – COSEWIC), Thorny Skate (Special Concern – COSEWIC), White Hake (Threatened – COSEWIC), Atlantic Herring, and Witch Flounder.
  - Many larval fish SAR such as American Plaice (Threatened – COSEWIC), Atlantic Cod (Endangered – COSEWIC), redfish (Endangered/Threatened – COSEWIC),

- **Aspy Bay**
  - North Aspy River is an important spawning river for Atlantic Salmon (Endangered – COSEWIC).

- **Ingonish Bays**
  - The Ingonish River and Clyburn Brook watersheds, both of which drain into the Ingonish Bays, support spawning Atlantic Salmon (Endangered – COSEWIC).

- **Bird Islands**
  - High concentration (relative to the rest of Sydney Bight) of Winter Skate (Threatened – COSEWIC).
  - Nursery area for two SAR species: Atlantic Cod (Endangered – COSEWIC) and White Hake (Threatened – COSEWIC).

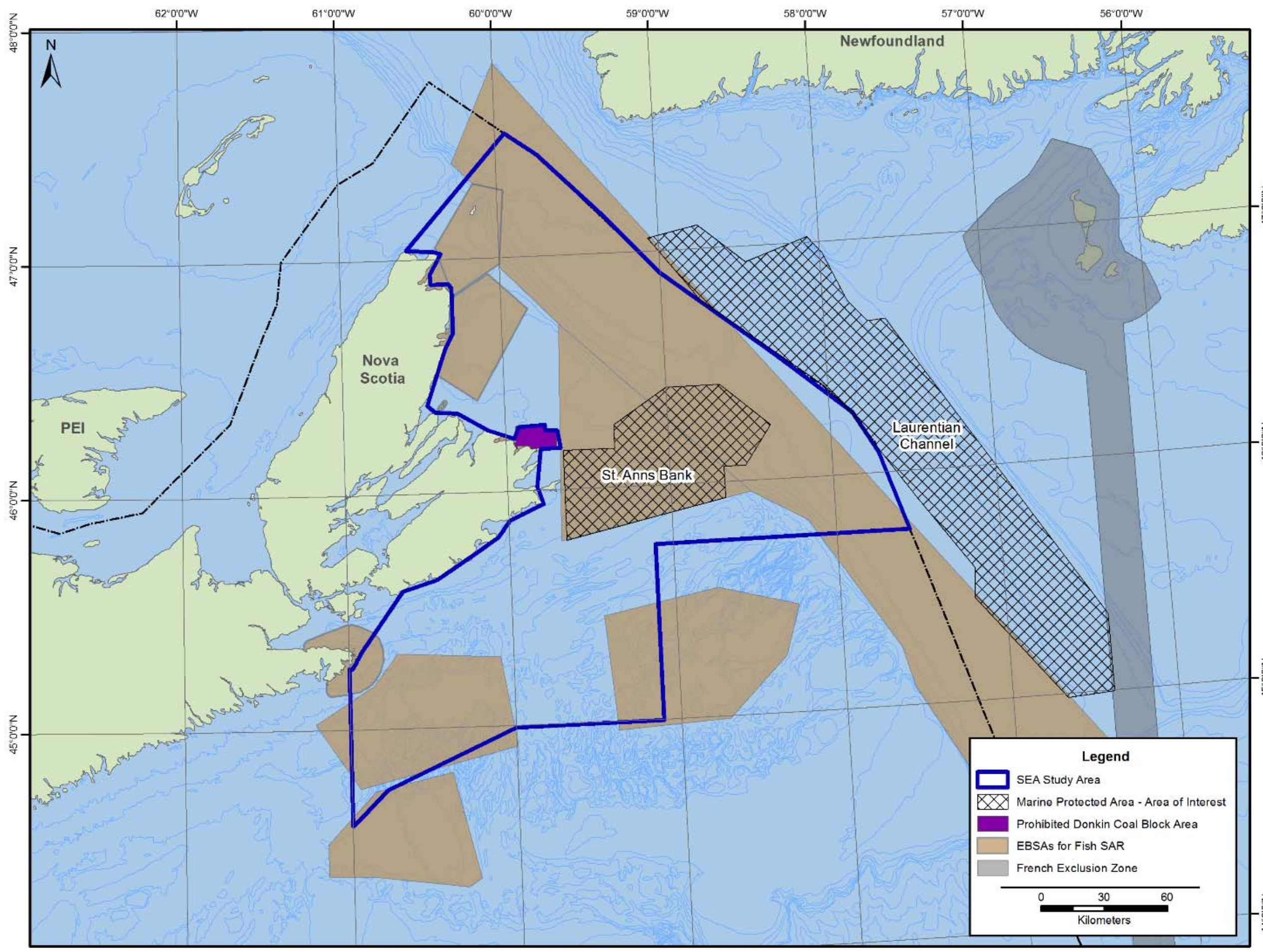
- **Indian Bay- Lingan Bay**
  - The Northwest Brook watershed, which drains into Lingan Bay, has been known to support spawning Atlantic Salmon (Endangered – COSEWIC).

- **Big Glace Bay**
  - The MacAskill's Brook watershed, which drains into Big Glace Lake, has been known to support spawning Atlantic Salmon (Endangered – COSEWIC).

- **The Canso Ledges (in part)**

- Historic importance for Atlantic Cod (Endangered – COSEWIC), and may still be important area for this species.
- Aggregations of several other SAR species: Atlantic Wolffish (Special Concern – SARA), Thorny Skate (Special Concern – COSEWIC), and Winter Skate (Threatened – COSEWIC).

Figure 5-2 Summary of Identified Important and Sensitive Areas for Marine Fish Species of Special Status



There are also various other important areas used in the life cycles of pelagic and demersal fish within the Study Area. In general, many species use the Cabot Strait) as their principal migration corridor (cod, redfish) and refuge area (capelin, herring) in the Gulf (DFO 2007). Specific areas of importance regarding migration routes and critical life stages of fish that are within or near the Study Area include:

- Atlantic cod populations within the Study Area are found in shallow waters in summer (0 – 50 m) and move to deeper waters in winter, going through the Cabot Strait and off of Newfoundland and Cape Breton's south coast. They return to shallower waters again in June;

- Atlantic salmon that move through the Cabot Strait in early summer into the Gulf and return in summer to spawn in freshwater;

- Atlantic mackerel migrate into the Gulf through the Cabot Strait in late spring / summer, and migrate out of the Gulf in the fall; and

The ecosystem of the eastern Scotian Shelf has changed and continues to do so. Fishing activity over many years has caused a trophic shift over the last 30 years that may not yet be stabilized, and consequently, the ecosystem may have somewhat less of a buffering capacity to potential stressors (Choi *et al.* 2005, Dufour and Ouellet 2007, Benoit *et al.* 2012). Climate change also has a compounding effect on the marine fish community with climate driven shifts in the presence, abundance and distribution of marine fish species throughout the general region (Benoit and Swain 2008, Benoit *et al.* 2012).

5.2.3.1.2 Summary of Environmental Planning Considerations for Marine Fish

The overall presence and abundance of marine and diadromous fish is relatively high in the Study Area as compared to other marine areas off Nova Scotia. As indicated, there is also a number of Species of Special Status known to occur in the region, as well as various key areas and times for marine and diadromous fish species.

The main possible effects of offshore petroleum activities on marine and diadromous fish are associated with potential accidental oil spills. The probability of such an event occurring is very low, with the actual effects of any such oil spill being dependent on factors such as the time of year, sea conditions, the volume and type of material spilled, and type of spill (i.e., surface or sub-surface). Direct effects would occur if fish are in the immediate area and come into contact with the spill and its zone of influence. As described previously, the particular species present in the region varies considerably according to season. The effects of an accidental oil spill on fish could be considerable within the zone of influence of a spill, however. Appropriate and adequate oil spill prevention, preparedness and response plans by individual operators are therefore required by the CNSOPB, to help ensure that the likelihood, and likely effects, of any such accidental events are minimized.

Additional and more likely effects on marine fish species are those related to sound emissions, particularly seismic noise related to exploration activities. The effects of such sound on marine fish can vary according to volume, distance, species, size, age of fish/invertebrate, as well as local bathymetry. Adherence to the mitigation activities outlined in Table 5-1, in particular the utilization of minimum sound levels, 'ramp-up' procedures, and minimizing vessel traffic will aid in mitigating potential effects on marine fish. Mandatory adherence to the Statement of Practice and avoidance of known species at risk and/or sensitive species and areas and/or times where possible in the planning and conduct of oil and gas activities will further mitigate potential effects on marine fish species.

Potential environmental effects can therefore likely be addressed through project-specific planning of appropriate mitigation measures and associated regulatory processes, to maximize avoidance of sensitive areas and times and through the identification and implementation of project and activity-specific environmental protection (mitigation) and emergency response measures.

5.2.3.2 Marine Bird Species of Special Status

Marine birds are present in the Study Area throughout the year, with many species moving in and out of the area at different times according to their particular characteristics, habitat preferences and seasonal activities. Existing and available information on the presence and geographic and seasonal occurrence of marine-associated avifauna in and near the region is presented in Section 4.2.2.

A number of bird Species at Risk and Species of Conservation Concern occur in the province and in the waters offshore. These include the: 1) Barrow's Goldeneye, 2) Harlequin Duck, 3) Piping Plover (*melodus* subspecies),4) Red Knot (rufa subspecies), 5) Buff-breasted Sandpiper, 6) Roseate Tern, 7) Peregrine Falcon, 8) Bank Swallow, 9) Olive-sided Flycatcher, 10) Eastern Wood-pewee, 11) Bicknell's Thrush, 12) Canada Warbler, 13) "Ipswich" Savannah Sparrow (*princeps* ssp.), 14) Bobolink, and 15) Short-eared Owl. Some of these species have the potential for negative interactions with projects within the Study Area for at least some part of the year; these species are addressed in Table 3-30. Species that do not inhabit the offshore environment, or those that only migrate over the ocean in the daytime (and are therefore unlikely to be affected by attraction to artificial marine lighting), were considered unlikely to be affected by the proposed Project and so were not assessed. The Rusty Blackbird breeds throughout the province and may migrate over the offshore area, but as a diurnal migrant (Avery 2013). Other diurnal migrant species at risk or species of conservation concern that occur in the province but are not considered here include the Chimney Swift (Cink and Collins 2002) and Barn Swallow (Brown and Bomberger Brown 1999).

5.2.3.2.1 Summary of Key Areas and Times for Marine Bird Species of Special Status

The Important Bird Area (IBA) program is coordinated by BirdLife International, and administered in Canada by the Canadian Nature Federation and Bird Studies Canada (IBA 2015). This program identifies areas of important habitat using internationally standardized criteria based on the presence of species at risk, species with restricted range, habitats holding representative species assemblages, or a congregation of a nationally and/or globally significant proportion of a species' population during one or more season. As discussed in Section 3.2.12 (Table 3-39 and Figure 3-35), there are a total of 15 designated IBAs in proximity to the Study Area. Collectively, these IBAs provide significant foraging, migratory stopover, and breeding habitats for many species of marine, land, and shorebirds.

