# ENVIRONMENTAL IMPACT STATEMENT OF THE PLACENTIA BAY ATLANTIC SALMON AQUACULTURE PROJECT

Prepared for

GRIEG NL

Prepared by

LGL LIMITED
environmental research associates

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# ENVIRONMENTAL IMPACT STATEMENT OF THE PLACENTIA BAY ATLANTIC SALMON AQUACULTURE PROJECT

**Volume 1 of 3**

Prepared for

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# Acronyms and Abbreviations

| | |
|---|---|
| ~ | Approximately |
| % | Percent |
| AAR | Aquaculture Activities Regulations |
| ABE | Adult Basic Education |
| AESL | Department of Advanced Education, Skills and Labour |
| AGD | Amoebic Gill Disease |
| AIS | Automatic Identification System |
| AMG | AquaMaof Group |
| ASIST | Applied Suicide Intervention Skills Training |
| ASF | Atlantic Salmon Federation |
| asl | Above sea level |
| ATK | Aboriginal Traditional Knowledge |
| ATV | All-Terrain Vehicle |
| BAP | Best Aquaculture Practices |
| BC | British Columbia |
| BKD | Bacterial Kidney Disease |
| BMA | Bay Management Area |
| BOD | Biochemical Oxygen Demand |
| BP | Burin Peninsula |
| BPJC | Burin Peninsula Joint Council |
| BPCC | Burin Peninsula Chamber of Commerce |
| BPWMC | Burin Peninsula Waste Management Corporation |
| CASD | Centre for Aquaculture and Seafood Development |
| CBD | Convention on Biological Diversity |
| CBDC | Community Business Development Corporation |
| CBED | Community Based Education Delivery |
| CCG | Canadian Coast Guard |
| CCMEWQ | Canadian Council of Ministers of Environment Water Quality |
| CCRI | Community-Based Coastal Resource Inventory |
| CCTV | Closed-circuit Television |
| CDWQ | Canada Drinking Water Quality |
| CEAA | Canadian Environmental Assessment Agency |
| CFER | Centre for Fisheries Ecosystems Research |
| CFI | Canada Fluorspar Inc. |
| CFIA | Canada Food Inspection Agency |
| CHS | Canadian Hydrographic Service |
| CISM | Critical Incident Stress Management |
| CMA | Coastal Management Area |
| CMS | Centre for Marine Simulation |
| CMT | Crises Management Team |
| CNA | College of the North Atlantic |
| COC | Code of Containment |
| COSEWIC | Committee on the Status of Endangered Wildlife in Canada |
| CPUE | Catch per Unit Effort |
| CRHP | Canadian Register of Historic Places |
| CSAR | Centre for Sustainable Aquatic Resources |
| CSAS | Canadian Science Advisory Secretariat |
| CSSD | Department of Children, Seniors and Social Development |
| CT Scanning | Computerized Tomography Scanning |
| CTec | Centre for Applied Ocean Technology |
| CV | Coefficient of Variation |
| CWS | Canadian Wildlife Service |

| | |
|---|---|
| DFLR/DFA | Department of Fisheries and Land Resources formerly Department of Fisheries and Aquaculture |
| DFO | Department of Fisheries and Oceans Canada |
| DNS | Denitrification System |
| DO | Dissolved Oxygen |
| DSC | Digital Selective Calling |
| DU4 | Designatable Unit 4 |
| EA | Environmental Assessment |
| EAC | Environmental Assessment Committee |
| EBITDA | Earnings Before Interest, Taxes, Depreciation and Amortization |
| EBSA | Ecologically and Biologically Significant Area |
| ECCC-CWS | Environment and Climate Change Canada-Canadian Wildlife Service |
| EDMO | Eastern Destination Marketing Organization |
| EEM | Environmental Effects Monitoring |
| EEMP | Environmental Effects Monitoring and Follow-up Program |
| EFCR | Economic Feed Conversion Ratio |
| EHA | Eastern Health Authority |
| EHJV | Eastern Habitat Joint Venture |
| EI | Employment Insurance |
| EIS | Environmental Impact Statement |
| ekW | Electrical kilowatt |
| EOC | Emergency Operations Center |
| *EPA* | *Environmental Protection Act* |
| EPIRB | Emergency Position Indicating Radio Beacon |
| EPP | Environmental Protection Plan |
| ERM | Enteric Red Mouth Disease |
| ERP | Emergency Response Plan |
| ERT | Emergency Response Team |
| *ESA* | *Endangered Species Act* |
| ETA | Estimated Time of Arrival |
| EU | European Union |
| FCR | Feed Conversion Ratio |
| FFAW | Fish, Food and Allied Workers |
| FHF | Norwegian Seafood Research Fund |
| FRP | Fibreglass Reinforced Polymer |
| FSC | Food, Social or Ceremonial |
| FTE | Full-Time Equivalent |
| g | gram |
| GDP | Gross Domestic Product |
| GIS | Geographic Information System |
| GM | Genetically Modified |
| GS | Genomic Selection |
| GSC | Geologic Survey of Canada |
| GSI | Global Salmon Initiative |
| GSSP | Global Boundary Stratotype Section and Point |
| GWE | Gutted Weight |
| HAB | Harmful Algal Bloom |
| HADD | Harmful Alterations, Disruption or Destruction Prohibition |
| HDPE | High-density Polyethylene |
| HFA | Herring Fishing Area |
| HFNL | Heritage Foundation of Newfoundland and Labrador |
| HRTA | Heritage Run Tourism Association |
| HSMBC | Historic Site and Monuments Board of Canada |
| Hz | Hertz |
| IBC | Intermediate Bulk Container |
| IC | Independent Core |

| | |
|---|---|
| ICSP | Integrated Community Sustainability Plan |
| ID | Identification |
| IMTT | International-Matex Tank Terminals |
| IOC | Intergovernmental Oceanographic Commission |
| IPN | Infectious Pancreatic Necrosis |
| IPNV | Infectious Pancreatic Necrosis Virus |
| ISA | Infectious Salmon Anemia |
| ISAV | Infectious Salmon Anemia Virus |
| IWC | International Whaling Commission |
| K+ | Potassium |
| kg | Kilogram |
| km/h | Kilometers per hour |
| kVA | Kilo-volt-ampere |
| kW | Kilowatt |
| L | Litre |
| L/m | Litres per Minute |
| LEED | Leadership in Energy and Environmental Design |
| LEK | Local Ecological Knowledge |
| LFA | Lobster Fishing Area |
| LHPP | Long Harbour Processing Plant |
| LOA | Length Overall |
| LOMA | Large Ocean Management Area |
| m | Meter |
| MAE | Newfoundland and Labrador Department of Municipal Affairs and Environment |
| MAMKA | Mi'kmaq Alsumk Mowimsikik Koqoey Association |
| MARPOL | Marine Pollution |
| *MBCA* | *Migratory Birds Convention Act* |
| MCP | Medical Care Plan |
| MCTS | Marine Communications and Traffic Services |
| MFN | Miawpukek First Nation |
| mg/L | Milligrams per Litre |
| MI | Marine Institute |
| min | Minute |
| mm | Millimetre |
| MMSI | Maritime Mobile Service Identity |
| MOU | Memorandum of Understanding |
| MPA | Marine Protected Area |
| MSDS | Material Safety Data Sheets |
| MT | Metric Tonnes |
| MUN | Memorial University or Newfoundland |
| MUNFLA | Memorial University of Newfoundland Folklore and Language Archive |
| MV | Motor Vessel |
| NA+ | Sodium |
| NAAHP | National Aquatic Animal Health Program |
| NAFO | Northwest Atlantic Fisheries Organization |
| NAIA | Newfoundland Aquaculture Industry Association |
| NAICS | North American Industrial Classification System |
| NAPS | National Air Pollution Surveillance Program |
| NASCO | North Atlantic Conservation Organization |
| NEFSC | Northeast Fisheries Service Centre |
| NGO | Non-government Organizations |
| NHS | National Historic Site |
| NIR | Near Infrared |
| NL | Newfoundland |
| NL-CAR | Newfoundland and Labrador Coalition for Aquaculture Reform |

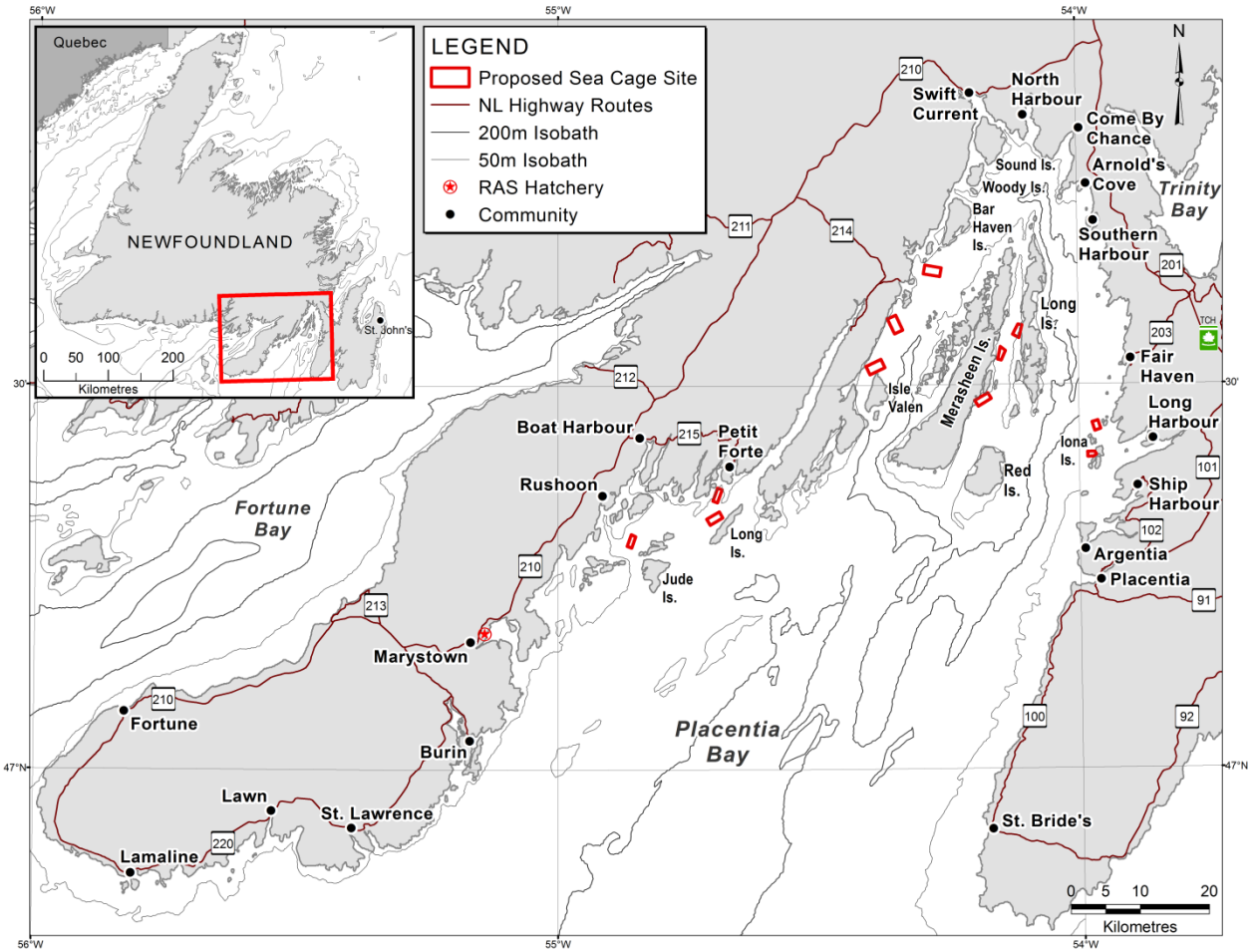
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|---|---|
| NLESD | Newfoundland and Labrador English School District |
| NLFIN | Newfoundland and Labrador Fisheries Information Network |
| NLHC | Newfoundland and Labrador Housing Corporation |
| NLRC | Newfoundland and Labrador Refining Corporation |
| nm | Nautical Miles |
| NMCA | National Marine Conservation Area |
| NOAA | National Oceanic and Atmospheric Administration |
| NOK | Norwegian Krone |
| NRS | Norway Royal Salmon |
| NS9415.E:2009 | Norwegian Standard 9415. Edit 2009 |
| NTU | Nephelometric Turbidity Units |
| *NWPA* | *Navigable Water Protection Act* |
| $O_2$ | Oxygen |
| OBIS | Ocean Biogeographic Information System |
| OCI | Ocean Choice International |
| OH & S | Occupational Health and Safety |
| OIE | World Organisation for Animal Health |
| OSC | Ocean Science Center |
| OSSC | Offshore Safety and Survival Centre |
| PAO | Provincial Archaeology Office |
| PB/GB | Placentia Bay/Grand Banks |
| PBIMPC | Placentia Bay Integrated Management Planning Committee |
| PD | Pancreas Disease |
| PDV | Pancreas Disease Virus |
| PFHCB | Professional Fish Harvesters Certification Board |
| pH | Potential Hydrogen – a measure of acidity or alkalinity of water soluble substances. |
| PIT | Passive Integrated Transponder |
| PLB | Personal Locator Beacon |
| ppm | parts per million |
| PRV | Piscine Virus |
| PSP | Paralytic Shellfish Poisoning |
| PWDA | Placentia West Development Association |
| QMP | Quality Management Program |
| QTL | Quantitative Trait Loci |
| R&D | Research and Development |
| RAS | Recirculating Aquaculture System |
| RCSMMP | Research Centre for the Study of Music, Media and Place |
| RMAF | Resource Management and Aboriginal Fisheries |
| RO | Response Organization |
| ROV | Remotely Operated Vehicle |
| rpm | Revolutions per minute |
| RV | Research Vessel |
| SAM | Stewardship Association of Municipalities |
| *SARA* | *Species At Risk Act* |
| SAV | Salmonid Alphavirus |
| SCUBA | Self-contained Underwater Breathing Apparatus |
| SDG | Sustainable Development Goals |
| SEA | Strategic Environmental Assessment |
| SeaWiFS | Sea-viewing, Wide-Field-of-View Sensor Spacecraft |
| SEFSC | Southeast Fisheries Service Centre |
| SERT | Safety and Emergency Response Training Centre |
| SFA 10 | Salmon Fishing Area 10 |
| SI | System International |
| SMB-PB | St. Mary's Bay-Placentia Bay |
| SNP | Single Nucleotide Polymorphism |