A number of EBSAs have been identified along the Atlantic coast of Nova Scotia, many for their important attributes related to birds and their habitats. The EBSAs are further discussed in Section 3.2.12, and many of the EBSAs that are of significance to birds are also designated as IBAs.

Other designated sites that are important to migratory birds include federal Migratory Bird Sanctuaries (MBS) and provincially designated wilderness areas and nature reserves. Migratory Bird Sanctuaries are designated by Environment Canada and are protected by the *Migratory Bird Sanctuary Regulations* regarding the taking, injuring, destruction or molestation of migratory birds or their nests or eggs in the sanctuaries. Hunting of migratory species is not permitted in any Migratory Bird Sanctuary. There is one MBS in the area, the Big Glace Bay Lake MBS, which is also an IBA and is described in the preceding table. The two types of provincially protected areas in Nova Scotia offer varying degrees and forms of protection. Wilderness areas (including Scatarie Island) are protected from certain uses but also support uses such as recreation, sport fishing, and other uses; nature reserves protect unique or rare species or features and are mostly used for education and research. These protected areas are further discussed in Section 3.2.12.

Nesting sites for colonial seabirds and rare species also constitute particularly important areas and habitats. Section 3.8 provides a summary of the major nesting sites for gulls, terns, alcids and storm-petrels in eastern Nova Scotia. Many of these colonies are also designated EBSAs and/or IBAs (Hastings *et al.* 2014, IBA 2015). As well, critical habitat beaches for Piping Plover in the Study Area include North Harbour Beach and South Harbour Beach (near Aspy Bay), Big Glace Bay Lake, and Dominion Beach (Figure 3-35). The abundance and distribution of birds in the Study Area changes throughout the year. Information on key locations and times of year for bird taxa, including Species of Special Status, is found in Section 3.8.

5.2.3.2.2 Summary of Environmental Planning Considerations for Marine Birds, including Species of Special Status

The overall presence and abundance of marine birds in the Study Area is similar to that of other marine areas off eastern Canada. Further, there are a number of species at risk that are known to occur in the region, as well as various key areas and times for marine avifauna which are described in Section 3.2.11.2. The main possible effects of offshore petroleum activities on marine birds are associated with potential accidental oil spills. The probability of such an event occurring is very low, with the actual effects of any such oil spill being dependent on factors such as the time of year, sea conditions, the volume and type of material spilled, and type of spill (*i.e.*, surface or sub-surface). Direct effects would occur if birds are in the immediate area and come into contact with the spill and its zone of influence. As described previously, the particular species present in the region varies considerably according to season. The effects of an accidental oil spill on pelagic birds could be considerable within the zone of influence of a spill, however, and these species are likely most vulnerable to oil spills as they spend considerable time on the surface of the water. These species occur in the area primarily in the winter period, when low temperatures may also slow down degradation or weathering of spilled oil and/or when oil spill response procedures would likely be most challenging. Appropriate and adequate oil spill prevention, preparedness and response plans by individual operators are therefore required, to help ensure that the likelihood, and likely effects, of any such accidental events are minimized.

Potential environmental effects are to be addressed through any proposed future project planning and associated regulatory processes, to seek to avoid sensitive areas and times and through the identification and implementation of project and activity-specific environmental protection (mitigation) and emergency response measures.

5.2.3.3 Marine Mammal Species of Special Status

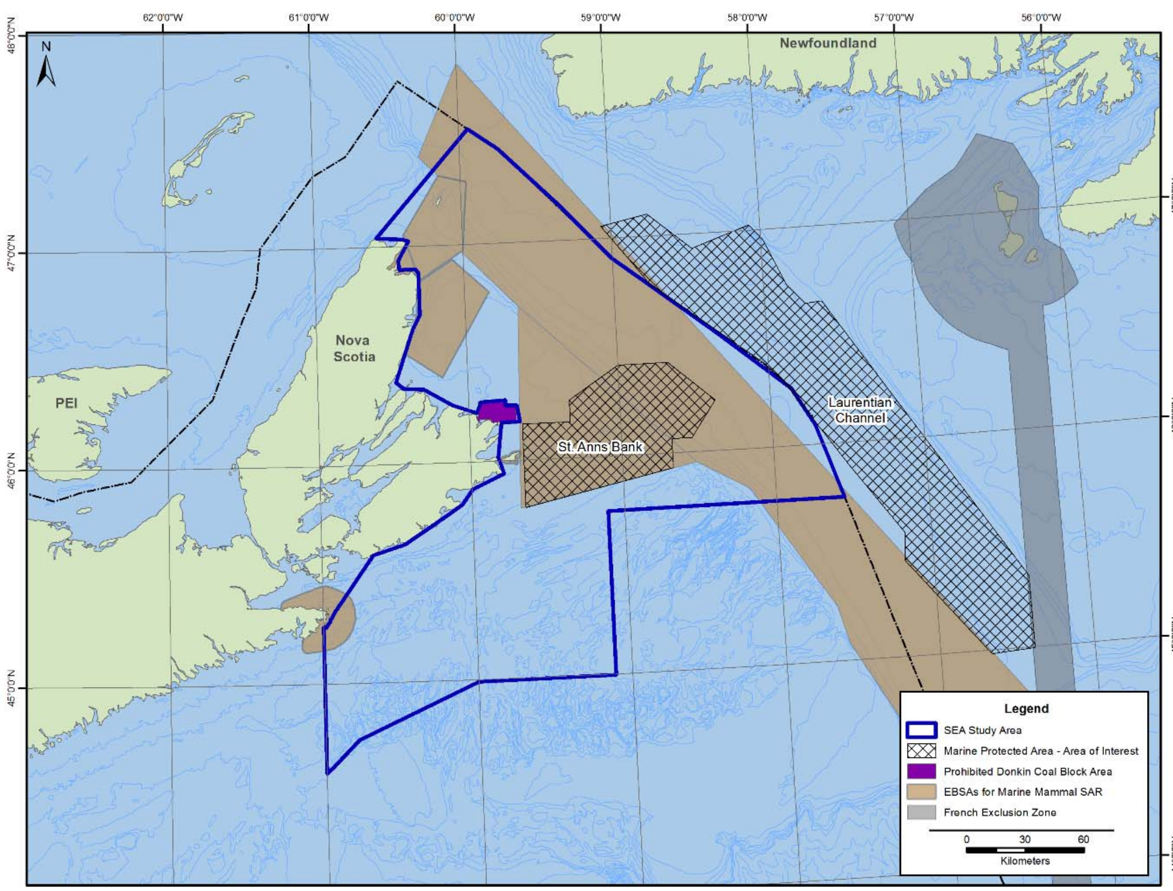
Marine mammals are present in the Study Area throughout the year, with many species utilizing and moving into and out of the area for various activities at different periods. Available information on the known geographic and seasonal occurrence of these species in and near the region is presented in Section 3.2.11.2.

A total of seven federally listed marine mammal species at risk (blue whale-Atlantic population, North Atlantic right whale, northern bottlenose whale-Scotian Shelf population, beluga-St. Lawrence Estuary population, fin whale-Atlantic population and harbour porpoise-Northwest Atlantic population) are known to occur in the Study Area. One additional species that may occur in the Study Area, killer whale, is listed by COSEWIC but not under *SARA*. Information on each of these species, including their general characteristics and known behaviour and activities, are provided in Section 3.2.11.3.

5.2.3.3.1 Important Areas and Times for Marine Mammals

Recent efforts were made by Fisheries and Oceans Canada to identify and designate selected areas around Nova Scotia that are of ecological and biological significance to marine life (Hastings *et al.* 2014, DFO 2014). Several of these areas were identified wholly or partly due to their significance to marine mammal species. EBSAs are discussed in further detail in Section 3.2.12 EBSAs of significance to marine Mammals Species of Special Status are shown in Figure 5-3.

Figure 5-3 Summary of Identified Important and Sensitive Areas for Marine Mammal Species of Special Status



The 2014 DFO document outlining offshore EBSAs list two EBSAs as being of significance to marine mammal Species of Special Status. These are the:

- **Laurentian Channel Slope**, which is a known migratory route for whales entering and exiting the GSL. (DFO 2014). High densities of krill also occur within this EBSA, providing an important food source for baleen whales.
- **St Anns Bank** is located along the same migratory route for marine mammals turtles and is also

an AOI as a proposed Marine Protected Area)

Coastal EBSAs off Nova Scotia were identified by Hastings *et al.* (2014). Four of these are stated as being of significant importance to marine mammals, including Species of Special Status. These include:

- **Cabot Strait** (between Cape North and St. Paul Island), which is an important cetacean migratory corridor. Blue Whales (Endangered – SARA) and Fin Whale (Special Concern – SARA) are known to migrate through the Cabot Strait as they enter and exit the GSL;
- **Aspy Bay,** a known breeding and feeding area for whales;
- **Scaterie Island,** which supports the largest breeding Grey Seal colony in the Atlantic coast sub-region; and
- **The Canso Ledges** are said to support an inshore concentration of Fin Whale (Special Concern – SARA).

5.2.3.3.2 Summary of Environmental Planning Considerations for Marine Mammals

Previous sections have provided information on marine mammals within and near the Study Area that will be relevant to future planning and decision-making related to offshore oil and gas activities in the region. The region is inhabited by marine mammals various times of the year, a number of which are considered to be at risk, with species moving in and out of the area utilizing its marine environment for various activities at different periods. Several areas within the Study Area have also been identified as being of overall ecological and biological significance for various reasons, including their use by and importance for marine mammals.

The presence of these species, location and times must be considered in planning, proposing, reviewing and implementing any future oil and gas exploration projects and activities in the Study Area. This, in combination with the general mitigation measures outlined above, including in particular the implementation of project specific marine mammal monitoring activities and avoidance protocols, will help to avoid or reduce any potential direct interactions with, and effects on, these species during individual projects. Potential environmental effects can therefore likely be addressed through project-specific planning and associated regulatory processes, through the identification and implementation of project and activity-specific mitigation and monitoring measures.

5.2.3.4 Sea Turtle Species of Special Status

Sea turtles are present in the Study Area throughout the summer and fall months, mainly for foraging and migration purposes. Available information on the known geographic and seasonal occurrence of these species in and near the region is presented in Section 3.2.11.4.

A single listed sea turtle (leatherback-Atlantic population) is known to occur in the Study Area. One additional species that may occur in the Study Area, loggerhead sea turtle (Atlantic Ocean population), is listed by COSEWIC but not under *SARA*. A third sea turtle species, the Kemp's ridley, is not federally listed but is considered to be globally endangered (TEWG, 2000). Information on each of these species, including their general characteristics and known behaviour and activities, are provided in Section 3.2.11.4.

5.2.3.4.1 Important Areas and Times for Sea Turtles

Fisheries and Oceans Canada recently identified select areas around Nova Scotia that are of ecological and biological significance to marine life (Hastings et al. 2014, DFO 2014). Several of these areas were identified wholly or partly due to their significance to sea turtle species. EBSAs are discussed in further detail in Section 3.2.12. EBSAs considered important to Sea Turtle SAR are depicted in Figure 5-4.

The 2014 DFO document outlining offshore EBSAs list two EBSAs as being of significance to sea turtle SAR. These are the:

- Laurentian Channel Slope, which is a known migratory route sea turtles entering and exiting the GSL. (DFO 2014).
- St Anns Bank is located along the same migratory route for sea turtles and is also an AOI as a proposed Marine Protected Area.

Coastal EBSAs off Nova Scotia were identified by Hastings *et al.* (2014). Two of these are stated as being of significant importance to sea turtles, including SAR. These include:

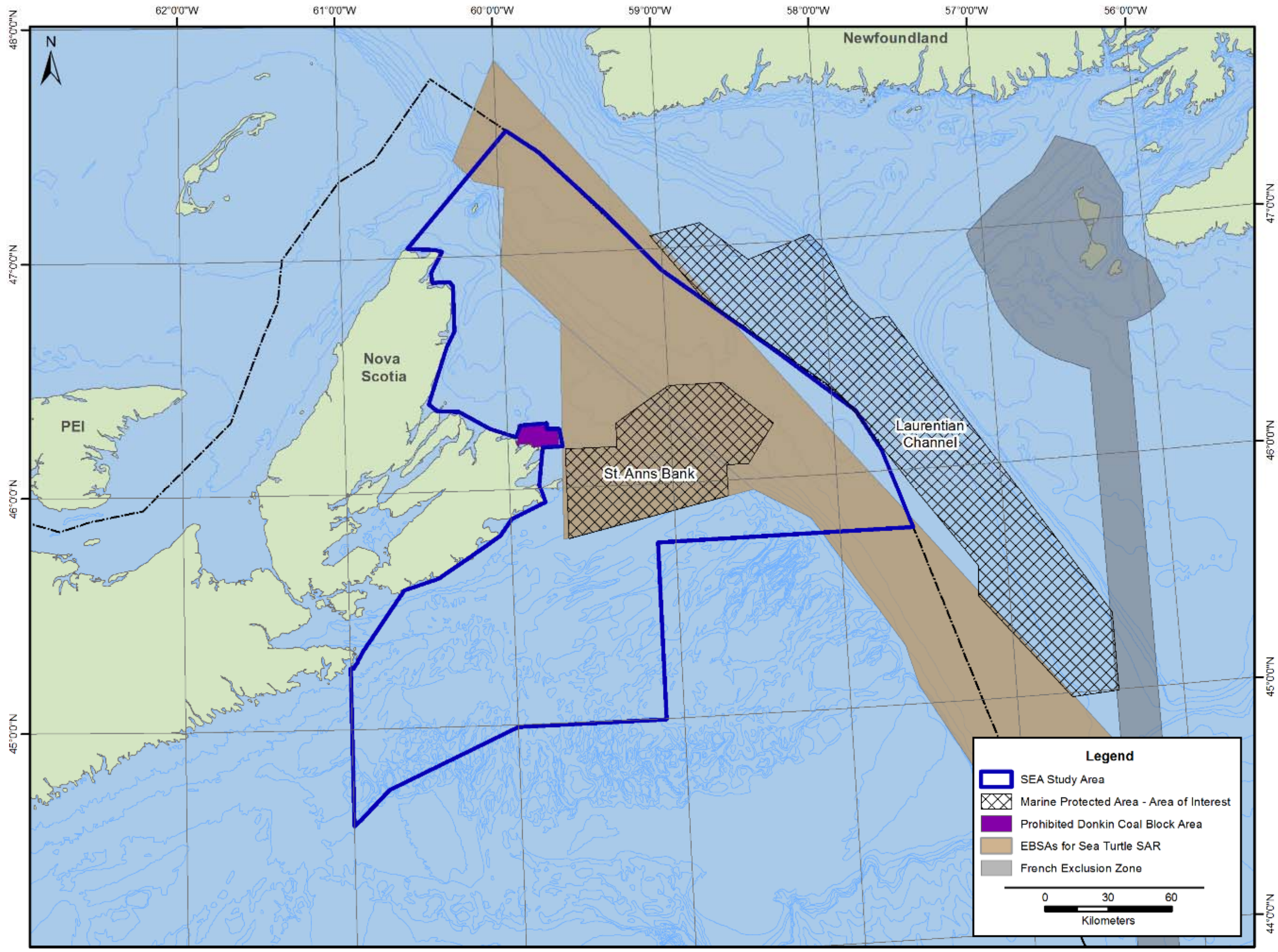
- Cabot Strait (between Cape North and St. Paul Island), which is part of the Gulf of St. Lawrence important habitat area for Leatherback Turtle (Endangered – SARA);
- Western Sydney Bight, which is also part of the Gulf of St. Lawrence important habitat area for Leatherback Turtle (Endangered – SARA);

DFO (2012b) also recognized the following areas as high-use feeding areas for sea turtles:

- waters east and southeast of Georges Bank, including the Northeast Channel near the southwestern boundary of the Canadian Exclusive Economic Zone;
- the southeastern Gulf of St. Lawrence and waters off eastern Cape Breton Island, including Sydney Bight, the Cabot Strait, portions of the Magdalen Shallows and adjacent portions of the Laurentian Channel; and
- waters south and east of the Burin Peninsula, Newfoundland, including parts of Placentia Bay.

Sea turtles are highly migratory and occur frequently in summer and fall in the overall region, and do not occur in the Study Area during the winter months.

Figure 5-4 Summary of Some Identified Important and Sensitive Areas for Sea Turtle Species of Special Status



5.2.3.4.2 Summary of Environmental Planning Considerations for Sea Turtles

Previous sections have provided information on sea turtles within and near the Study Area that will be relevant to future planning and decision-making related to offshore oil and gas activities in the region. The region is inhabited by sea turtles during the summer and fall months, all species of which are considered to be at risk. The presence of these species, location and times must be considered in planning, proposing, reviewing and implementing any future oil and gas exploration projects and activities in the Study Area. This, in combination with the general mitigation measures outlined above, including in particular the implementation of project specific sea turtle monitoring activities and avoidance protocols, will help to avoid or reduce any potential direct interactions with, and effects on, these species during any future projects. Potential environmental effects can therefore likely be addressed through project-specific planning and associated regulatory processes, through the identification and implementation of project and activity-specific mitigation and monitoring measures.

5.3 Fisheries

Fisheries are an important and integral component of the socioeconomic environment of much of the Study Area. Commercial harvesting is conducted throughout the area through core licences or developmental fisheries permits / licences, and involves fishers from Nova Scotia and other provinces which are represented by a number of organizations. There are also important recreational fisheries, Aboriginal communal commercial fisheries, and Food, Social and Ceremonial fisheries that take place in the Study Area as well.

5.3.1 Potential Environmental Interactions and Existing Knowledge

Commercial fisheries have the potential to be affected both directly and indirectly. Potential effects to marine fish are discussed in Section 5.2.1.1.1. Direct effects can be experienced through potential direct spatial interactions between offshore oil and gas operations and fishing operations in which fishing activity is impeded or gear is damaged. Indirect activities can occur over time through ecosystemic changes caused by potential offshore petroleum activities that result in negative changes in the size, distribution and health of fish populations or fish habitat. Ensuring adequate and appropriate planning and use of appropriate mitigation strategies such as avoiding potential interactions between offshore oil and gas exploration equipment and fishing vessels and gear is a key to effective implementation of both industry operations.

Considering the fishing industry and oil and gas activities occupy the same marine space and oil and gas activities could occur during fishing seasons within the Study Area, the potential exists for direct interaction between these two sectors. Potential interruptions may result in negative economic impacts on fishing ventures, such as:

- loss of profit due to direct costs of replacing or repairing any fishing gear affected, or
- reduced fishing income due to the need to change fishing location or timing of fishing activity (such as reduced fishing activity, increased cost and time to travel to and fish at alternate locations).

Also, any environmental effects resulting from oil and gas activities that result in decreases in the presence, abundance, distribution or health of fish resources in an area could potentially result in longer-term negative consequences for the fishers dependent on these resources for their livelihoods. While it is understood that there are natural variations in the relative abundance of different fishery resources, the potential negative impact on key commercial species, in the case of a spill, could have significant long term impacts on the livelihoods and incomes in the coastal fishing communities in the Study Area.

Much of the available information and insight regarding potential interactions between marine fisheries and the offshore oil and gas industry has been gathered through consultations with fishers and other individuals and organizations that are involved in the fishing industry. Key issues concerning commercial fisheries which have been identified include:

- damage to gear,
- loss of access (time or area) and associated logistical changes to operations,
- reduced fish catches (quantity and/or value),
- biophysical effects on fish populations (including real or perceived tainting) and subsequent reductions in the landed value.

Oil spills have also been noted as the primary issues of concern.

Like many other coastal regions, offshore oil and gas exploration activities have been occurring in the Nova Scotia Offshore Area for decades. The views and insights of those involved in the commercial fishery, resulting from their individual and collective experiences, provide an important source of “existing knowledge” regarding potential issues and effects, mitigation measures and their effectiveness, and other factors relevant to the planning and possible conduct of future offshore oil and gas activities in the Study Area.

Damage to fishing gear or vessels can result from physical contact with seismic vessels, drill rigs, or equipment and vessels supporting oil and gas exploration. This is particularly important to fixed gear fisheries where gear (longline, crab traps lobster traps etc.) is deployed and left for some period before recovery. Project-related discharges into the marine environment, such as small spills and materials lost from vessels or drill rigs can also damage or foul fishing gear. In addition to the direct costs of fixing or replacing any damaged fishing vessels or gear, further economic loss might also result from any associated reduction in fishing times such as reduced catches, or increased operating costs in less favourable weather.

Temporary or long-term loss of access to fishing grounds may occur when safety zones are required and established around exploration drilling activities or during similar periods of disruption during active seismic survey work. The nature, spatial extent, duration and possible implications of any such restrictions depends on the type, location, timing and other characteristics of the offshore oil and gas project or activity in question, as well as the nature and scale of fishing activity that currently occurs in the area. The area in which fishing activity can be reduced or interrupted during seismic survey vessel operation can be significant. As a result of the often limited manoeuvrability of offshore geophysical survey vessels during seismic survey activity (resulting from the length of the deployed streamer and other factors), other mobile vessels must often give way for safety reasons under the *Canada Shipping Act (*2001). There is also potential for interaction with fixed fishing gear that have been deployed along or near a survey line at the same time as planned oil and gas activities. The requirement to fish in and/or travel through alternative areas during these periods can have implications for catch rates and the cost and efficiency of fishing activity as well. The safety (no-fishing) zones that are typically established around offshore drilling operations are usually quite small in size, although for certain fisheries that use longline gear or others the exclusion zone may need to be larger.

The possible biophysical effects of offshore oil and gas activities on fish resources (Section 5.3) may also indirectly affect fishing activity. The potential effects of seismic surveys on the presence, abundance and distribution (spatial and temporal) of commercial fish species, particularly snow crab, has been raised as a concern due to the high value of the harvest, and the scientific literature and anecdotal reports have not provided consistent and conclusive results on this issue (Section 5.3). Drilling operations may also affect fish behaviour (migration and foraging), health (toxicity and bioaccumulation), condition (taint), and habitat (smothering of benthic habitats). Any such biophysical effects to fish and fish habitat could result in a subsequent loss of fish catch or catch value. Even where there is a low potential for, or occurrence, of such effects, perceived effects in the marketplace (fish quality, taint) can indirectly affect economic returns from the fishery (although this is much more likely to occur after a large oil spill than as a result of routine offshore activities).