| | |
|---|---|
| SOP | Standard Operating Procedures |
| SPM | Saint Pierre et Miquelon |
| SRS | Self-recruiting Species |
| SSAC | Species Status Advisory Committee |
| SSC | Species Specialist Sub-Committee |
| t/m | Tonne per metre |
| TAC | Total Allowable Catch |
| TC | Transport Canada |
| TCII | Department of Tourism, Culture, Industry and Innovation |
| TDVAA | Tourism Destination Visitor Appeal Assessment |
| TMS/MS-222 | Tricaine Mesylate |
| TNASS | Trans North Atlantic Sightings Survey |
| UA | Unit Area |
| UK | United Kingdom |
| UN | United Nations |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| US | United Stated |
| USM | Unsuitable Material |
| USS | United States Ship |
| UV | Ultraviolet |
| V | Volt |
| VEC | Valued Environmental Component |
| VTS | Vessel Traffic Services |
| VTSS | Vessel Traffic Separation Scheme |
| WEP | Women's Employment Plan |
| *WER* | *Wilderness and Ecological Reserves Act* |
| WHMIS | Workplace Hazardous Materials Information System |
| WHSCC | Workplace Health, Safety and Compensation Commission |
| WISE NL | Women in Science and Engineering Newfoundland and Labrador |
| WRDC | Women in Resource Development Corporation |
| YMCA | Young Men's Christian Association |
| 2n | Diploid |
| 3n | Triploid |

# Executive Summary

## Introduction

The Proponent, Grieg NL Nurseries Ltd. and Grieg NL Seafarms Ltd. (referred to as Grieg NL), proposes to build and operate a land-based Recirculating Aquaculture System (RAS) Hatchery for Atlantic salmon (*Salmo salar*) in the Marystown Marine Industrial Park, and marine-based farms in Placentia Bay (see map below). Grieg NL is required through the provincial environmental assessment process to prepare an Environmental Impact Statement (EIS) for the proposed Placentia Bay Atlantic Salmon Aquaculture Project.




**Location of the proposed land-based RAS Hatchery and marine-based sea cage sites for the Placentia Bay Atlantic Salmon Aquaculture Project.**

This three-volume document was prepared pursuant to the Newfoundland and Labrador *Environmental Protection Act* and is in compliance with the EIS Guidelines issued by the Newfoundland and Labrador Department of Municipal Affairs and Environment (DMAE) on 8 March 2018. These EIS Guidelines were prepared by representatives from the DMAE, Department of Fisheries and Land Resources (DFLR), Fisheries and Oceans Canada (DFO), and other government agencies; comments from the interested

public were also considered. The purpose of the EIS is to identify and assess the significance of biophysical and socio-economic effects of the Project taking into consideration mitigation measures. A key aspect of the EIS involved consultation with the public and addressing public concerns.

Grieg NL is a private company registered in Newfoundland and Labrador and based in Marystown. The company is proposing best available technology at both its RAS Hatchery and sea cage sites. Grieg NL proposes to use a number of mitigation measures that go beyond the common aquaculture industry standard. These measures include such approaches as the utilization of sterile triploid all-female Atlantic salmon to minimize potential effects on wild salmon, the use of lumpfish (*Cyclopterus lumpus*) to control sea lice, and fallowing protocols that exceed government requirements.

The EIS submission is composed of three Volumes:

Volume 1 is the main body of the EIS and includes this Executive Summary, the description of the Project, a description of the existing biophysical and socio-economic environment in Placentia Bay, the effects assessment, details on public consultation, mitigation measures, and follow-up monitoring.

Volume 2 contains supporting appendices for the EIS including the Waste Management, Spill Management, and Emergency Response plans.

Volume 3 contains the four Component Studies required by the EIS Guidelines. These studies are considered stand-alone documents.

## The Proponent

The Proponent is Grieg NL Nurseries Ltd. and Grieg NL Seafarms Ltd. These companies are owned by Grieg NL Salmon Ltd. (hereafter referred to as Grieg NL), a private company registered in Newfoundland and Labrador and based in Marystown. Grieg NL is 80% owned by the Norwegian based Grieg Group and 20% owned by the Newfoundland based Ocean Choice International (OCI).

Grieg NL's Chief Executive Officer is Mr. Knut Skeidsvoll who is based at the company's office in Marystown. The principle contact person for the EIS is Mr. Perry Power.

**Chief Executive Officer:**

| | |
|---|---|
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| | |
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# The Project

Grieg NL's proposed Placentia Bay Atlantic Salmon Aquaculture Project has two primary components: (1) a land-based RAS Hatchery located in the Marystown Marine Industrial Park, and (2) 11 sea cage sites located in the northern portion of Placentia Bay. A phased-approach will be used to ramp-up production of salmon. Grieg NL is proposing to construct, operate, and decommission the Project in an environmentally sound and sustainable manner, which meets and/or exceeds federal and provincial regulatory requirements.

## Rationale

Recognizing the growing demand for farmed salmon, Grieg NL was invited by the Government of Newfoundland and Labrador to investigate salmon farming opportunities in the Province. A key aspect of Grieg NL's investigation into potential opportunities involved consulting with local stakeholders with focus on the Burin Peninsula. It was determined that Placentia Bay offers an excellent marine setting, a suitable and strategically located site to construct a facility for raising Atlantic salmon smolt, and an available work force to undertake a successful salmon farming project. These factors, combined with state-of-the-art aquaculture technology and industry best practices planned by Grieg NL, will allow salmon to be farmed in an environmentally and financially sustainable manner. In addition, the proximity to the North American markets has positively factored into Grieg NL's decision to undertake the Project.

## Alternatives

The EIS is required to conduct a comparative analysis of alternative methods of carrying out the Project and alternatives to the Project. Grieg NL identified one alternative to the Project and three primary alternatives within the Project. Five key criteria were used in the analysis: environmental effects, technical feasibility, economic feasibility, market access, and regulatory regime.

Realistically, the only alternative to the Project is 'No Project' and this would mean that Grieg NL would not proceed with constructing the hatchery and sea cages. Grieg NL does not consider the 'No Project' alternative to be viable given that the company's goal is to provide high quality product to the North American market.

The three scenarios identified as alternatives within the Project include:

- *Alternative 1, West Coast Project*: represents a re-location of the proposed Project to an alternate location in Newfoundland. Based on a preliminary evaluation conducted by Grieg NL, the most likely alternate location is the west coast in the Bay St. George and Codroy Valley area, rather than in Marystown and Placentia Bay.

- *Alternative 2, Total 'On-Land" Project*: represents an absence of any use of the marine environment for rearing salmon. All growth of fish up to market size would be in tanks on land and utilizing new and emerging technologies.

- *Alternative 3, Conventional Technology Project*: represents the proposed undertaking employing conventional technologies currently employed in Newfoundland (i.e., diploid (non-sterile) eggs; conventional sea cages; two year at-sea rearing cycle).

Based on the comparative analysis, the proposed Project was selected over the three alternatives within the Project with respect to technical, economic and market feasibility, and compares well with respect to environmental considerations.

**Project Principles**

Grieg NL has incorporated several key Project Principles in the design and operational practices intended for the Placentia Bay Atlantic Salmon Aquaculture Project:

***Sustainability.***—Grieg NL is committed to sustainable aquaculture. As part of the Grieg Group of Companies, Grieg NL will follow the principles of Grieg Seafood, which has identified key priority areas for sustainable aquaculture, all of which play a role in the planning and implementation of the Project. Key priorities include food safety and quality, fish health, minimizing effects on the environment, transparency and ongoing stakeholder engagement, maximizing local employment and benefits, and employee health, safety and working environment.

***Best Available Technology and Operational Practices.***—Grieg NL will use state-of-the-art technology at both its RAS Hatchery and sea cage sites. Grieg NL is also committed to acquiring accreditation and implementing Best Aquaculture Practices (BAP) through an international and proven third-party aquaculture certification program. BAP guidelines and procedures are designed to minimize effects on the environment and maximize socio-economic opportunities. Grieg NL will ensure that project activities are conducted in full compliance with all applicable environmental, health and safety laws and regulations, by applying best available technologies and highest standards.

***Precautionary Principle***.—Grieg NL proposes to use a number of mitigation measures that go beyond the common industry standard. These mitigations are described in detail in the EIS and include such approaches as the utilization of sterile triploid all-female Atlantic salmon to minimize effects on wild salmon, the use of lumpfish to control sea lice, and fallowing protocols that exceed government requirements. Grieg NL has included consideration of the effects of climate change in choosing a design for sea cages, such as potential storms of increased frequency and severity. Grieg NL is committed to the development and implementation of an Environmental Protection Plan (EPP), to help ensure a high level of environmental protection throughout the Project.

***Community Engagement and Participation.***—Grieg NL considers community engagement and participation to be integral to sustainability. To this end, Grieg NL has led an active program of information and discussion about the proposed Project through a variety of forums and media since the start of project feasibility studies in 2015. Grieg NL has consistently encouraged area residents and businesses to consider opportunities with the proposed Project and is in ongoing communication with relevant regional economic development groups.

## Project Overview

The Placentia Bay Atlantic Salmon Aquaculture Project has two primary components: (1) a land-based Recirculating Aquaculture System (RAS) Hatchery located in the Marystown Marine Industrial Park and (2) sea cage sites located in the northern portion of Placentia Bay that will be used to grow the salmon to market size. The development of the Project, including Construction and Operations/Maintenance of the RAS Hatchery and sea farms, will undergo a phased approach before reaching peak production of seven million salmon per year. It is anticipated that the RAS Hatchery will be operational in Year 2 and reach

full production capacity in Year 6. The first harvest at peak production at the sea farms is anticipated to occur in Year 8.

At the RAS Hatchery, smolt will be grown to sizes ranging from 350–1,400 g and then will be transferred to a well boat and delivered directly to sea cage sites. Eleven sea cage sites will be located within four Bay Management Areas (BMAs), which have been established for biosecurity purposes. Three of the BMAs are planned for semi-annual production and one BMA is planned for seasonal production. The semi-annual and seasonal sea cage sites will each have a maximum of 12 and 6 sea cages, respectively. Each of these sea cages can hold 160,000 salmon. At peak production, there will be seven active sea cage sites with 78 sea cages in operation per year. Each year, the sea cage sites in one BMA will be fallowed before the sea cages will be restocked with salmon.

Each sea cage site will be attended by several vessels including a feed/accommodation barge, satellite feed barge, service vessel, crew vessel, and a work boat. Once salmon have reached market size (~5 kg) they will be transferred to a dead hold vessel and then onto a third-party for processing.

Personnel working at the sea cage sites will be transported via dedicated crew vessels. Grieg NL anticipates one-week shifts at sea where personnel will live aboard the feed/accommodation barge. The crew change sites will have specific areas for embarkation to and disembarkation from the proposed sea cage sites, which is designed to avoid cross-contamination. Crew changes for the proposed sea cage sites in the Rushoon, Merasheen and Red Island BMAs will be conducted in Petit Forte and in Long Harbour for the Long Harbour BMA.

Services and supplies for all BMAs will be provided using wharf facilities at two former OCI premises, one each in Marystown and Burin. One of the resupply sites will be designated “inflow” and the other “outflow” to prevent cross-contamination of clean/new equipment going to the sea cage sites and used equipment returning for cleaning and servicing. Additionally, the resupply site designated as outflow will receive waste from the sea cage sites.

## RAS Hatchery

The RAS Hatchery consists of three primary biosecure facilities (i.e., First-Feeding, Smoltification, and Post-Smolt) that have a total area of 30,000 $m^2$. The site for the RAS Hatchery in the Marystown Marine Industrial Park was cleared in 2016 and 2017. The Recirculating Aquaculture System (RAS) that will be used at the hatchery is considered state-of-the-art and operates by filtering water from the fish tanks so it can be reused. The system uses 300 L of water per minute versus the 500,000 L of water per minute, which is typical in a flow-through system that is not reusing any water to accomplish an equivalent production of smolt.

### Sea Cage Sites

The proposed sea cage sites (see maps) have areas ranging from 0.8 $km^2$ to 3.2 $km^2$ and occur in water depths ranging from ~10 m to 308 m. Sites have been selected based on suitable water currents and depths, bottom type, shelter from wind and waves, and input from local users and regulatory agencies. Semi-annual and seasonal sea cage sites will have 12 or 6 sea cages, respectively; sea cages will be arranged in a line with a feed barge located between the cages. The sea cages and associated mooring system used to house fish will be state-of-the-art, heavy duty Aqualine Midgard Systems. Each sea cage is 50 m in diameter, extends 45 m below the surface, and will consist of a cage net, floating collar, gangway, sinker ring (tube), winches, and fish mortality removal system. Additionally, for mitigation purposes, all

sea cages will be equipped with anti-bird netting and will be attended by a Remotely Operated Vehicle (ROV) and operator as well as camera monitoring above and below the water surface.

# Effects Assessment Methodology

## Approach

The effects assessment followed well-established methods, consistent with those of the Canadian Environmental Assessment Agency (CEAA) and the requirements of the EIS Guidelines.

The key steps in conducting the effects assessment included:

- Developing a detailed project description;
- Defining the geographic and temporal scope of the Project;
- Consulting with the public, government agencies, and subject matter experts;
- Incorporating field data for the proposed sea cage sites;
- Identifying and defining the Valued Environmental Components (VECs) against which the potential effects of the Project are evaluated;
- Characterizing and evaluating potential environmental effects on VECs;
- Evaluating the nature and risk of potential accidental events;
- Developing mitigation measures, monitoring tools, and reporting procedures;
- Identifying data gaps and evaluating the influence of these gaps on confidence in effects predictions;
- Determining the nature and significance of any residual effects;
- Determining potential cumulative effects; and
- Proposing follow-up monitoring to confirm the accuracy of the EIS.

Two general types of effects are considered as per the EIS Guidelines:

1. Effects of the environment on the Project; and
2. Effects of the Project on the environment, including the biophysical and human environments.

Four biophysical VECs and two socio-economic VECs have been selected to focus the assessment:

- Fish and Fish Habitat;
- Wild Atlantic Salmon;
- Species at Risk;
- Sensitive Areas;
- Demographics; and
- Economy: Training, Employment, and Business.

Matrix tables were prepared to identify possible Project activities that could interact with each VEC, listing planned activities by phase and identifying potential interactions. Each interaction was evaluated for its potential to cause effects. Where the potential was deemed unlikely or incidental it was not considered further; in this way the assessment focused on key issues and substantive environmental effects. An interaction was considered to have a potential effect if it could change the abundance or distribution of a VEC directly or indirectly.

The criteria taken into account when evaluating the nature and extent of environmental effects include magnitude, geographic extent, duration and frequency, reversibility, and ecological, socio-cultural and economic context.

**Component Studies**

The EIS Guidelines for the Project required that the Proponent conduct four Component Studies:

1. Wild Atlantic Salmon;
2. Fish and Fish Habitat;
3. Cultural, Recreational and Commercial Importance of the Waters of Placentia Bay; and
4. Aqualine Midgard Sea-cage Study.

The first three Component Studies were essentially literature reviews whereas the Aqualine Midgard Sea-cage Study was a systematic technical review by a panel of experts on the integrity and suitability of the sea cage system for operation in Placentia Bay. Where appropriate, relevant aspects of the Component Studies have been directly included in the EIS.

**Assessment Boundaries**

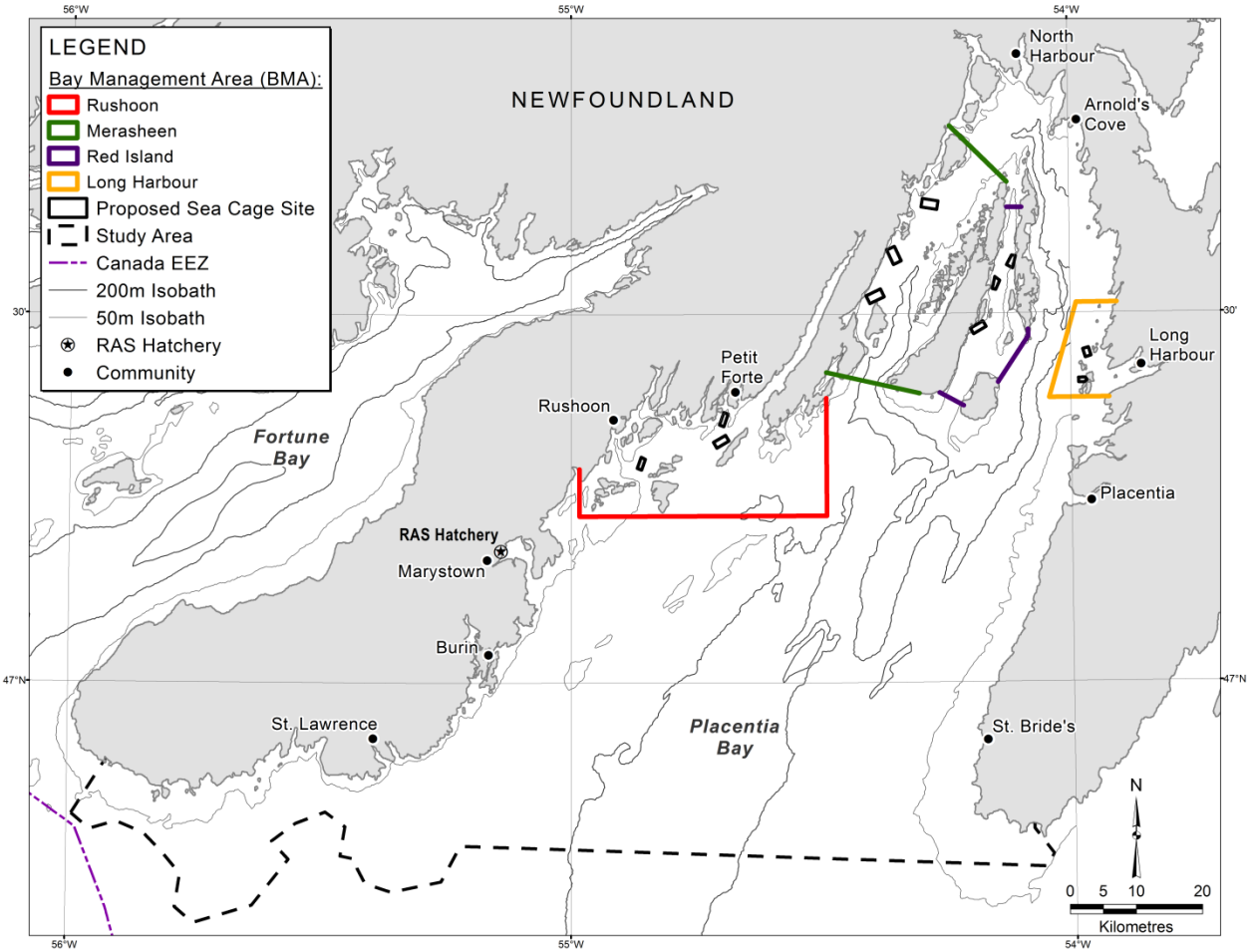
Spatial and temporal boundaries were established for the assessment. The Project Area is defined as the physical footprint of the Project and includes the land-based facility (RAS Hatchery) site and the proposed sea cage sites. The land-based facility falls entirely within the Marystown Marine Industrial Park. The boundaries of the Study Area correspond to those of the Placentia Bay Extension Ecologically and Biologically Significant Area or EBSA as defined by DFO (see map below). This is considered the maximum extent wherein there is potential for effects of the Project to occur. Additionally, the socio-economic assessment also focuses on the Burin Peninsula. The temporal boundaries of the Project extend from the start of Construction through Decommissioning and Rehabilitation.