The most important potential effects from major oil spills in the marine environment are extended loss of access to fishing grounds, damage to fishing equipment, fish mortality and tainting, and associated economic effects due to loss of industry value and markets.

The main potential interactions between offshore oil and gas exploration activities and marine fisheries may therefore be summarized as follows (Table 5-2):

- Possible damage to fishing gear or vessels as a result of direct interactions with oil and gas related equipment, activities and/or environmental discharges;
- Loss of access to preferred fishing areas and travel routes during offshore exploration or production activities, and possible resulting decreases in fishing success and overall efficiency;
- Indirect effects on fish landings and values due to possible biophysical effects on fish resources and their habitats (including fish abundance, fecundity, distribution or quality);

- Possible interference with governmental / industry fish survey activities, including direct disturbance and/or effects upon research results and associated management decisions; and
- The potential effects of offshore oil spills on fishing activity, equipment and fish resources and the resulting implications for fishers and their livelihoods and communities.

Table 5-2 Fisheries: Potential Environmental Interactions

Components / Activities	Potential Environmental Interactions				
	Possible Gear Damage	Loss of Access to Fishing Areas (Decreased Fishing Effectiveness / Efficiency)	Decreased Abundance, Location and/or Quality of Fish Resources	Decreased Quality / Value of Fishing Activities	Interference with Fisheries Research Surveys
Seismic and Seabed Surveys	●	●	●	●	●
Exploratory Drilling	●	●	●	●	●
Vessel Traffic	●		●	●	
Well Abandonment	●	●			
Accidental Spills	●	●	●	●	●

5.3.2 Environmental Mitigation Measures

A number of procedures and mitigation measures have been used in the NS offshore area and elsewhere to avoid or reduce possible negative interactions between offshore oil and gas activities and marine commercial fisheries. These interactions are summarized in Table 5-2.

Ensuring the safety of offshore personnel and equipment working in both the fishing and oil and gas industries is a primary concern and objective of both industry and regulators. The establishment of safety (no-fishing) zones around offshore oil and gas installations and in areas of high vessel traffic helps to minimize the potential for negative interactions between oil and gas activities and the fishing industry. Typically, no-fishing zones are relatively small in size, but again this depends on the nature of the installation and activity and the adjacent fisheries. If a series of wells are to be drilled in a given area, a sequential approach to drilling is often used for logistical reasons (such as rig availability and mobilization), which also helps minimize the total area affected through loss of access to fishing grounds at any one time.

Early consultation/engagement and communication between offshore oil and gas operators, government departments and agencies and the fishing industry in planning and implementing offshore seismic surveys and drilling programs is by far the most effective mechanism for avoiding conflicts and adverse socio-economic impacts. Notices to Mariners and other methods have been used to get timely information about offshore oil and gas activities to fishers and other organizations. Fisheries Liaison Officer (FLO) positions have also been established by oil and gas operators to serve as an essential link for on-going communication with the fishing industry and local coastal communities during offshore programs. FLOs are often local fishers who are hired and placed on-board offshore oil and gas installations and vessels, whose responsibilities include communicating with fishing vessels, as well as proposing alternative routes to operator to avoid important fishing areas and activities.

The use of established and common marine traffic routes by support and supply vessels where possible can also help minimize disturbances to and effects on the fishing industry. Oil and gas related vessels are typically made aware of the nature of, and key locations and times for, fishing activity in the region, as a further precaution and for planning purposes to potentially use alternate routes around fishing grounds at peak times.

The CNSOPB's Geophysical, Geological, Environmental and Geotechnical Program Guidelines include various requirements and measures related to environmental planning, mitigation, monitoring and reporting which are intended to help avoid or reduce the potential for interactions with other ocean users, including associated scheduling, operational planning and communications, gear and/or vessel damage compensation programs, and incident documentation and reporting. The various mitigation measures to avoid or reduce the potential environmental (biophysical) effects of offshore oil and gas activities on fish and fish habitat that are highlighted in Table 5-3 can also serve to help address any indirect effects on marine commercial fisheries.

A key and recurring concern of the commercial fishing industry about potential negative effects of oil and gas operations relate to the potential for a large oil spill on the marine environment, and thus, on fishing activity and the livelihoods and incomes of fishers and their communities. The prevention of oil spills has been and is a major priority for the industry and regulators alike including the CNSOPB and offshore drilling operators who are required to develop plans which outline procedures for preventing and effectively responding to such spills. The regulatory reviews of proposed offshore drilling programs include an analysis of possible types and probabilities for oil spill, as well as detailed modelling of the likely fate and behaviour of hypothetical spills based on project and site specific factors, including hydrocarbon types and properties, water depths and characteristics, currents and other oceanographic conditions and patterns. This information and analysis is then used in assessing and evaluating the potential for, and likely nature and magnitude of, interactions between any such spill and fishing activities, for use in project planning and associated regulatory decisions around whether and how the particular drilling program in question may proceed. As part of the regulatory review and approval processes that apply to offshore drilling activities in the NS Offshore Area, operators are also expected to demonstrate that they have the ability and capacity to undertake such activities in a safe and environmentally responsible manner. This includes the development and implementation of systematic and comprehensive oil spill prevention plans and procedures, as well as ensuring that they have the ability to respond to a spill event in an effective and timely manner, should one occur.

Should the above measures be unsuccessful in preventing adverse environmental effects to marine fisheries or other components of the socioeconomic environment (such as gear damage due to interference with seismic streamers, or in the unlikely event of a large offshore oil spill in the area), a variety of processes and measures exist to compensate fishers and others for losses or damages related to offshore oil and gas activity.

Table 5-3 Summary of Standard Environmental Mitigation Measures and Their Applicability: Fisheries

Mitigation Measures	Applicability				
	Seismic and Seabed Surveys	Exploration Drilling	Vessel Traffic	Well Abandonment	Accidental Spills
Planning of oil and gas activities to avoid key fishing areas / harvesting times where possible	●	●	●		
On-going information gathering and analysis regarding fishing areas and times and continued monitoring of fishing activity	●	●	●	●	●
Establishment and communication of safety / no-fishing zones	●	●		●	
Sequential approach to drilling multiple wells in an area		●			
Open, active and continuous communications and coordination procedures	●	●	●	●	●
Hiring Fisheries Liaison Officers (FLOs) and using Single Points of Contact	●	●	●	●	●
Early issuance of Notices to Mariners and other notifications / direct industry communications	●	●	●	●	●
Avoidance of fisheries science survey activities (areas / times)	●	●			
Open, active and continuous communications and coordination procedures	●	●	●	●	●
Hiring Fisheries Liaison Officers (FLOs) and using Single Points of Contact	●	●	●	●	●

5.3.3 Environmental Planning Considerations

Based on the available information regarding marine fisheries in the Study Area and adjacent regions, the following sections summarize a number of key planning considerations which may help to inform planners and decision-makers regarding future exploration licencing and the design and conduct of any future associated oil and gas activities in the region. This includes highlighting particular fishing activities, areas and times which may be considered in such planning, to help avoid or reduce potential interactions between the oil and gas and fishing sectors within the Study Area.

As illustrated and described in Chapter 3, a variety of commercial fisheries occur within and throughout the Study Area and adjacent regions throughout the year, and the region is characterized by a somewhat complex spatial and temporal pattern of fishing activity. This, along with the rather dynamic nature of the fishery over time makes it somewhat difficult to be specific about any particular locations and times which should be avoided or in which activities should be otherwise planned or restricted. This is complicated by the spatial shifts in the industry effort which have been experienced in greater frequency and area in recent years (often attributed to climate change effects without substantiation).

Figure 3-41 to Figure 3-60 illustrate the areas where specific harvesting activities are known to occur. In general, the overall fishing effort is widely distributed throughout the Study Area. Depending on the specific harvesting season, there is a shift of predominant fishing effort between regions (offshore fishery near Laurentian Channel to inshore coastal fishery). Of particular significance is the areas along the south eastern portion of the Study Area (Orpheus Graben) where there is considerable effort in the snow crab and shrimp industries, and the general inshore areas where the lobster fishery occurs.

On-going communication between offshore oil and gas operators and the fishing industry, through the various processes and forums described above, has been and remains the most effective means for ensuring that such activities are carried out in a safe and environmentally responsible manner, avoiding or reducing adverse interactions between the oil and gas and fishing sectors. Notices to Mariners and other communications, the use of FLOs, and the CNSOPB’s Fisheries Advisory Committee have been particularly useful in creating and maintaining open and on-going dialogue between the two industries, and in fostering a proactive and cooperative approach to identifying and addressing any issues or concerns.

5.4 Special Areas

A number of marine and coastal areas within and adjacent to the Study Area have been designated as being special, some of which are formally protected or designated under provincial, federal and/or other legislation and processes due to their ecological, historical and/or socio-cultural characteristics and importance. Others have been identified as being sensitive or otherwise special for biophysical and/or socio-cultural reasons, but do not have formal protection. These include, for example, the following:

Table 5-4 Protected and Special Areas in the Study Area

Type	Name
Costal Ecologically and Biologically Significant Areas (EBSA)	Western Sydney Bight Cabot Strait (between Cape North and St. Paul Island) Aspy Bay Ingonish Bays Bird Islands Indian Bay- Lingan Bay Big Glace Bay

Type	Name
	Morien Bay Scaterie Island Portnova Islands Islet off of Baleine Harbour Rock Green Island Guyon Islands Rocks of Cape Fourchu Point Michaud and Basque Islands The Canso Ledges
Offshore Ecologically and Biologically Significant Areas (EBSA)	St. Ann’s Bank Laurentian Channel Canso Bank and Canso Basin Misaine Bank Middle Bank
Marine Protected Area - Areas of Interest	St. Ann’s Bank Laurentian Channel
Provincial Parks and Protected Areas	Andrews Island Provincial Park Reserve Cape Smokey Provincial Park Gabarus Wilderness Area Scatarie Island Wilderness Area Basques Islands Nature Reserve (Pending) Fourchu Coast Wilderness Area (Pending)
International Bird Areas (IBA)	Rock of Fourchu Head Bird Islands, Cape Dauphin Port Nova Islands, Louisbourg Cape North, Bay St. Lawrence St. Paul Island, Cabot Strait Basques Islands and Point Michaud Scatarie Island, Main-a-Dieu Northern Head and South Head, Glace Bay

These areas were identified, mapped and described throughout Chapter 3, and the potential for interactions with, and effects on, these areas resulting from future oil and gas activities in the Study Area is given particular attention in the SEA.

This VEC focuses on marine and coastal areas in the Study Area that have existing designations of which have been identified through other processes as being particularly important and/or special locations. Other areas that have been identified as being particularly important and/or sensitive from a purely ecological perspective (such as fish spawning areas, bird colonies) or for fishing activity have been considered and assessed integrally within the other applicable VEC(s).