**Cumulative Effects**

Cumulative effects were assessed for within-project activities as well as for effects in combination with other external projects. The other projects and activities within Placentia Bay that were considered in the cumulative effects assessments included vessel traffic, existing aquaculture, sewage outfalls, industrial outfalls and proposed developments for Placentia Bay.

**Accidents and Malfunctions**

Accidental events can lead to negative effects on the environment. The severity of effects depends on the type of event, magnitude, location and time of year. Extensive measures will be taken to prevent such occurrences, and a high level of emergency preparedness will be in place. For assessment of the potential effects of accidental events and malfunctions in the marine environment, two fish escape scenarios (emergency and worst-case), two mass fish mortality scenarios (emergency and worst-case), and four spill scenarios (three emergency and one worst-case) were considered. Substances considered in the spill scenarios included fish feed, diesel fuel, formic acid, sewage, and ensilage. Accident scenarios were also developed for the RAS Hatchery but it was determined that there was little to no chance for VECs to interact with these potential events.




**The locations of the Study Area, proposed sea cage sites and the RAS Hatchery for Grieg NL's Placentia Bay Atlantic Salmon Aquaculture Project. Also shown are the Bay Management Areas.**

## Public and Other Consultations

As noted previously, Grieg NL considers community engagement and participation to be integral to the sustainability of the proposed Project. To this end, Grieg NL has led an active program of consultation about the proposed Project through a variety of forums and media since the start of feasibility studies in 2015. Consultation continued in 2016 and 2017 and is on-going with municipal councils, businesses, local fishers and their union FFAW-UNIFOR, education facilities, local stakeholder groups such as the Placentia Bay Integrated Management Planning Committee, as well as with provincial and federal government agencies. In addition, Grieg NL has consulted with various salmonid interest groups in the province. A detailed Consultation Report was prepared and is included as Appendix D of the EIS (Volume 2).

During the preparation of the EIS, Grieg NL was required pursuant to the provincial *Environmental Protection Act* to provide an opportunity for interested members of the public to meet with the company at a place adjacent to or within the geographical area of the undertaking to:

- provide information concerning the undertaking to the people whose environment may be affected by the undertaking; and
- record and respond to the concerns of the local community regarding the environmental effects of the undertaking.

To meet this prescribed public consultation requirement, Grieg NL hosted an advertised public information session in Marystown with live streaming to Gander, St. John's and Corner Brook on 13 March 2018. During this session, questions, comments, and concerns raised about the Project were recorded. Many of the key issues raised in this session had been raised previously and related to:

- Use of triploid, female Atlantic salmon and assurances that these fish were sterile and suitable for use in Placentia Bay;
- Ice conditions in Placentia Bay and an ice management plan;
- Effects of fish escapes on wild fish populations;
- Disease and disease management;
- Control of sea lice and potential use of therapeutants;
- The use of lumpfish as a cleaner fish to control sea lice;
- Effects on benthic habitat; and
- Wastes, particularly ensilage, and waste management plan.

The relevant issues raised during consultations have been addressed in the EIS.

## Mitigation Measures

The EIS describes in detail the mitigation measures which are in place for each phase of the Project at both the RAS Hatchery and sea cage sites to minimize effects on the environment (see Section 2.5). As summarized below, these measures include consideration of the key issues and concerns raised during consultations.

**Procedures to Minimize the Risk of Fish Escapes from Sea Cages**

Grieg NL will meet or exceed the management strategy called the *Code of Containment for the Cage Culture of Salmonids in Newfoundland and Labrador* (COC), which has been prepared by federal and provincial regulators to minimize the chance of fish escapes from sea cages. The COC outlines procedures for sea cage equipment, fish handling practices, inspections, reporting, and escape response drills.

The Aqualine Midgard sea cage system will be used at all sea cage sites and its robust design has been deemed suitable for conditions in Placentia Bay by a panel of independent experts who prepared the Component Study entitled *Aqualine Midgard Sea-cage Study*. The sea cage system is designed to withstand 9 m significant wave heights and has features that will minimize the risk of predator incursions.

In the unlikely event that sea ice or an iceberg pose a threat to the sea cages, a three-tiered approach has been developed to manage ice based on its type and size. In the rare circumstance of a major ice incursion which cannot be mitigated through the three-tiered approach, Grieg NL's Emergency Response Plan will be implemented and the fish will be harvested or the sea cage(s) will be towed to a safe location.

**Genetic Integrity and Biological Fitness of Wild Atlantic Salmon**

Although mitigation measures and monitoring procedures are in place to prevent fish escapes, it is still possible that some salmon may escape from the sea cages. The concern is that released salmon may affect the genetic integrity and biological fitness of wild Atlantic salmon in Placentia Bay. To minimize this risk, Grieg NL will be using fertilized triploid (sterile and all-female) Atlantic salmon eggs supplied from an accredited company named Stofnfiskur (based in Iceland). Stofnfiskur has modified and improved triploidy induction procedures to ensure that 100% triploidy results are produced. Stofnfiskur uses a two-tier testing procedure to verify triploidy results. Details on the Stofnfiskur triploidy (and all-female) induction and verification procedures are provided as an appendix to the EIS.

DFO has proposed that the sea cages be at least 20–30 km from the mouths of salmon rivers in order to reduce the possibility of farmed escapees interacting with wild salmon stocks. Grieg NL's proposed sea cage sites are located more than 50 km away from the majority of scheduled rivers. Only the sea cage sites in the Rushoon BMA are located <20 km from a scheduled salmon river.

**Fish Health**

A number of aquatic disease-causing agents (pathogens) such as viruses and bacteria as well as parasites (i.e., sea lice), which occur naturally in the environment, can affect farmed fish. These pathogens can be spread by equipment used to transfer fish as well as through the water by animals (including sick or moribund fish) releasing the pathogens or parasites. A number of tools will be used to eliminate or minimize the spread of disease and sea lice at the sea cage sites and the surrounding aquatic environment including biosecurity measures, routine good husbandry practices, health checks and procedures, use of specialized feed and feeding procedures, sea lice control procedures, water quality monitoring, vaccinations, and removal and treatment of dead fish. Grieg NL will implement a Fish Health Management Plan for its sea farms and RAS Hatchery; this plan has been included as an appendix to the EIS.

**Control of Sea Lice**

Grieg NL will use an adaptive management approach involving several methods to control sea lice. Lumpfish, developed from Newfoundland broodstock, will be used as a cleaner fish to minimize sea lice occurrence on salmon in all sea cages. Lumpfish naturally exhibit a "scan-and-pick" feeding behaviour and have been successfully used as cleaner fish in other cold-water aquaculture projects. If monitoring indicates an increase in sea lice levels, guidance will be acquired from private and provincial veterinarians to develop an effective strategy. Other sea lice control options include use of sea lice skirts and by delivering feed through a dispenser located ~6–7 m below the surface, where sea lice are less prevalent. These measures will be done in combination with the use of functional feed that is formulated to make it more difficult for sea lice to attach to the salmon. If these measures are ineffective, three options will be considered: (1) the use of a "Thermolicer", (2) therapeutants, or (3) harvesting the fish. Continuous monitoring and response is important to ensure sea lice levels remain low and the use of therapeutants can be minimized or eliminated.

**Effects on Benthic Habitat**

Proposed sea cage sites were selected based on sufficient current velocity and direction necessary to minimize depositional build-up from sea cages, adequate water depth for deployment of sea cages, and suitable bottom type (i.e., >50% hard bottom). As a minimum, specific requirements in the DFO Aquaculture Activities Regulations (AAR) and DFLR's Aquaculture Licence Application process will be

met. In Newfoundland and Labrador, the mandatory fallowing time after harvesting is seven months for a sea cage site and four months for a BMA. As a precautionary measure, Grieg NL will more than double this fallowing time for sea cages to 16–19 months after harvesting. In addition, BMA fallowing time will range from four to seven months. This will result in increased time for the benthic community to recover and hence decreased environmental effects.

**Waste Management**

A Waste Management Plan has been developed which details procedures for minimizing, handling, and treating wastes produced during the Project. Dead fish at both the RAS Hatchery and sea cage sites will be used as ensilage. The ensilage will be transported to either a local company in Newfoundland that will use the product as a commercial fertilizer and/or animal feed additive or to a feed supply company located in Denmark.

## Effects Assessment

The existing biophysical and socio-economic environment of the Study Area was described in detail in the EIS. Much of this information was essential for predicting the effects of planned Project activities and accident scenarios on VECs.

**Planned Project Activities**

Identified interactions between biophysical VECs and planned sea farm project activities are provided in the table below. For each VEC, an assessment including predictions of magnitude, geographic extent, and duration was made for all interactions. The summary of effects predictions provided below focuses on key issues.

***Fish and Fish Habitat VEC***

The assessment of the Fish and Fish Habitat (FFH) VEC included consideration of various biophysical components of fish and fish habitat including seawater, sediment, plankton, invertebrate and fish eggs and larvae, and juvenile/adult invertebrates and fishes.

The primary negative effect on fish and fish habitat associated with finfish aquaculture operations is the potential for accumulation of organic waste (i.e., excess fish feed, fish feces, and biofoulants cleaned from the cages) on the seabed below and adjacent to the sea cages, which could potentially cause chemical, physical and biological changes to the surficial sediment. There is also potential for the transfer of disease and/or parasites from farm fish to wild fishes but there is little evidence to support this for non-salmonid fishes. With mitigation measures in place (e.g., cessation of feeding at ~80% satiation, siting of sea cages at locations with suitable currents and depth to distribute organic waste, fallowing of sea cage sites, routine husbandry practices, procedures for fish health maintenance), effects on fish and fish habitat from planned Project activities were predicted to be minor, localized, and short-term, with the exception of benthic habitat change attributable to the footprint of mooring anchors, which would be continuous but reversible.

Overall, the residual effects of planned Project activities on the FFH VEC were predicted to be *not significant*. The level of confidence with this prediction ranged from *medium* to *high*.

**Potential interactions of planned sea farm Project activities and the biophysical VECs.**

| Project Activities | Fish & Fish Habitat VEC | Wild Salmon VEC | Species at Risk VEC | Sensitive Areas VEC |
|---|---|---|---|---|
| CONSTRUCTION | | | | |
| Towing Sea Cages | | | X | X |
| Sea Cage System Installation | X | | X | X |
| Vessel Traffic | | | X | X |
| OPERATIONS & MAINTENANCE | | | | |
| Transfer Fish to Sea | | | X | |
| Feeding Fish | X | X | X | |
| Presence of Farmed Salmon | X | X | X | X |
| Deposition from Sea Cages | X | | X | X |
| Fish Health Maintenance | | | | |
| Use of Cleaner Fish | X | X | X | |
| Fish Mortalities | X | X | X | |
| Thermolicer[a] | | | | |
| Therapeutants[a] | X | X | X | |
| Antibiotics[b] | X | X | X | |
| Sea Cage Maintenance | | | | |
| Net Cleaning | X | | X | |
| Net Repair | | | X | |
| Sea Cage Sites | | | | |
| Presence | X | | X | |
| Lights | X | X | X | |
| Use of Vessels[c] | | | | |
| Presence | | | X | X |
| Lights | X | X | X | |
| Noise | | | X | X |
| Atmospheric Emissions | | | | X |
| Transfer Fish from Sea | | | X | |
| Production of Waste | X | X | X | X |
| DECOMMISSIONING & REHABILITATION | | | | |
| Towing Sea Cages | | | X | X |
| Sea Cage System Removal | X | | X | X |
| Vessel Traffic | | | X | X |

[a] The use of the Thermolicer and therapeutants are adaptive mitigation measures for sea lice and will only be used as a last resort based on guidance from private and provincial veterinarians.
[b] Antibiotics will only be used as a last resort and will be based on guidance from private and provincial veterinarians.
[c] All Project vessels including those associated with personnel transfer and resupply.

### *Wild Atlantic Salmon VEC*

The assessment of the Wild Salmon (WS) VEC included consideration of both immature and mature Atlantic salmon. The wild salmon comprising the Placentia Bay stocks are part of the South Newfoundland population designated as *Threatened* by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The current DFO maximum abundance estimate for the Placentia Bay stocks is 5,099 mature salmon. Little is known about the migratory corridors used by both immature and mature salmon within Placentia Bay during movements between the rivers and the feeding areas in offshore marine waters.

The primary potential negative effect on wild salmon associated with finfish aquaculture operations is the potential for transfer of disease and parasites from farm salmon to wild salmon. Wild salmon would likely have to occur very close to the sea cages to be infected so attraction to sea cages will be mitigated

by cessation of feeding at ~80% satiation, siting of sea cages at locations with suitable currents and depth to distribute organic waste, and maintenance of sea cage fish health. With mitigation measures in place, effects on wild salmon from planned Project activities were predicted to be minor, localized, and relatively short-term.

Overall, the residual effects of planned Project activities on the WS VEC were predicted to be *not significant*. The level of confidence with this prediction ranged from *medium* to *high*.

***Species at Risk VEC***

The assessment of the Species at Risk (SAR) VEC included 'those species listed by the provincial *Endangered Species Act* (*ESA*) and/or on Schedule 1 of the federal *Species at Risk Act* (*SARA*). Effects of Project activities were assessed for six fish species (white shark, northern wolffish, spotted wolffish, Atlantic wolffish, American eel, and banded killifish), five bird species (Ivory Gull, Harlequin Duck, Red Knot, Barrow's Goldeneye, and Piping Plover), five marine mammal species (blue, North Atlantic right, fin, northern bottlenose, and Sowerby's beaked whale), and two sea turtle species (leatherback and loggerhead sea turtles).

Of the six fish SAR considered, the three wolffish species are demersal, the white shark and American eel are pelagic, and the banded killifish, if it occurs in the marine environment, remains in shallow estuarine waters. Effects on fish SAR were predicted to be minor, localized, primarily limited to the sea cage sites, and short-term, with the exception of benthic habitat change attributable to the footprint of mooring anchors, which would be continuous but reversible.

Few interactions between bird SAR and the Project are expected because, with the exception of small numbers of Harlequin Ducks and perhaps Barrow's Goldeneye in winter, other species (i.e., Ivory Gull, Piping Plover, and Red Knot) are not expected to occur at the proposed sea cage sites or along the transit routes to the sea cage sites. The primary negative effects on birds associated with finfish aquaculture operations is the potential for entanglement in the sea cages and anti-predator nets, and attraction to artificial lighting at night which may lead to birds colliding with vessels. With mitigation measures in place (e.g., appropriate bird netting, reduction in light use where practicable, monitoring vessels and release protocols), effects on bird SAR from planned Project activities were predicted to be minor, localized, and short-term.

Of the three baleen whale SAR that are known to occur in the Study Area, only fin whales are expected to regularly occur there. However, there have been recent detections (acoustic and visual) of the critically endangered North Atlantic right whale in Placentia Bay. There have been several studies of marine mammal interactions with aquaculture operations around the world and limited study of sea turtles. The primary types of effects identified for marine mammals and sea turtles include entanglement, loss of habitat, vessel strikes, and disturbance from noise. Potential entanglement and loss of habitat for marine mammals are related to the physical presence of sea cages and associated mooring systems. Marine mammal and sea turtle SAR could experience disturbance related to noise and possibly the physical presence of vessels and equipment during most Project activities. With mitigation measures in place (e.g., mooring and buoy lines will be kept tensioned, video monitoring, and slow vessel speeds), effects on marine mammal and sea turtle SAR from planned Project activities were predicted to be minor, localized and short-term with the exception of a minor loss in habitat from the sea cage footprints.

Overall, the residual effects of planned Project activities on the SAR VEC were predicted to be *not significant*. The level of confidence with this prediction ranged from *medium* to *high*. In the highly

unlikely event that a blue whale or North Atlantic right whale experiences mortality as a result of entanglement in a sea cage this effect is considered *significant*.

***Sensitive Areas VEC***

Several sensitive areas have been identified in the Study Area. The assessment of sensitive areas focused on the principal features which led to Placentia Bay being declared an EBSA as well as the proposed leatherback sea turtle critical habitat. Placentia Bay hosts a high aggregation of ichthyoplankton, particularly those of Atlantic cod, cunner, American plaice and capelin, in the western and northern portions of the Bay. Identified ichthyoplankton high-aggregation areas overlap all 11 proposed sea cage sites. Placentia Bay is characterized by high pelagic and demersal fish species diversity, as well as shellfish and other marine invertebrates. It also has the largest Atlantic cod spawning stock within the Northwest Atlantic. Placentia Bay is also an important area for feeding and/or migration for marine mammals and leatherback sea turtles, particularly during the spring and summer months. Harbour seals occur there year-round and Placentia Bay hosts the highest densities of river otters in the province. Placentia Bay supports high numbers of birds, and has four Important Bird Areas (IBAs) for nesting, feeding and overwintering. Critical habitat for leatherback sea turtles was recently proposed for the southern portion of Placentia Bay, the northern extent of which is near the Rushoon BMA. The principal features which led to the proposed designation include the quantity and quality of gelatinous prey items, acoustic environment, and water quality. The proposed sea cage sites only overlap with the Placentia Bay EBSA.

The deposition of organic material from fish in the sea cages and potential transfer of disease and parasites to wild fishes were identified as the key concern for the Sensitive Areas VEC. With mitigation measures in place (e.g., cessation of feeding at ~80% satiation, siting of sea cages at locations with suitable currents and depth to distribute organic waste, fallowing of sea cage sites, routine husbandry practices, procedures for fish health maintenance), effects on the Sensitive Areas VEC from planned Project activities were predicted to be minor, localized and short- to medium-term.

Overall, the residual effects of planned Project activities on the Sensitive Areas VEC were predicted to be *not significant*. The level of confidence with this prediction ranged from *medium* to *high*.

***Socio-economic VECs***

Grieg NL's proposed Project is seen as having potential socio-economic implications that are important to the residents of the Burin Peninsula, particularly those within the Study Area. Over the past few years, the Burin Peninsula has seen a high level of out-migration, economic decline and need of long-distance commute for work.

The Project proposed by Grieg NL is not the 'boom and bust' activity accompanied by an influx of temporary workers that has often been the experience of Burin Peninsula residents. This Project is the start of a long-term industry that should continue for years.

Grieg NL anticipates that the construction phase, which will involve the building of the RAS Hatchery and fabrication of the sea cages, will require more than 200 skilled workers for technical and engineering positions, and skilled trades. With the current downturn in the construction industry in the province, it is expected that a sufficient labour pool will be available on the Burin Peninsula itself or within the Placentia Bay area. During the operations phase, Grieg NL expects to directly hire 170 workers, with additional hires by contractors and suppliers. While some positions relate to administration and

maintenance, most are technical and specific to the industry. The Project will also require a wide range of services that will be purchased by Grieg NL and its suppliers and contractors.

Based on the assessment of the potential effects of planned Project activities on the Demographics VEC and the Economy: Training, Employment, and Business VEC, the effects of the proposed Project are considered *positive* and *significant*.

### *Cumulative Effects*

The assessments of cumulative effects on the biophysical and socio-economic VECs included consideration of vessel traffic, existing aquaculture, sewage outfalls, industrial outfalls and proposed developments for Placentia Bay. Overall, it was predicted that there would be *no significant* negative cumulative effects of other projects in combination with Grieg NL's proposed Project on VECs. The mitigation measures which will be implemented by Grieg NL and the general lack of spatial overlap amongst projects limits potential cumulative effects. The level of confidence with this prediction ranged from *medium* to *high*.

### *Accidents and Malfunctions*

The effects of eight marine accidental event scenarios were assessed for each VEC and details are provided in the EIS. A key concern as identified during consultations is that escaped farmed salmon may affect the genetic integrity and biological fitness of wild Atlantic salmon in Placentia Bay. This concern is exacerbated because the wild salmon comprising the Placentia Bay stock are part of the South Newfoundland population considered *Threatened* by the federal government. The worst-case fish escape scenario assumed that 2,000,000 salmon escaped from the Rushoon BMA sea cages during spring/early summer as a result of a hurricane-like storm that was not forecasted. It was also assumed that the sea cage mooring system was not properly secured.

The residual effects of this worst-case fish escape scenario on wild Atlantic salmon were predicted to be *not significant*. The level of confidence with this prediction is *medium*. Triploid female salmon are sterile and studies suggest that they do not enter freshwater systems where they could potentially compete ecologically with wild salmon. Resource competition between escaped farm salmon and wild salmon in Placentia Bay would likely be minimal given that both immature and mature wild salmon are focused on migration in the marine environment. Currently, little is known about the behaviour of both immature and mature wild Atlantic salmon in Placentia Bay during migration. To address this data gap, DFO plans to conduct a study of Atlantic salmon migration corridors in Placentia Bay in 2018.

### *Follow-up Monitoring*

Follow-up monitoring will be implemented to validate predictions regarding the residual effects of planned Project activities on the Fish and Fish Habitat VEC at the sea cage sites. The focus will be on monitoring benthic habitat and water quality at the sea cage sites. Follow-up monitoring with the guidance of DFO and DFLR would also be conducted in the event of an accidental escape of farm fish. This monitoring would include sampling Atlantic salmon in scheduled salmon rivers located nearest the location of the escape in order to determine whether escaped farm salmon have entered the freshwater systems. Sampling would involve collecting and analyzing blood samples, which will provide information such as source of the fish (i.e., wild or farm), the broodstock of the fish, and whether or not the fish is triploid and/or female. If the follow-up monitoring identifies unforeseen negative effects, mitigation measures will be adjusted or new mitigation measures will be implemented and additional follow-up monitoring will be conducted as warranted.

Grieg NL has identified follow-up monitoring related to training, employment, and business. It will continue to work with public and private training institutions to ensure that necessary training is available for actual and potential employees and contractors, particularly at locations on the Burin Peninsula. The company will monitor efforts and success regarding diversity in hiring and retention by their contractors. Finally, Grieg NL will continue its proactive program of communication with communities, local commercial fishers, stakeholder groups, and development groups to ensure that the Project benefits are realized and concerns addressed.