5.4.1 Potential Environmental Interactions and Existing Knowledge

Environmental interactions between offshore oil and gas activities and identified special (including protected) areas may be both direct and indirect in nature and cause. The conduct of oil and gas exploration activities directly within or near such areas may, for example, have adverse implications for these locations and their important and defining ecological and socio-cultural characteristics. These interactions may occur through the possible presence of oil and gas exploration or production equipment, personnel and activities in the area, as well as the associated routine emissions and resulting disturbances that may occur in nearby environments.

Biophysical effects resulting from oil and gas or other human activities within the Study Area may also "spread" to adjacent special areas by affecting the marine fish, birds, mammals or other environmental components that move to and through the area (see existing knowledge information provided in the preceding section). Although unlikely to occur, any large oil spill in the marine environment may, depending upon its magnitude, location and oceanographic conditions, also extend to other areas, potentially affecting these areas and their associated environmental components and characteristics. Any resulting decrease in the real or perceived integrity of these areas in the short or long term may also affect their ecological and/or societal importance and value. This may, in turn, have important implications for the communities and economies that depend on any such areas and their associated fishing and aquaculture industries, tourism activities and recreational opportunities, which are outlined in Sections 5.3 and 5.5.

Table 5-5 Special Areas: Potential Environmental Interactions

Project Component / Activity	Potential Interactions with:	
	Environmental Features and/or Processes	Human Use and/or Societal Value
Seismic and Seabed Surveys	●	●
Exploratory Drilling	●	●
Vessel Traffic	●	●
Well Abandonment	●	●
Accidental Spills	●	●

In 2011, the Canada Nova Scotia Offshore Petroleum Board released a review of the results of various offshore oil and gas environmental effects monitoring programs. This study covered a variety of monitoring programs for seismic surveys, exploration drilling wells, the Cohasset-Panuke Project and the Sable Offshore Energy Project in the Nova Scotia offshore between 1992 and 2008. The monitoring programs for exploration focused on: the effects of seismic surveys on marine species (i.e. snow crab, marine mammals, fish ear structures); and the effects of drilling wells on chemical, physical and biological features of the ocean floor and on substrate characteristics, cutting mound dimensions and epibenthic fauna (CNSOPB 2011).

Two surveys regarding the effects of seismic noise on marine mammals were conducted in and near The Gully Marine Protected Area (MPA). An acoustic monitoring program conducted to verify and validate predicted sounds effects determined that acoustic noise levels received in The Gully MPA were lower than levels known to cause behavioral changes in marine mammals. A review of a collection of academic research papers related to 3-D seismic surveys determined that whales did not abandon The Gully area when seismic vessels were 30 km or further away (CNSOPB 2011).

5.4.2 Environmental Mitigation Measures

Special areas are identified and / or protected due to their sensitive biological, physical or cultural features. Most of the protected and special areas (ecologically and biologically sensitive areas; marine protected areas; provincial parks, wilderness areas and nature reserves; and international bird areas) that are located within the Study Area and Cape Breton Highlands National Park have been designated due to particular sensitive species or habitats. These areas are used by marine species (including some listed as endangered, threatened, depleted and of special concern) for breeding, feeding, spawning, migrating, overwintering, foraging, nesting and roosting as well as habitats for juvenile fish and staging areas and bird migration routes. Some of these protected and special areas maintain globally significant numbers of particular species or significant nesting colonies of shorebirds, waterfowl or seabirds. They may also provide representative examples of sensitive natural areas such as coasts, beaches and lagoons. Many of these protected areas, including the nearby Cape Breton Highlands National Park, provide tourism and recreational opportunities including activities based on the special natural features of these sites. For additional information on biological aspects of these special areas, see Section 3.2.12.

For formally protected areas, oil and gas related activities may be prohibited or otherwise restricted, pursuant to applicable legislation, to avoid or reduce the potential for negative effects on these areas.

For other important and sensitive areas, a number of environmental protection measures and procedures are typically used in the NS offshore area to avoid or reduce the possible adverse effects of offshore oil and gas activities on the marine (biophysical) environment, including both planned activities and potential accidental events. These have been listed and described in Section 5.2, and their implementation would also serve to help address any associated effects on any special areas and sensitive environments within or near the Study Area.

With reference to protected and special areas themselves, prior to executing seismic surveys, operators must use environmental assessment to identify protected areas and local sensitivities and schedule operations during least sensitive periods. For exploration and appraisal drilling in the offshore, operators should select the least sensitive location within the confines of the bottom target / drilling envelope, consider directional drilling to access targets beneath sensitive areas and consider cluster drilling to limit the extents of drilling sites. In coastal areas, operators should be encouraged to select equipment (*e.g.* vessel instead of helicopter) based on particular sensitivities of wildlife populations or habitats (UNEP 1997).

These and/or other required mitigation measures would be determined on a project-specific basis, through the individual regulatory reviews of proposed exploration (seismic or drilling) projects. Again, any individual, proposed oil and gas exploration projects will also require the receipt of applicable (project-specific) permits and authorizations from all relevant federal and provincial regulatory departments and agencies.

5.4.3 Environmental Planning Considerations

A number of protected and sensitive areas are present in the Study Area, such as those listed at the beginning of this section. These include: coastal and offshore ecologically and biologically significant areas; marine protected areas of interest (*e.g.* St. Ann's Bank and the Laurentian Channel); Nova Scotia provincial parks, Cape Breton Highlands National Park, wilderness areas and pending nature reserves; and international bird areas. These identified areas are located within the ocean environment, on various islands or in coastal areas within the Study Area. A number of others protected and sensitive areas are located within 10 km of the Study Area boundary (see Section 3.2).

Existing projects and areas with oil and gas development history can be used as case studies for the development of environmental planning and monitoring programs in the Study Area. The CNSOPB's resource conservation approach is designed to ensure that operators are committed to resource conservation, to audit activity authorization applications from a resource conservation perspective and to perform necessary studies and surveillance to develop and support independent understanding of marine resources (Lee *et al.* 2011).

5.5 Other Marine Components, Activities and Ocean Users

A number of other human activities and components also occur within or near the marine environment, and therefore have the potential to interact with, and be affected by, any future offshore oil and gas activities in the Study Area. These include general vessel traffic to, from and through the area, as well as whale and sea bird tours and other commercial and recreational marine pursuits.

5.5.1 Potential Environmental Interactions and Existing Knowledge

Many of the potential interactions between offshore oil and gas related exploration activities and other anthropogenic features and activities in the marine environment are similar to those described previously for fisheries, and include:

- Damage to fishing vessels, equipment or infrastructure as a result of direct interactions with oil and gas related equipment, activities and/or environmental discharges;
- Loss of access to preferred use area and travel routes during offshore exploration activities, and possible resulting decreases in the value (economic or otherwise) or quality of these initiatives;

- Indirect effects on consumptive resource use due to possible biophysical effects on ocean resources and areas; and
- The potential effects of offshore oil spills on marine components, activities and ocean users, including and the nature, presence and quality of resources and the natural environment in general.

Table 5-6 Other Marine Components, Activities and Ocean Users: Potential Environmental Interactions

Components / Activities	Potential Environmental Interactions			
	Possible Damage to Equipment or Infrastructure	Loss of Access to Key Areas and/or Resources	Decreased Abundance, Location and Quality of Resources	Decreased Quality / Value of Activities and Experiences
Seismic and Seabed Surveys	●	●		●
Exploratory Drilling	●	●	●	●
Vessel Traffic	●		●	
Well Abandonment	●	●	●	●
Accidental Spills	●	●	●	●

Relevant mitigation measures and management practices found in this study are incorporated into the following sections. Effects on the fishing industry and relevant effects management are discussed in Section 5.3.

5.5.2 Environmental Mitigation Measures

As described in the previous VECs, a number of environmental protection measures and procedures are typically used in the NS Offshore Area to avoid or reduce the possible adverse effects of offshore oil and gas activities on the marine (biophysical) environment, including both planned activities and potential accidental events. These have been listed and described in Sections 5.1 to 5.4 above and their associated Tables, and their implementation would also serve to help address any associated effects on other marine activities within or near the Study Area.

These and/or other required mitigation measures would be determined on a project-specific basis, through the individual regulatory reviews of proposed exploration projects.

5.5.2.1 Seismic Surveys

Operators of seismic surveys should consult local authorities and other stakeholders regarding the survey program, permitting and notifications to user groups, make adequate allowance for deviation of towed equipment when turning and remain on planned survey track to avoid inadvertent interactions. Seismic operators should also make all towed equipment highly visible and labelled, attach active location devices to auxiliary equipment to aid location and recovery and prepare a contingency plan for lost equipment. All equipment should be stored and handled according to operator's procedures and local regulations. Operators should also report all unplanned interactions with other resource users to appropriate authorities (UNEP 1997).

5.5.2.2 Exploration Drilling Exercises

Operators of exploration and appraisal drilling exercises, should consult with local authorities regarding site selection and support infrastructure and activities including ports, vessel traffic and airport traffic. In coastal areas, operators should select sites and equipment to minimize disturbance, noise, light and visual intrusion. During the actual well drilling program, operators are encouraged to maintain communications with local authorities regarding notifications to other resource users and to meet the requirements established in the project planning process including operations of supply vessels. When decommissioning an exploratory well, it is recommended that operators remove all debris from the seabed, if possible, and decommission support facilities to meet planning requirements (UNEP 1997).

5.5.3 Environmental Planning Considerations

Aside from the fishing industry, which is discussed in Section 5.3, various human activities occur within the marine and coastal environment of the Study Area. These include tourism and recreation, shipping and transportation movements and military exercises that may interact with seismic surveys and other vessel movements. Also, the Study Area includes elements such as unexploded explosive ordnances and marine communications cables, which may require special attention, particularly when planning exploratory well drilling.

In jurisdictions such as Nova Scotia and Canada, the environmental planning process including environmental assessment, project specific environmental management plans, regulatory permitting and compliance programs are used to develop detailed requirements to prevent or minimize adverse effects and enhance possible beneficial effects. Project planning also includes consultation and communications programs and establishes compliance and monitoring regimes to ensure regulatory requirements are met. Along with environmental issues, monitoring may include socio-economic interactions, local liaison activities and potentially assessment of complaints from other resource user groups. With careful planning, consultation, issues management, negotiation and accommodation, most if not all adverse aspects of a development on other human activities can be avoided and/or mitigated.

6 POTENTIAL EFFECTS OF THE ENVIRONMENT ON OFFSHORE EXPLORATION ACTIVITIES

The physical environmental setting, and the potential effects conditions may have, are essential considerations in the planning, review and conduct of oil and gas exploration and development activities. These efforts help ensure that human health and safety, equipment and infrastructure, and the environment are appropriately protected.

Knowledge of the bathymetry, wind, wave, current and any ice conditions likely to be encountered is required for selection of the type and size of seismic, drilling and supply vessels and other equipment required. Planning and safe operations for activities may also be affected by vessel or platform icing, visibility, and to a lesser extent air and sea temperatures. Time of year will be a key factor in determining the level of risk, or effect, which may be encountered for any of these environmental parameters.

A regional overview of the physical environment of the Study Area was presented in Section 3.1.

6.1 Potential Effects

Wind and waves have the potential to increase stress on surfaces and vessels and disrupt scheduling, operations and, for seismic surveys, affect survey data quality. Vessels and equipment must be able to withstand the range of conditions expected, or forecast, to be encountered. Seismic survey operations may typically be limited by wind or sea conditions.

For the Study Area gale force winds (34-40 knots, 63-74 km/h) in the spring and summer and storm force winds (48-55 knots, 89-102 km/h) in the fall and winter can be expected. Conditions further offshore will generally be more severe with maximum significant wave heights up to 8 m in the spring and 9 or 10 m in the winter. The largest waves, up to 12 m, are encountered in August and are associated with the passage of tropical systems. Nearer the coast, maximum significant wave heights will range from just over 3 m in July to 8 m in December.

Currents may be a factor depending on depth and on any equipment or operations potentially affected. Current magnitudes will vary depending on the time of year and location but may be expected to be on the order of 0.05 to 0.2 m/s on average with maximum speeds generally from about 0.3 m/s to 0.7 m/s. Any vessels and materials used must be rated to function and adhere to the appropriate standards and codes for expected conditions. Sea temperatures will seldom be less than about -0.4°C to 0.5°C (February). The combination of low air and sea temperature, strong winds, and high waves can lead to vessel icing. The vessel itself is also a critical factor for icing potential: the vessel size, hull design which affects amount of spray produced during sailing, and amount of vessel rigging which can act as a ‘trap’ for spray accumulation, are considerations. The risk of vessel or platform icing is greatest in the northern portion of the Study Area with potential for moderate icing or worse as high as 20% in January.

While the summer to early fall generally favours calmer seas, ceiling and visibility restrictions may be a factor for shipping or flying activities, particularly in summer. For example, in June and July poor or very poor visibility less than the 2 km can be expected from 20 to 25% of the time.

Sea ice coverage may limit access to regions of the Study Area. Depending on the year sea ice may be present from January or early February to mid-March. Icebergs, are a rare occurrence. Nevertheless, sea ice or iceberg presence, can pose a personnel safety risk, restrict or disrupt vessel activities, and has the potential to damage vessels or equipment. The risk can be further mitigated by careful review of present and forecast ice conditions prior to operations.

Depending on the nature, location and timing and duration of specific offshore activities, the potential effects of the biological environment may also be a consideration in planning and undertaking such programs. Potential effects may include, biofouling (or, the colonization of offshore structures by epibenthic communities), plankton blooms and possible interference during visual inspections of structures.

6.2 Essential Preparation

To mitigate the effects of the physical environment on any offshore activities there must be careful and adequate planning, design, and operations procedures that consider the expected normal and extreme conditions which may be encountered. In concert with this, adequate monitoring and forecasting of conditions are required.

Monitoring, forecasting and reporting of atmospheric, oceanographic and ice parameters are required for operators of oil and gas drilling exploration programs and offshore drilling installations to support the safe and prudent conduct of operations, emergency response, and spill counter-measures and to comply with the Offshore Physical Environment Guidelines (NEB et al., 2008). For marine seismic activities, weather forecasting and observation programs are prudent measures to ensure safe and efficient planning and operations of activities and to mitigate weather and sea related effects.

Good monitoring and forecasting of weather conditions enable the planning of work scopes for appropriate weather windows. They also support safe supply and crew change operations via helicopter and supply vessel. Through adequate monitoring and forecasting, project activities can be adjusted to maintain a safe working environment. The subsequent reporting establishes a sound and reliable environmental database. This in turn assists in the implementation of environmental effects monitoring programs and assessing future operational needs in the area. It also enables regulators to perform their duties relating to environmental assessment, to the review of design and operating criteria, and to the review and approval of applications and contingency plans.

Given the resources, experience and expertise available to any proponents, together with the support and oversight of the regulatory agencies, the highest standard of careful planning and preparation to avoid any significant effects are anticipated.

7 CUMULATIVE ENVIRONMENTAL EFFECTS

An integral component of environmental assessment is cumulative effects assessment. The Canadian Council of Ministers of the Environment has defined the operational concepts and processes which explain the importance of Cumulative Effects Assessment (CEA). These principles form the foundation upon which provincial, territorial and federal agencies have advanced cumulative effects assessment (see Table 7-1). However, there is a growing awareness of the complexity of issues that cause and contribute to local cumulative effects, including impacts which result from larger scale trans-geographical issues (such as Climate Change), or the common occurrence of public perception of change which is not based on documented or recorded environmental changes (Shifting Baseline Syndrome).

Table 7-1 CCME Cumulative Effects Assessment Principles

Principle	Definition
Knowledge-based	Knowledge is needed to assess the cumulative effects of activities on air, water, land and biodiversity. Effective science and monitoring systems and networks provide the information needed to measure performance and support the development of outcomes and objectives.
Outcomes and environmental objectives-based	Cumulative effects management is driven by defined outcomes or objectives for the desired quality or state of air, water, land and biodiversity now and in the future. Cumulative effects approaches recognize the economic, environmental and social (may include cultural and spiritual) implications of meeting those objectives.
Future-focused	Cumulative effects denote the combined impacts of past, present and reasonably foreseeable future human activities on the region's environmental objectives. It requires a broader, forward-looking approach to planning and management that balances environmental factors with economic and social (may include cultural and spiritual) considerations.
Place-based	Cumulative effects management is place-based or site-specific and intended to bring people and their activities together and build relationships among stakeholders to support shared stewardship within an area. Any outcomes must support and reflect the interests of the area being considered and its people.
Collaborative	Collaboration is a significant and challenging component of a cumulative effects management approach.
Adaptive	Cumulative effects management includes a shared responsibility to adapt and take corrective actions if outcomes or objectives are not being achieved.
Comprehensive	Uses both regulatory and non-regulatory approaches.

http://www.ccme.ca/en/current_priorities/cumulative_effects Draft BREA CEF Report March 2015

7.1 Natural and Anthropogenic Sources of Environmental Change

Not all of the impacts or effects of a new development are apparent at the onset, and it is now well understood that multiple natural and human activities can result in significant cumulative effects on the environment. Cumulative effects are changes to the environment that are caused by new activities in combination with other past, present and future human actions. Cumulative effects occur when there are new or additional interactions between activities, new or additional interactions between activities and the environment, and/or new or additional interactions between components of the environment. The incremental effects of new activities may be significant even though the effects of each individual activity are considered insignificant if they are assessed independently.

7.2 Cumulative Environmental Effects Analysis

Cumulative environmental effects (CEE) which may result from offshore exploration programs in the Study Area are assessed for each VEC, to the degree possible. CEE assessment at the SEA-level is constrained by the fact that the specific activities, and the spatial and temporal boundaries of these activities are not known at this stage.

7.2.1 Species of Special Status

Cumulative effects on marine species of special status can occur as a result of the combined effects of offshore oil and gas exploration activities, general marine traffic and other human activities and associated disturbances within the marine environment. Each of these may result in, for example, direct or indirect effects on species of special status, their food sources, and/or their breeding, rearing, foraging, or spawning habitats. These effects may interact with effects from other unrelated threats to marine ecosystems, such as climate change, sea level rise, marine traffic, fishing, marine pollution, to create a greater effect than would be expected from these factors on their own. Observed natural and/or anthropogenic changes in the environment of the Study Area, such as water temperature changes and associated differences in the presence, location and timing of fish species and populations in the region, may also have effects on the occurrence and distribution of Species of Special Status. As such these species tend to be less resilient to environmental changes than more common species; cumulative effects in the Study Area may be greater on Species of Special Status than on species with more secure populations.

7.2.2 Special Areas

The potential environmental effects of offshore seismic surveys and drilling programs in the Study Area may interact with each other and/or with other projects and activities in the region to result in cumulative environmental effects. Existing (and any future) protected areas in the Study Area and elsewhere will not be subject to direct effects by such activities within their boundaries, however, they could be affected by offshore oil and gas activities that may occur in adjacent areas, by way of associated visual, noise or other disturbances. This could result in hydrocarbon contamination, loss of protective and foraging habitat, and an increase in predation. Protected areas may also be subject to natural stressors, both on-going and potential.

Consideration of potential cumulative environmental effects resulting from multiple stressors affecting protected or sensitive areas would be part of the planning and decision-making regarding any future offshore oil and gas activities in the region, in order to reduce the potential for overlap and interaction between individual seismic surveys and/or drilling programs in the area and their effects, as well as the effects of these activities in combination with those of other unrelated projects and activities in the region.

7.2.3 Fisheries

Cumulative effects on marine commercial fisheries can occur as a result of the combined effects of offshore oil and gas exploration and/or production activities, general marine traffic and other human activities and associated disturbances within the marine environment. Each of these may result in, for example, direct spatial conflict with fishing activity, damage to fishing equipment, ecosystemic effects on fish resources and/or other effects on fisheries in the Study Area. Overlapping uses of marine space can result in negative cumulative environmental effects. Observed natural and/or anthropogenic changes in the environment of the Study Area, such as water temperature changes and associated differences in the presence, location and timing of fish species and populations in the region, could have an effect upon the nature and distribution of fishing activity. These effects can be more pronounced as increased coastal development, and coastal urbanization place greater demands on marine spaces.

At this time, the anticipated level and duration of exploration in the region and the likely geographical scope of potential drilling and seismic survey programs may result in only limited potential for interaction between the effects of these activities on commercial fisheries. The establishment of safety zones around drill sites is an important mitigation measure to prevent potential direct spatial conflicts, but this does not mitigate the wider cumulative effects if other marine use activities are increasing in adjacent areas. Any potential for cumulative effects will, however, depend on the eventual intensity and spatial and temporal nature of these activities. Avoiding or reducing such effect overlap can be addressed through proper planning and review individual projects and activities as they are defined and proposed, such as scheduling and distributing a seismic program to begin in an area only after a long line fleet has left that area.

The potential for interference with fishing activity by drill rigs, seismic surveying or supply vessels as well as general marine traffic to and through the Study Area can be mitigated through proper marine spatial planning, good communication between the various marine activities (such as Notices to Mariners, participation in Fisheries Advisory meetings, etc). Wherever possible, seismic surveys should to be planned to coordinate program activities with the fishing industry to reduce potential conflict with commercial fishing activity during peak fishing times. In addition, routing supply vessel traffic to avoid the more active fishing aggregations in a region is a practice generally used for activities in the marine environment, with common routes used where possible.

7.2.4 Other Marine Components, Activities and Ocean Users

Cumulative effects on other marine components, activities and ocean users can occur as a result of the combined effects of offshore oil and gas exploration activities, general marine traffic and human activities associated with other industrial operations, commercial shipping and transportation, military activities, tourism and recreation as well as the presence of subsea components such as communications cables and unexploded explosive ordnances. Any of these activities, and other uses of the marine environment including the fishery, may result in direct disturbances of one another's operations and convenient use of marine resources both in terms of geographic area and time of year.