## Conclusions

The EIS and required Component Studies provided a comprehensive review and analysis of the potential effects of the proposed Placentia Bay Atlantic Salmon Aquaculture Project on biophysical and socio-economic VECs. Effects on demographics and the economy are considered a significant positive contribution to the Study Area and the Province. With the implementation of mitigation measures, the residual effects of planned Project activities and accidental events are predicted as not significant on fish and fish habitat, wild Atlantic salmon, species at risk, and sensitive areas within Placentia Bay. Data gaps, particularly those related to wild Atlantic salmon migration routes and the degree of ecological interaction between wild salmon and escaped farmed salmon, limit the confidence in some effects predictions.

# SUMMARY OF COMPONENT STUDIES

## Wild Atlantic Salmon Component Study

Prepared by: LGL Limited
388 Kenmount Road
P.O. Box 13248 Stn. A
St. John's, NL A1B 4A5

This study provides a review of wild Atlantic salmon with a focus on the salmon that occur in Placentia Bay. It also reviews the potential genetic and ecological interactions between wild and farmed salmon and the mitigation measures and follow-up monitoring intended to minimize the potential effects of Grieg NL's Project.

## Fish and Fish Habitat Component Study

Prepared by: LGL Limited
388 Kenmount Road
P.O. Box 13248 Stn. A
St. John's, NL A1B 4A5

This study provides a review of the existing fish and fish habitat in Placentia Bay with focus on the sea cage sites, the mitigation measures intended to minimize the potential effects of the proposed Project on fish and fish habitat, and the follow-up monitoring intended to validate the effects conclusions in the EIS.

## The Cultural, Recreational and Commercial Importance of the Waters of Placentia Bay Component Study

Prepared by: Leslie Grattan and Associates
91 Barnes Road
St. John's, NL A1C 3X5

Butland Communications
35 York Street, Suite 101
St. John's, NL A1C 1K6

LGL Limited
388 Kenmount Road
P.O. Box 13248 Stn. A
St. John's, NL A1B 4A5

This study provides a detailed description of the cultural, recreational and commercial usage of Placentia Bay. It focuses on fisheries, tourism, recreational activities, marine navigation, and culturally and ecologically important areas. The study also includes mitigation measures that will be undertaken to protect these uses and areas from the potential effects of the Project, as well as follow-up monitoring.

## Aqualine Midgard Sea-cage Study

Prepared by: Spence Corrosion Canada Inc.
5 Job Street, Suite 301
St. John's, NL A1E 1H1

DNV GL,
121 Kelsey Drive
St. John's, NL A1B 0C7

Engineered Pipe Group
10 Panther Place, Unit 'C'
Mount Pearl, NL A1N 5B1

AKVA Group North America
35 York Street
St. John's, NL A1C 1K6

This study is a systematic technical review by a panel of experts on the integrity and suitability of the Aqualine Midgard sea cage system, which is proposed by Grieg NL for operations in Placentia Bay.

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| c | A literature review of the effects of disease and parasites from farm salmon on wild Atlantic salmon. | Vol. 3<br>LGL 2018a<br>4.3 | Effects of Sea Lice and Disease Transfer from Farmed Salmon to Wild Atlantic Salmon |
| d | Proximity of the sea cages to scheduled and non-scheduled salmon rivers and potential effects on migrating wild Atlantic salmon. | Vol. 3<br>LGL 2018a<br>4.4 | Potential Effect of Proximity of Sea Cages to Salmon Rivers |
| e | Oceanographic and meteorological data at the sea cage sites including water currents, wind and wave action, flood and tidal zones, ice dynamics, and storm patterns. | Vol. 3<br>LGL 2018a<br>4.5<br><br>Appendix B | Oceanographic and Meteorological Data<br><br>Metocean Conditions for the Placentia Bay Aquaculture Sites, Oceans Ltd. |
| f | Water-quality data at the sea cage sites including water temperature, salinity and dissolved oxygen. | Vol. 3<br>LGL 2018a<br>4.6<br><br>Appendix C | Water Quality<br><br>Sea Cage Site Water Quality Data: Water Temperature and Dissolved Oxygen |
| g | Aquatic dispersion modeling to predict the biochemical oxygen demand (BOD) material deposition from marine cage sites, as per the guidelines of the Aquaculture Activities Regulations. | Vol. 3<br>LGL 2018a<br>Appendix D | Benthic Depositional Modelling for Grieg Seafarms in Placentia Bay |
| h | Effect of sea cage deposits (i.e., pesticides, therapeutants, and disinfectants), disease, and parasites on the adjacent aquatic environment (i.e., lease area) including possible effects on wild Atlantic salmon. | Vol. 3<br>LGL 2018a<br>4.7 | Effects of Deposition from the Sea Cages |
| i | Monitoring that will be undertaken to ensure compliance with all federal and provincial regulations related to the use and release of pesticides, therapeutants, and disinfectants in the marine environment. | Vol. 3<br>LGL 2018a<br>4.8 | Mitigation and Monitoring |
| 4.3.2 | Fish and Fish Habitat | Vol. 3<br>LGL 2018b | |
| a | Identify fish and fish habitat using benthic surveys, including identification of significant habitat, which may include invertebrates, crustaceans, corals and sponges, and eelgrass. | Vol. 3<br>LGL 2018b<br>4.1.1.1<br><br>4.1.2<br><br>Appendix B | Marine Water<br><br>Project Area<br><br>Application of Available Multibeam Acoustic and Seascape Data to Map Proposed Marine Finfish Production Locations in Placentia Bay, Newfoundland |
| b | Identify fish and fish habitat, including species at risk, invasive species, marine mammals, and those species that directly or indirectly support a fishery, such as: cod, lobster, sea-run trout, herring, sharks, scallops, crab, seals, mussels, and lumpfish. | Vol. 3<br>LGL 2018b<br>4.1.1.1 | Marine Water |

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| c | Features that led to the designation of Placentia Bay as part of an EBSA within the Newfoundland and Labrador Shelves Bioregion, including details of the biodiversity, composition, abundance, and distribution of ichthyoplankton, marine mammals, corals, sponges, and spawning and nursery habitat areas important for fish, avifauna within important bird areas, and any other features that may have been considered in this designation. | Vol. 3<br>LGL 2018b<br>4.1.1<br><br>4.2 | <br><br>Study Area Overview<br><br>Placentia Bay Extension EBSA Significant Areas |
| d | Water quality and benthic characteristics consistent with the baseline monitoring requirements of the provincial aquaculture licensing process. | Vol. 3<br>LGL 2018b<br>4.1.2<br><br>Appendix A<br><br>Appendix B<br><br>Appendix C | <br><br>Project Area<br><br>Sea Cage Site Water Quality Data<br>Application of Available Multibeam Acoustic and Seascape Data<br>Sea Cage Site Physical and Biological Benthic Data |
| e | Oceanographic and meteorological data at the sea cage sites including water currents, wind and wave action, flood and tidal zones, ice dynamics, and storm patterns. | Vol. 3<br>LGL 2018b<br>4.3<br><br>Appendix B<br><br>Appendix D | <br><br>Oceanographic and Meteorological Data<br><br>Application of Available Multibeam Acoustic and Seascape Data<br><br>Metocean Conditions for the Placentia Bay Aquaculture Sites Oceans Ltd. February 2018 |
| f | Aquatic dispersion modeling to predict the BOD material deposition from marine cage sites, as per the Aquaculture Activities Regulations. | Vol. 3<br>LGL 2018b<br>4.4<br><br>Appendix E | <br><br>Benthic Depositional Modelling<br><br>Benthic Depositional Modelling for Grieg Seafarms in Placentia Bay |
| g | Monitoring that will be undertaken to ensure compliance with federal and provincial regulations related to the use and release of pesticides, therapeutants, and disinfectants in the marine environment, including possible effects on non-target organisms. | Vol. 3<br>LGL 2018b<br>4.5 | <br><br>Mitigation and Monitoring |
| 4.3.3 | The Cultural, Recreational, and Commercial Importance of the Waters of Placentia Bay | Vol. 3<br>Grattan et al. 2018 | |
| a | Fisheries | Vol. 3<br>Grattan et al. 2018<br>4.1 | <br><br>Fisheries |
| b | Tourism operators, outfitters camps, cabins, and recreational activities. | Vol. 3<br>Grattan et al. 2018<br>4.2 | <br><br>Tourism, Outfitters, Cabins and Recreation |
| c | Marine navigation (e.g., commercial and recreational boat traffic). | Vol. 3<br>Grattan et al. 2018<br>4.3 | <br><br>Marine Navigation |
| d | Unique sites or special features, environmentally sensitive areas, reserves or protected areas, conservation agreement lands, and habitat enhancement projects. | Vol. 3<br>Grattan et al. 2018<br>4.4 | <br><br>Sensitive Areas |
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| | | Sullivan et al. 2018 | |
| a | A summary of the successes, failures, and lessons learned from Midgard cage system installations at marine aquaculture sites in northern environments. | Vol. 3<br>Sullivan et al. 2018<br>1.4.2 | Summary of Success, Failures and Lessons Learned |
| b | Methods and results of structural and operational tests conducted for, or collected by, the panel of experts on the Midgard cage system, and a synopsis of test results and conclusions for any previous structural and operational tests conducted on the cage system. | Vol. 3<br>Sullivan et al. 2018<br>1.4.3 | Methods and Results of Structural and Operational Tests |
| c | The application of oceanographic and meteorological data, including past sea-ice events, to predict the performance of the sea cages in the study area. | Vol. 3<br>Sullivan et al. 2018<br>1.4.4 | Prediction of the Performance of Sea Cages in the Study Area |
| d | A description of the proposed Aqualine Midgard cage system, which has been designed against a Norwegian technical standard that has been viewed as effective as reducing escape incident rates in other jurisdictions. | Vol. 3<br>Sullivan et al. 2018<br>1.4.1 | Overview of Aqualine Midgard System |
| e | Evaluation of the Norwegian technical standard in comparison to current containment practices and standards in Newfoundland and Labrador, with a view to confirming the integrity of the proposed system in the Newfoundland marine environment. | Vol. 3<br>Sullivan et al. 2018<br>1.4.5 | Norwegian Technical Standard in Comparison to Current Containment Practices and Standards in Newfoundland and Labrador |
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| a | Direct and indirect genetic and ecological interactions between escaped sterile and non-sterile European-strain farmed salmon and wild Atlantic salmon, including potential health and fitness effects. | Vol. 1<br>7.7.1.1<br>7.7.1.2 | Fish Escape-Emergency Scenario<br>Fish Escape-Worst-case Scenario |
| b | Direct and indirect genetic and ecological interactions between escaped lumpfish (i.e., cleaner fish) and wild lumpfish, including potential health and fitness effects. | Vol. 1<br>7.7.1.1<br>7.7.1.2 | Fish Escape-Emergency Scenario<br>Fish Escape-Worst-case Scenario |
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| a | Procedures that will be undertaken to monitor sea cages for structural integrity on a routine basis during operations, including frequency of monitoring as per the requirements of the Code of Containment. | Vol. 1<br>2.5.2.2 | Operations and Maintenance<br>*Fish Escape* |
| b | Procedures that will be undertaken to ensure containment of farmed salmon and cleaner fish in sea cages. | Vol. 1<br>2.5.2.2 | Operations and Maintenance<br>*Fish Escape* |
| c | Procedures that will be undertaken to prevent escapes of farmed salmon and cleaner fish, particularly during high risk | Vol. 1<br>2.5.2.2 | Operations and Maintenance |