Certain human uses of the marine environment occur year-round and these include commercial and industrial activities and related marine shipping. General marine shipping and transportation of people and goods occur year-round though schedules and routes may be seasonally affected by the presence of pack ice in the Gulf of St. Lawrence or Cabot Strait. Since the initiation of Frigate refit program, Military training exercises are conducted throughout the year. Transportation to and from Atlantic Canadian ports can also occur at any time of year. Tourism and recreation activities generally occur from May to October and often in coastal areas. To some extent, it is likely that the level of any or all activities in the marine environment, including offshore oil and gas exploration, is heightened from spring to fall when the weather is more favourable. Unexploded explosive ordnances and submarine cables exist on an ongoing basis, are generally not affected by activities that are limited to the ocean's surface but require special consideration for subsea activities.

Mitigating the effects of offshore oil and gas exploration activities on other marine components, activities and ocean users requires a process of consultation and communications to avoid any unwanted interactions, avoid damage to infrastructure and equipment, limit inconvenience to other users, ensure the safety of the general public and other commercial and industrial users and to enable other sectors (and the communities that rely upon them) to conduct their usual activities and business operations. These consultation and communications activities can occur with:

- companies (e.g., Martin Marietta Minerals, Superport Corporation, Marine Atlantic Inc.);
- user groups (e.g., harbour authorities, fish harvesters associations, recreational sailing clubs);
- industry associations (e.g., Tourism Industry of Nova Scotia, Aquaculture Association of Nova Scotia, International Cable Protection Committee);
- government departments (e.g., Canadian Coast Guard, National Defence Canada, Fisheries and Oceans Canada-Small Craft Harbours); and
- other agencies and also through groups organized to share information and address multi-sector use of the marine environment.

In addition, new resource development projects along the coast may increase marine transportation. Mitigation of potential cumulative effects will require active communication to ensure these projects can proceed with in a manner that is constructive and can avoid potential negative cumulative impacts. With an appropriate level of consultation, communication and public information, most if not all negative effects on other marine components, activities and ocean users can be avoided. In cases where these effects are unavoidable, they should be minimized through cooperation and communications.

8 INFORMATION AVAILABILITY, REQUIREMENTS, AND OPPORTUNITIES- NEED

This SEA provides an overview of the VECs in the SEA Study Area, and is based on available information. The following sections identify any important data gaps and information requirements recognized during the preparation of this report that may be relevant to planning and decision-making at the strategic (licensing) and/or project levels.

8.1 Species of Conservation Concern

Several Species at Risk are known to, or have potential to occur in the Study Area either on a seasonal or permanent basis. For some species, including marine mammals and sea turtles which are known to be at-risk, the available information is quite general in nature and only available for broad geographic regions. Detailed information on the occurrence, abundance and distribution of at-risk fish, birds, marine mammals, and sea turtles is not available for all locations or times throughout the Study Area. A lack of specific and essential information and knowledge about biological behaviour for many marine mammal, fish, turtle, and bird species on the Scotian Shelf and Laurentian Channel Slope is recognized as a problematic for management decision-making. This lack of information, along with an incomplete understanding of the specific effects of some oil and gas development activities (such as seismic surveying) on marine animals is recognized as a data gap for this SEA, as it has been for previous SEAs in eastern Canada (*e.g*. Western Newfoundland (LGL Limited 2005)).

8.2 Commercial fishing

Much of the data necessary for the Strategic Environmental Assessment regarding fishing activity in the Study Area and surrounding marine areas is available from the federal Department of Fisheries and Oceans. Additional information is available from the Nova Scotia Department of Fisheries and Aquaculture which is responsible for the management and regulation of post-harvest processing, and buyer's licensing, as well as management and monitoring of coastal aquaculture activities.

Though the data available from DFO and NSDNR are not entirely comprehensive or current due to the time lag between reporting and analysis, particularly with regard to important inshore fisheries (such as lobster), the information available provides an effective understanding of fishing activity in the area that is considered adequate and appropriate for the purposes of this SEA. It is important that this information remain available in a useful format and in a timely manner to government agencies and offshore oil and gas developers and operators. Existing fisheries data sets and other available information, supplemented by continued dialogue and information-sharing involving fishers and their representative organizations and other industry groups, provide useful information for such planning and decision-making.

8.3 Protected areas

For areas that are formally designated as protected under federal or provincial government legislation or other means, information is available regarding their location, size, and important ecological and/or socioeconomic features and value,. This is very useful during the consideration and planning, assessing and implementation stages of any future oil and gas activities in the region. Most of these areas have also been subject to considerable study and analysis both before and after their designations as Protected Areas. However, as discussed earlier, several other areas have also been identified as being of special interest or sensitivity, though are not formally protected. Information on the exact locations and physical and biological characteristics of these sites is often not as readily available.

9 SUMMARY AND CONCLUSIONS

9.1 Summary of Mitigation Measures

Sections 9.1.1 to 9.1.4 provide a summary of typical mitigation measures which are often implemented during offshore oil and gas exploration activities in the Nova Scotia Offshore Area and elsewhere to avoid or reduce potential environmental effects.

9.1.1 Seismic and Seabed Surveys, and Vertical Seismic Profiling

Geophysical surveys include 2-D and 3-D seismic surveys, seabed surveys, electromagnetic, and gravity and magnetic surveys, and vertical seismic profiles.

For practicality and summation purposes, seismic and seabed surveys and vertical seismic profiling activities have been addressed together, as the mitigation measures are similar for each activity and the CNSOPB regulates these activities under a single guidance document, the *Geophysical, Geological, Geotechnical and Environmental Program Guidelines.*

Geophysical surveys proposed for the Study Area must be completed in compliance with the *Geophysical, Geological, Geotechnical and Environmental Program Guidelines* (CNSOPB, January 2015).

Table 9-1 outlines the key mitigation measures for each applicable VEC to be taken into consideration when planning and designing a geophysical program in the Study Area.

Table 9-1 Geophysical Surveys – Mitigation Measures

Mitigation Measures
Species of Special Status • Avoidance of known species at risk and/or sensitive species and areas and/or times where possible in the planning and conduct of oil and gas activities • Adherence to the Statement of Practice • Reduction of airgun source levels in the design and implementation of offshore seismic programs to the minimum level practical for the survey • The use of a gradual "ramp-up" procedure over a minimum 20 minute period to allow mobile marine animals to move away from the area • Establishment of a safety zone around the seismic air source array (with a radius of at least 500 m), which is monitored by a qualified Marine Mammal Observer (or through Passive Acoustic Monitoring in low visibility conditions) and specific protocols regarding observation requirements and times and shut-down as required • Shut-down of seismic sound source(s) during line changes and maintenance activities • Minimizing the amount of associated vessel and aircraft traffic, and the use of existing and common travel routes where possible and the avoidance of low-level aircraft operations wherever possible • Minimizing environmental discharges and emissions from planned operations and activities, including compliance with relevant regulations and standards • The installation and use of oil water separators to treat contained deck drainage, with collected oil stored and disposed of properly • Treatment of operational discharges (such as sewage, deck drainage, bilge/cooling water, wash fluids, other waste) prior to release in compliance with the OWTG and other applicable regulations and standards • Minimizing the use of artificial lighting on offshore vessels, where possible with due regard to safety and associated operational requirements • Inspections of ship hulls and equipment for invasive species and associated follow-up maintenance • Maximizing use of local vessels and equipment to reduce the spread of invasive species • All foreign vessels operating in Canadian jurisdiction to comply with the Ballast Water Control and Management Regulations of the Canada Shipping Act (2001) during ballasting and de-ballasting activities • Appropriate handling, storage, transportation and on-shore disposal of solid and hazardous wastes • Selection and screening of chemicals under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands* • Use of turtle guards to minimize potential for turtle entanglement **Fisheries** • Planning of oil and gas activities to avoid key fishing areas / harvesting times where possible • On-going information gathering and analysis regarding fishing areas and times and continued monitoring of fishing activity • Establishment and communication of safety / no-fishing zones

Mitigation Measures
• Open, active and continuous communications and coordination procedures • Hiring Fisheries Liaison Officers (FLOs) and using Single Points of Contact • Early issuance of Notices to Mariners and other notifications / direct industry communications • Avoidance of fisheries science survey activities (areas / times) • Conducting educational and training initiatives for Project personnel • Establishment, communication and implementation of a Fishing Gear Damage or Loss Compensation Program **Special Areas** • Environmental assessment to identify protected areas and local sensitivities and schedule operations during least sensitive periods; **Other Marine Users** • Consult local authorities and other stakeholders regarding the survey program, permitting and notifications to user groups • Make adequate allowance for deviation of towed equipment when turning and remain on planned survey track to avoid inadvertent interactions • Make all towed equipment highly visible and labelled, attach active location devices to auxiliary equipment to aid location and recovery and prepare a contingency plan for lost equipment • All equipment should be stored and handled according to operator's procedures and local regulations • Report all unplanned interactions with other resource users to appropriate authorities

9.1.2 Exploration Drilling and Well Abandonment

The CNSOPB manages and regulates offshore drilling activities through the *Drilling and Production Regulations* (March 2011). The associated guidelines detail the approvals, authorizations and conditions required for drilling offshore Nova Scotia. The primary approvals are an Operations Authorization and a Well Approval. The Environmental Protection Plan and a project specific Environmental Assessment should address, at a minimum, mitigation measures as identified in Table 9-2. It is reasserted that these measures are general in nature and will be required to be updated to reflect project specific details.

Table 9-2 Exploration Drilling and Well Abandonment – Mitigation Measures

Mitigation Measures
Species of Special Status • Avoidance of known species at risk and/or sensitive species and areas and/or times where possible in the planning and conduct of oil and gas activities • Minimizing the amount of associated vessel and aircraft traffic, and the use of existing and common travel routes where possible and the avoidance of low-level aircraft operations wherever possible • Minimizing environmental discharges and emissions from planned operations and activities, including compliance with relevant regulations and standards • Pre-drilling surveys of the sea bed to assess the potential presence of sensitive benthic micro-habitats (such as corals and sponges)

Mitigation Measures
• The installation and use of oil water separators to treat contained deck drainage, with collected oil stored and disposed of properly • Treatment of operational discharges (such as sewage, deck drainage, bilge / cooling water, wash fluids other waste) prior to release in compliance with the Offshore Waste Treatment Guidelines and other applicable regulations and standards • Minimizing the use of artificial lighting on offshore vessels and installation, where possible with due regard to safety and associated operational requirements • Programs and protocols for the collection and release of marine birds that become stranded on offshore installations, including associated regulatory guidance and permit requirements • Inspections of ship hulls, drilling rigs and equipment for invasive species and associated follow-up maintenance. Maximizing use of local vessels, drill rigs and equipment to reduce the spread of invasive species • All foreign vessels operating in Canadian jurisdiction to comply with the Ballast Water Control and Management Regulations of the Canada Shipping Act (2001) during ballasting and de-ballasting activities; • Avoiding or minimizing flaring, and the use of high efficiency burners • Appropriate handling, storage, transportation and on-shore disposal of solid and hazardous wastes; • Water contaminated with hydrocarbons generated during flow testing (within certain tolerances), can be atomized in the flare (using high efficiency burners) or shipped on-shore for disposal • Selection and screening of chemicals under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands* • Selection of non-toxic drilling fluids, including the use of WBMs wherever possible and technically feasible • The use of mechanical procedures during well completion and abandonment activities where possible, including the proactive design of well structures to facilitate this • Should blasting be required (such as in well abandonment), appropriate scheduling of these activities to avoid sensitive times, as well as setting of charges below the sediment surface, minimizing the amount of explosives utilized the use of high velocity explosives and staggering of individual blasts **Fisheries** • Planning of oil and gas activities to avoid key fishing areas / harvesting times where possible • On-going information gathering and analysis regarding fishing areas and times and continued monitoring of fishing activity • Establishment and communication of safety / no-fishing zones • Sequential approach to drilling multiple wells in an area • Open, active and continuous communications and coordination procedures • Hiring Fisheries Liaison Officers (FLOs) and using Single Points of Contact • Early issuance of Notices to Mariners and other notifications / direct industry communications • Avoidance of fisheries science survey activities (areas / times) • Conducting educational and training initiatives for Project personnel • Establishment, communication and implementation of a Fishing Gear Damage or Loss Compensation Program **Special Areas** • Environmental assessment to identify protected areas and local sensitivities and schedule operations during least sensitive periods • Select the least sensitive location within the confines of the bottom target / drilling envelope

Mitigation Measures
• Consider directional drilling to access targets beneath sensitive areas • Consider cluster drilling to limit the extents of drilling sites • In coastal areas, select equipment (e.g. vessel instead of helicopter) based on particular sensitivities of wildlife populations or habitats **Other Marine Users** • Consult with local authorities regarding site selection and support infrastructure and activities including ports, vessel traffic and airport traffic • In coastal areas, select sites and equipment to minimize disturbance, noise, light and visual intrusion • During drilling program, maintain communications with local authorities regarding notifications to other resource users and to meet the requirements established in the project planning process including operations of supply vessels • When decommissioning an exploratory well, it is recommended that operators remove all debris from the seabed and decommission support facilities to meet planning requirements

9.1.3 Vessel and Helicopter Traffic

Supply vessels and helicopters that are used to transport personnel, equipment and materials to and from a drilling rig during an offshore drilling program, seismic vessels, and stand-by vessels all have the potential to effect VECs. The CNSOPB's *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* include various requirements and mitigation measures which are intended to avoid or reduce the potential for interactions with marine species and habitats, commercial fisheries and other ocean users.

Table 9-3 outlines the key mitigation measures for each applicable VEC to be taken into consideration when planning oil and gas exploration activities in the Study Area.

Table 9-3 Vessel and Helicopter Traffic – Mitigation Measures

Mitigation Measures
Species of Special Status • Avoidance of known species at risk and/or sensitive species and areas and/or times where possible in the planning and conduct of oil and gas activities • Minimizing the amount of associated vessel and aircraft traffic, and the use of existing and common travel routes where possible and the avoidance of low-level aircraft operations wherever possible • Minimizing environmental discharges and emissions from planned operations and activities, including compliance with relevant regulations and standards • The installation and use of oil water separators to treat contained deck drainage, with collected oil stored and disposed of properly • Treatment of operational discharges (such as sewage, deck drainage, bilge / cooling water, wash fluids, other waste) prior to release in compliance with the Offshore Waste Treatment Guidelines and other applicable

Mitigation Measures
regulations and standards • Minimizing the use of artificial lighting on offshore vessels where possible with due regard to safety and associated operational requirements • Programs and protocols for the collection and release of marine birds that become stranded including associated regulatory guidance and permit requirements • Inspections of ship hulls and equipment for invasive species and associated follow-up maintenance. Maximizing use of local vessels and equipment to reduce the spread of invasive species • All foreign vessels operating in Canadian jurisdiction to comply with the Ballast Water Control and Management Regulations of the Canada Shipping Act (2001) during ballasting and de-ballasting activities • Appropriate handling, storage, transportation and on-shore disposal of solid and hazardous wastes • Selection and screening of chemicals under *the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands* **Fisheries** • Planning of oil and gas activities to avoid key fishing areas / harvesting times where possible • On-going information gathering and analysis regarding fishing areas and times and continued monitoring of fishing activity • Open, active and continuous communications and coordination procedures • Hiring Fisheries Liaison Officers (FLOs) and using Single Points of Contact • Early issuance of Notices to Mariners and other notifications / direct industry communications • Conducting educational and training initiatives for Project personnel • Establishment, communication and implementation of a Fishing Gear Damage or Loss Compensation Program **Special Areas** • Environmental assessment to identify protected areas and local sensitivities and schedule operations during least sensitive periods • In coastal areas, select equipment (e.g. vessel instead of helicopter) based on particular sensitivities of wildlife populations or habitats **Other Marine Users** • Consult with local authorities regarding site selection and support infrastructure and activities including ports, vessel traffic and airport traffic • In coastal areas, select sites and equipment to minimize disturbance, noise, light and visual intrusion • Maintain communications with local authorities regarding notifications to other resource users and to meet the requirements established in the project planning process including operations of supply vessels

9.1.4 Accidental Spills

Inherent in the nature of oil and gas activities is the risk of releases of hydrocarbons to the surrounding environment. Given Nova Scotia's, in particular Cape Breton's, reliance on the marine environment for livelihood (fisheries), recreation and tourism, accidental oil spills take on a special significance. The CNSOPB requires the preparation and submission of Environmental Protection Plans (EPP) for offshore drilling activities; the EPP includes identification of potential environmental emergencies and hazards and the appropriate emergency response plan and spill response plan that would be implemented in such situations.

Additionally, to address the potential devastating effects on the economy should a significant spill occur, the CNSOPB has implemented a guideline to identify compensation sources, *Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity* (March 2002). Specifically, the guidelines are intended to:

a. describe the various compensation sources available to potential claimants for loss or damage related to petroleum activity offshore Nova Scotia; and
b. outline the regulatory and administrative roles which the Board exercises respecting compensation payments for actual loss or damage directly attributable to offshore operators. (CNSOPB, Compensation Guidelines, March 2002)

Table 9-4 lists the general mitigation measures that, at a minimum, should be considered when planning offshore exploration activities.

Table 9-4 Accidental Spills – Mitigation Measures

Mitigation Measures
Species of Special Status • Appropriate handling, storage, transportation and on-shore disposal of solid and hazardous wastes • Selection and screening of chemicals under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands* • Spill prevention plans and procedures, with associated and effective spill preparedness and response plans in place
Fisheries • On-going information gathering and analysis regarding fishing areas and times and continued monitoring of fishing activity • Open, active and continuous communications and coordination procedures • Hiring Fisheries Liaison Officers (FLOs) and using Single Points of Contact • Early issuance of Notices to Mariners and other notifications / direct industry communications • Open, active and continuous communications and coordination procedures
Special Areas • Environmental assessment to identify protected areas and local sensitivities and schedule operations during least sensitive periods

9.2 Conclusions

In Nova Scotia, the environmental planning process, which includes environmental assessment, project specific environmental management plans, regulatory permitting and compliance programs, can be used to develop detailed guidance on measures to prevent or minimize adverse effects. Consultation, inspections and audits, and communications programs establish compliance and monitoring regimes to ensure regulatory requirements are met. Through planning, consultation, issues management, negotiation and accommodation, most adverse aspects of oil and gas exploration activities can be avoided, mitigated or influenced for the good of the environment and other resource users as well as the oil and gas exploration project.

A summary of the specific planning considerations for each of the VECs assessed in the SEA is provided in Sections 9.2.1 to 9.2.4.

9.2.1 Species at Risk

A number of fish species that are designated as being at risk (and which are formally protected) under the Canadian Species at Risk Act (SARA) and/or the Nova Scotia Endangered Species Act (NS ESA) are known or likely to occur in the Study Area, including several species of wolfish as well as the white shark.

Several other species in the Study Area have also been evaluated and designated by COSEWIC, but are not currently protected under SARA. In many cases, these species occur in expected habitat zones during some seasons and/or have somewhat predictable migrations. For example, significant aggregations of a given Atlantic salmon population can occur near natal estuaries when smolt leave rivers for marine migrations (spring) and as adults return for spawning migrations (summer). Various other COSEWIC-listed species aggregate for migration and spawning (e.g. Atlantic cod) or are restricted to limited areas.

9.2.2 Fisheries

Based on the available information regarding marine fisheries in the Study Area and adjacent regions, consideration should be given to particular fishing activities, areas and times to help avoid or reduce potential interactions between the oil and gas and fishing sectors within the Study Area.

A variety of commercial fisheries occur within and throughout the Study Area and adjacent regions throughout the year, and the region is characterized by a complex spatial and temporal pattern of fishing activity. The overall fishing effort is widely distributed throughout the Study Area, depending on the specific harvesting season, there is a shift of predominant fishing effort between regions (offshore fishery near Laurentian Channel to inshore coastal fishery). Of particular significance is the areas along the south eastern portion of the Study Area (Orpheus Graben) where there is considerable effort in the snow crab and shrimp industries, and the general inshore areas where the lobster fishery occurs. These high value commercial fisheries contribute significantly to employment and income amongst the regions fishing communities.

On-going communication between offshore oil and gas operators and the fishing industry has been and remains the most effective means for ensuring that such activities are carried out in a manner to avoid or reduce adverse interactions between the oil and gas and fishing sectors. Notices to Mariners and other communications, the use of FLOs, the CNSOPB's Fisheries Advisory Committee have been particularly useful in creating and maintaining open and on-going dialogue between the two industries, and in fostering a proactive and cooperative approach to identifying and addressing any issues or concerns.

9.2.3 Special Areas

A number of protected and sensitive areas are present in or adjacent to the Study Area, these include: coastal and offshore ecologically and biologically significant areas; marine protected areas of interest (e.g. St. Ann's Bank and the Laurentian Channel); Nova Scotia provincial parks, Cape Breton Highlands National Park, wilderness areas and pending nature reserves; and international bird areas.

In Nova Scotia, operators of oil and gas activities are required to meet particular regulatory requirements including legislation, regulations, guidelines and policies. The CNSOPB's resource conservation approach is designed to ensure that operators are committed to resource conservation, to audit activity authorization applications from a resource conservation perspective and to perform necessary studies and surveillance to develop and support independent understanding of marine resources (Lee et al. 2011).

9.2.4 Other Ocean Users

Aside from the fishing industry, various human activities occur within the marine and coastal environment of the Study Area. These include tourism and recreation, shipping and transportation movements and military exercises that may interact with seismic surveys and other vessel movements. The Study Area also includes unexploded explosive ordnances and marine communications cables, which may require special attention, particularly when planning exploratory drilling programs.

In conclusion, there is opportunity to introduce new resource activity into the regional environment and economy of Nova Scotia. However, as is the case in all regions, full consideration must be given to minimizing the potential effects and optimizing the benefits of oil and gas exploration activities to Nova Scotia. As a result, attention must be given to an array of mitigation activities and measures, many of which are well established and proven effective offshore Nova Scotia and in other jurisdictions. In light of the longstanding involvement of local industries in the marine environment and the recognized ecological significance of some of the marine and coastal environments in the Study Area, consideration should be given to enhanced mitigation measures. These could include buffer zones around designated Special Areas and important fishing areas, and the introduction of seasonality into exploration activities to minimize spatial conflicts. It is understood that local engagement will be required to facilitate mitigation, and to ensure mutual benefits of any new project are accrued.

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