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| | activities such as site transfer, treatment and harvest. | | *Fish Escape* |
| d | Procedures that will be undertaken to recapture escapes of farmed salmon and cleaner fish. | Vol. 1<br>2.5.2.2<br><br>Vol. 2<br>Appendix T | Operations and Maintenance<br>*Fish Escape*<br><br>Grieg NL Emergency Response Plan |
| e | Procedures that will be undertaken to enumerate, document, and report on escapes of farmed salmon and cleaner fish. | Vol. 1<br>2.5.2.2<br><br>Vol. 2<br>Appendix T | Operations and Maintenance<br>*Fish Escape*<br><br>Grieg NL Emergency Response Plan |
| f | Procedures that will be undertaken to identify potential predators and to protect caged salmon from predators, such as fish, marine mammals and seabirds. | Vol. 1<br>2.5.2.2 | Operations and Maintenance<br>*Fish Escape* |
| g | Procedures to minimize the risk of attraction, capture and/or harm to fish, marine mammals and seabirds by the sea cages and project equipment. | Vol. 1<br>2.5.2.2 | Operations and Maintenance<br>*Fish Escape*<br>*Entanglement* |
| h | Procedures to minimize the genetic consequences of wild/farmed salmon interactions. | Vol. 1<br>2.5.2.2 | Operations and Maintenance<br>*Genetic Integrity and Biological Fitness of Wild Salmon* |
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| j | Procedures to regularly evaluate fish health (farmed salmon and lumpfish) through all life stages, particularly prior to authorization of entry to sea cages. | Vol. 1<br>2.5.1.2<br><br>2.5.2.2 | Operations and Maintenance<br>*Fish Health*<br><br>Operations and Maintenance<br>*Fish Health* |
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| l | Procedures to mitigate disease and parasites within a sea cage and/or seafarm, and to the surrounding aquatic environment. | Vol. 1<br>2.5.2.2 | Operations and Maintenance<br>*Fish Health* |
| m | Procedures to mitigate disease and parasites from wild Atlantic salmon to farmed salmon. | Vol. 1<br>2.5.2.2 | Operations and Maintenance<br>*Fish Health* |
| n | Procedures to protect fish and fish habitat beneath and surrounding the sea farms from the effects of deposits. | Vol. 1<br>2.5.2.2 | Operations and |

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| p | Procedures to avoid and protect environmentally sensitive habitat and areas, such as EBSAs and migration routes for wild Atlantic salmon. | Vol. 1<br>2.5.2.2 | Operations and Maintenance<br>*Effects on Marine Habitat* |
| q | Procedures for site security and biosecurity at the hatchery and sea farms. | Vol. 1<br>2.5.1.2<br><br>2.5.2.2 | Operations and Maintenance<br>*Biosecurity Measures*<br>*Site Security*<br><br>Operations and Maintenance<br>*Fish Health*<br>*Site Security* |
| r | Procedures to prevent/minimize sedimentation and erosion and to stabilize disturbed shoreline areas during construction and operation of facilities and access roads. | Vol. 1<br>2.5.1.1 | Construction<br>*Erosion and Sedimentation Control* |
| s | Procedures to minimize project-related greenhouse gas emissions. | Vol. 1<br>2.5.1.2<br><br>2.5.2.2 | Operations and Maintenance<br>*RAS Hatchery Design*<br><br>Operations and Maintenance<br>*Greenhouse Gas Emissions* |
| t | Procedures to avoid, minimize, or as a last resort, compensate for any potential loss of wetlands or wetland functions. | Vol. 1<br>4.3 | Terrestrial Environment |
| 7.2 | Emergency Response/Contingency Plans | Vol. 2<br>Appendix T | Grieg NL Emergency Response Plan |
| a | Accidental spills and/or releases of chemicals, gasoline and associated products, fish feed, therapeutants, pesticides, or any potentially hazardous substance on land or in water. | Vol. 2<br>Appendix M<br><br>Appendix T | Grieg NL Spill Management Plan: Land and Water<br>Grieg NL Emergency Response Plan |
| b | Security breach at the hatchery and/or sea farms. | Vol. 2<br>Appendix T | Grieg NL Emergency Response Plan |
| c | Mass mortality at the hatchery and/or sea farms. | Vol. 2<br>Appendix K<br><br>Appendix T | Grieg NL Fish Health Management Plan<br>Grieg NL Emergency Response Plan |
| d | Escape and/or accidental release of fish from hatchery or sea farms into the surrounding environment. | Vol. 2<br>Appendix T | Grieg NL Emergency Response Plan |
| e | Identification of and response to unhealthy fish, parasites, and/or pathogens within the hatchery or sea cages. | Vol. 2<br>Appendix K | Grieg NL Fish Health Management Plan |
| 7.3 | Waste Management Plan | Vol. 2<br>Appendix J | Grieg NL Waste Management Plan |
| a | Sanitary wastes. | Vol. 2<br>Appendix J | Grieg NL Waste |

| Guideline Requirement | | EIS | |
|---|---|---|---|
| **Section** | **Title** | **Vol. / Section** | **Title** |
| | | | Management Plan |
| b | Fish mortalities, including a description of procedures and mass mortality plans. | Vol. 2<br>Appendix J | Grieg NL Waste Management Plan |
| c | Chemical waste (e.g., petroleum products, paints, and cleaning products). | Vol. 2<br>Appendix J | Grieg NL Waste Management Plan |
| d | Operational debris and refuse (e.g., feed bags, pallets, rope, nets, buoys, cage materials, and litter). | Vol. 2<br>Appendix J | Grieg NL Waste Management Plan |
| e | Biofouling material (i.e., organisms and matter that accumulates on nets). | Vol. 2<br>Appendix J | Grieg NL Waste Management Plan |
| f | Nutrient loading (e.g., fish feed and fish feces). | Vol. 2<br>Appendix J | Grieg NL Waste Management Plan |
| g | Procedures that will be undertaken to ensure release water from the hatchery, should this be required, conforms to the requirements of the Environmental Control Water and Sewage Regulations (2003). | Vol. 2<br>Appendix J | Grieg NL Waste Management Plan |
| h | Details of the anaerobic digesting process for organic solids at the hatchery and analysis procedures to determine the agricultural grade of the soil amendment, if required. | Vol. 2<br>Appendix J | Grieg NL Waste Management Plan |
| 7.4 | Environmental Effects Monitoring and Follow-up Program (EEMP) | Vol. 1<br>7.8 | Follow-up Monitoring |
| **Section 8** | **Residual Effects and Determination of Significance** | Vol. 1<br>7.0 | Effects of the Project on the Environ. |
| **Section 9** | **Assessment Summary and Conclusions** | Vol. 1<br>7.9 | Assessment Summary and Conclusion |
| **Section 10: Public Participation** | | | |
| a | Provide information concerning the undertaking to the people whose environment may be affected by the undertaking. | Vol. 1<br>5.0<br><br>Vol. 2<br>Appendix D | Consultations<br><br>Public Consultation Report |
| b | Record and respond to the concerns of the local community regarding the environmental effects of the undertaking. | Vol. 1<br>5.0<br><br>Vol. 2<br>Appendix D | Consultations<br><br>Public Consultation Report |
| **Section 11** | **Environmental Protection Plan (EPP)** | Vol. 1<br>8.2 | EPP Outline |
| **Section 12** | **References** | Vol. 1<br>9 | References |
| **Section 13** | **Personnel** | Vol. 2<br>Appendix B | EIS Key Personnel |
| **Section 14** | **Commitments Made in the EIS** | Vol. 1<br>Exec. Summary | List of Commitments |
| **Section 15** | **Copies of Reports** | | 20 hard copies, 20 electronic copies submitted to DMAE |

# List of Commitments

| Monitoring and Mitigation Commitments | |
|---|---|
| **Proponent EIS Commitment** | **EIS Section** |
| **RAS Hatchery (land-based)** | |
| *Erosion and Sedimentation Control* | Section 2.5.1.1 |
| • Grubbing will be contained to areas necessary for project development. | |
| • Grubbed material will not be pushed into areas that are to be left undisturbed. | |
| • Grubbed material will be stockpiled in a designated area. | |
| • A minimum 15 m buffer zone will be maintained between grubbed areas and any adjacent watercourse, including Jones Brook and Placentia Bay. | |
| • Rock berm, silt fencing, and hay bales will be used to control run-off and potential sedimentation of waterways, particularly in susceptible areas. | |
| • Sediment control structures will be monitored, maintained, and repaired on a scheduled basis (minimum weekly) and before/after rainfall events >10 mm. | |
| • Additional silt fencing and hay bales will be stored on site and available if needed. | |
| *Breeding Bird Surveys* | Section 2.5.1.1 |
| • If future site clearance activities are required during the breeding bird period, the area will be monitored/visually inspected by construction personnel. If any evidence is detected, clearing will be delayed and a bird biologist will be consulted. | |
| *Blasting Mitigation Measures* | Section 2.5.1.1 |
| • A licensed, qualified and experienced contractor will be hired to conduct all drilling and blasting operations to ensure all permitting requirements are met. | |
| • Explosives will not be stored or remain on-site overnight. | |
| • Blasting patterns and procedures will be developed to minimize seismic impact within the pre-blast survey zone and proper techniques to reduce flyrock potential will be utilized. | |
| • A blast safety manual will be required from the licensed contractor and key aspects of the manual (including a blasting warning protocol) and a site employee muster station area will be reviewed with site personnel prior to blasting operations. | |
| • The site will be surveyed for animals, such as moose or black bear, prior to any blasting. Blasting will be delayed until the animals leave the site. | |
| *Hazardous Materials, Mitigation and Management Measures* | Section 2.5.1.1 |
| • Procedures for the handling of fuels and other hazardous materials as well as contingency plans for spills will be present in hard copy at receiving, storage, transfer and disposal areas. | |
| • Transportation, storage and use of fuels and all other hazardous materials at the construction site will be conducted in compliance with all relevant laws and regulations. | |
| • A complete inventory of the hazardous materials on the job site shall be maintained according to WHMIS regulations and will be made available to regulatory agencies upon request or in case of an emergency. | |
| All contractors will be required to observe strict compliance with the requirements of WHMIS regarding employee training, use, handling, storage, and disposal of hazardous materials and regarding labeling and provision of Material Safety Data Sheets as required by WHMIS legislation. | |
| All contractors will be required to observe strict compliance with the requirements of the most recent version of the *Transportation of Dangerous Goods Act*. | |
| Contractors will be required to submit a detailed EPP prior to the start of construction. | |
| *Waste Management* | Section 2.5.1.1 |
| • The amount of waste generated will be minimized to the extent possible, primarily by recycling or reusing materials. All materials will be handled according to the procedures in the Waste Management Plan. | |
| *RAS Hatchery Design* | Section 2.5.1.2 |
| • The RAS Hatchery will be designed and aim for obtaining certification under the globally-recognized Leadership in Energy and Environmental Design rating system (LEED). | |
| • Pre-fab building materials will be used to construct the facilities with emphasis on the manufacturer's commitment to reducing their impact on the environment. | |
| • The water required for aquaculture operations will be supplied by a nearby well, which was drilled specifically for the Project thereby reducing the effects on Marystown's municipal water supply. | |
| • There will be separate, biosecure rooms/buildings for each stage of salmon development. | |
| *Fish Health – Husbandry Practices* | Section 2.5.1.2 |
| • Will employ standard cleaning and disinfecting procedures in the RAS Hatchery. | |
| • Tanks will be cleaned and inspected on a routine schedule. | |
| • Smaller equipment that is used daily will be cleaned and disinfected at the end of each personnel shift. | |
| • All tools and equipment will be designated for each facility and not shared or transferred between | |

| Monitoring and Mitigation Commitments | |
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| buildings or sites. | |
| • All surfaces will be scrubbed or sprayed with a disinfectant and any electrical equipment will be wiped down with disinfectant wipes and heat applied. | |
| *Fish Health – Biosecurity Measures* | Section 2.5.1.2 |
| • Protocols will be in place to enhance biosecurity as personnel, equipment, and fish move between rooms and/or buildings. | |
| • Personnel will have separate work clothes for each facility and will be required to change upon entering a new building. | |
| • Disinfection procedures for personnel and their clothing will be in place. | |
| *Fish Health – Specialized Feed* | Section 2.5.1.2 |
| • All feed will be obtained from a major supplier and be CFIA approved as well as EU approved. | |
| *Fish Health – Feed Storage and Delivery* | Section 2.5.1.2 |
| • All feed will be stored in enclosed structures and/or facilities to eliminate the attraction of wild animals including pests/predators and the potential transfer of disease from wild animals. | |
| *Fish Health – Water Quality* | Section 2.5.1.2 |
| • Water Quality will be monitored and maintained at optimal conditions for growth during first-feeding, smoltification, and post-smolt production. | |
| • A routine program will be established for monitoring, measuring, and recording water quality in all buildings of the RAS Hatchery. | |
| • Waste and other debris in the tanks will undergo a series of treatments before being partially or totally reused. | |
| • Incoming water will be filtered with a fine filtration system. | |
| *Fish Health – Mortality Removal* | Section 2.5.1.2 |
| • Fish mortalities as well as moribund fish will be visually assessed and collected at a minimum, daily, via a port on each tank. Mortalities will be immediately transported to a centralized ensilage tank. | |
| *Fish Health – Health Checks and Procedures* | Section 2.5.1.2 |
| • Salmon at each stage of development will undergo health checks and procedures to minimize health risks such as disease. | |
| • Prior to being shipped to Newfoundland, eyed eggs will be tested and certified as disease-free. | |
| • Prior to entering the First-Feeding Facility, the eggs will be brought to a disinfection room where they will be rinsed, then disinfected as per Article 4.4.2 of the Aquatic Animal Health Code and de-boxed. | |
| • All equipment encountering eggs or egg containers will also be disinfected. | |
| • Records of time, source, and location of eggs will be maintained. | |
| • During incubation, eggs will be monitored and nonviable eggs promptly removed to eliminate fungal growth. | |
| • A private veterinarian will be used to respond to signs of health issues and to conduct routine monitoring prior to each transfer of fish to a new facility. | |
| • Staff and management will work closely with this private veterinarian to communicate any indication of health or disease concerns. | |
| • Staff will be trained to be familiar with normal fish appearance and behaviour and will be aware of the importance of relating any changes observed to supervisors or management. | |
| • A Fish Health Management plan will implemented to ensure fish health is optimized within all facilities. | |
| • Each transfer between hatchery facilities will be done with minimal stress on the fish. | |
| • Records will be maintained for each transfer including date, time, number, and weight of fish. | |
| • Where appropriate, fish will be anesthetized to minimize stress and trauma during handling. | |
| • All handled fish will be closely monitored for a period post-handling. | |
| • Participation in routine checks by a provincial veterinarian as part of the Province's passive surveillance program. | |
| • Prior to transfer to sea, fish will be vaccinated as per the specific recommendations of provincial veterinarians. | |
| • Will include the BKD and ISA vaccine, if recommended, based on consultations with the private veterinarian and DFLR. | |
| *Fish Escapes* | Section 2.5.1.2 |
| • During fish transfers between tanks and facilities, fish will be carefully monitored and counted. | |
| • Smolt will be transferred to a well boat via a double pipe leading from the Post-Smolt Facility to Mortier Bay. The pipe will be constructed such that a protective sacrificial pipe surrounds the transfer pipe. | |
| • A reinforced, continuous hose extending ~50 m from the shoreline to the well boat will be used to transfer fish. It will sit at the water's surface and will be continuously monitored by personnel. | |

| Monitoring and Mitigation Commitments | |
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| • Fish will be counted by fish counter as well as being monitored via video as they exit the hatchery and as they enter the well boat. | |
| • The day prior to transport, all equipment to be used will be checked and prepared (including checking the pipe and hose for breaches) and a checklist will be followed on the day of transfer. | |
| • Transfer of fish to the well boat will only occur during calm conditions. | |
| *Site Security* | Section 2.5.1.2 |
| • Fencing will be constructed around the land-based facilities and all staff, contractors, sub-contractors, vendors, and visitors who enter the area will have to pass through a security gate. | |
| • A closed-circuit television system will be installed around (and inside) the RAS Hatchery covering many of the vulnerable areas, public access points and adjacent streets. The system will be monitored by security from a Security Control Room. | |
| • Perimeter breach, intruder and panic alarms will be installed and continuously monitored from the Security Control Room and security will respond immediately to these alarms. | |
| • Members of the Security Team will carry out routine patrols of the buildings to provide a visible deterrence to criminal activity. | |
| *Emergency Response/Contingency Plan* | Section 2.5.1.2 |
| • Will have an Emergency Response Plan detailing procedures to respond to accidents, malfunctions, and emergencies. | |
| *Decommissioning and Rehabilitation* | Section 2.5.1.3 |
| • A plan will be developed with input from regulatory agencies that outlines procedures for shutting down operations at the RAS Hatchery. The plan will clearly lay out the approach and mitigation and monitoring details regarding removal of all fish and fish products, waste, chemicals, equipment and infrastructure. | |
| **Sea Cage Sites (marine-based)** | |
| *Construction* | Section 2.5.2.1 |
| • A tow route established in consultation with local fishers will be used and the tow speed will be a maximum of 3 knots (5.6 km/h). | |
| • Towing activities will be clearly communicated to stakeholders in the area and through Notice to Mariners. | |
| • Anchors will be installed for moorings at each of the sea cage sites and inspected prior to sea cage installation. Footprint of anchors will be minimized to extent possible. | |
| *Fish Escape – Equipment* | Section 2.5.2.2 |
| • COC requirements will be followed. | |
| • Aqualine Midgard cage systems will be used – these are based on Norwegian Standards and are considered industry best practice. | |
| • ROVs will be used to assist in tasks such as net inspections and in-situ net repair, if required. | |
| *Fish Escape – Handling Practices* | Section 2.5.2.2 |
| • Handling and feeding fish during potential superchill conditions will be avoided. | |
| • Will adhere to the best practices included in Appendix 6 of the COC including those for grading, weight sampling, sea lice counts, transportation, well boat treatments, and harvesting. | |
| *Fish Escape – Inspections* | Section 2.5.2.2 |
| • As a minimum, nets will be visually inspected every 90 days by an ROV. | |
| • Surface components of mooring systems, cages, nets and ropes on each site will be inspected once per week and recorded. | |
| • Underwater components of the mooring system, including the anchors, will be inspected based on a schedule developed in consultation with Aqualine and approved by DFO or DFLR. | |
| • Periodically, audits of the cage system as specified in COC Procedures for Compliance will be conducted and DFLR will arrange for audits of net testing procedures. Audits by DFLR will be conducted at a minimum of twice yearly (one in the spring, after fish entry; one audit in fall/early winter). | |
| • Any identified damaged equipment will be repaired or replaced immediately. | |
| *Fish Escape – Other Mitigation Measures* | Section 2.5.2.2 |
| • Immediately contact DFO and DFLR to determine fish recovery response. | |
| • Escape response drills will be performed on site annually to prepare for a fish escape event. | |
| • All new employees will also perform an escape response drill as part of their orientation. | |
| • Each BMA will have an escape response kit and all marine personnel will be trained in its use. | |
| • The Emergency Response Plan will be enacted if a recapture response is authorized. | |
| *Ice Monitoring and Mitigation* | Section 2.5.2.2 |
| • All sea cages will be routinely monitored for ice accretion by personnel on-site or via video camera. | |
| • Ice accretion will be minimized by personnel removing ice as it accumulates, which is typically done with rubber mallets. | |
| • Will routinely (minimum daily) receive and monitor broadcasts on ice conditions from the MCTS and receive guidance on the predicted timing and extent of any pack ice (or iceberg) incursions. | |

| Monitoring and Mitigation Commitments | |
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| • A three-tiered approach will be used to manage ice based on the type and size of the ice. | |
| • Emergency Response Plan will detail procedures to either harvest the fish or tow the sea cage(s) to a safe location in the event of a major ice incursion. | |
| *Predator Protection and Control* | Section 2.5.2.2 |
| • Each sea cage will have bird nets covering the entire top to prevent birds from taking fish. | |
| • Mesh size will be sufficient to deter predators but minimize the risk of entanglement and mesh will be dark colour. | |
| • A Migratory Bird Handling Permit will be in place and follow reporting requirements. | |
| • Will follow established procedures to release any tangled birds. | |
| • Each cage will have one or two cameras that offer 360 degree viewing and can be raised and lowered within the water column. | |
| • Nets will be repaired as quickly as possible by an ROV should a hole be detected. | |
| • Fish behaviour will be monitored from the control center for indications that a predator may be nearby. | |
| • Acoustic deterrent devices will not be used to keep marine mammals away. | |
| • Predator management will be conducted in such a manner as to ensure human safety. | |
| *Genetic Integrity and Biological Fitness of Wild Salmon* | Section 2.5.2.2 |
| • Only using fertilized triploid (sterile and all-female) Atlantic salmon eggs supplied from an accredited and approved company called Stofnfiskur. | |
| *Genetic Integrity and Biological Fitness of Wild Lumpfish* | Section 2.5.2.2 |
| • Lumpfish from a native broodstock will be used to produce farmed lumpfish used as cleaner fish in the sea cages. | |
| • Sea cages will be stocked with lumpfish once they reach 20–50 g (~5–10 months old) and harvest them 12–16 months later at 17–26 months of age prior to sexual maturity. | |
| *Fish Health* | Section 2.5.2.2 |
| • Mitigation measures and regular monitoring will be in place to maintain fish health including biosecurity measures, routine husbandry practices, health checks and procedures, use of specialized feed and feeding procedures, sea lice control procedures, water quality monitoring, vaccinations, and removal and treatment of dead fish. | |
| • Will implement a Fish Health Management Plan for its sea farms and all personnel will be trained in its proper procedures. | |
| • Health Checks and Procedures – Routine parasite screening will be carried out as well as routine diagnostic testing. | |
| • All routine parasite screening and active surveillance will be conducted by Grieg NL personnel on a schedule determined in consultation with provincial authorities and a private veterinarian that also considers fish health and welfare. | |
| • A passive surveillance program along with diagnostic testing will also be performed by provincial veterinarians. | |
| • Antibiotics will only be utilized as a last resort based on recommendations of health authorities. | |
| • The sea cage net will extend 45 m below the water surface to give sufficient volume to allow fish to avoid unstable surface conditions and thereby decrease stress. | |
| • Fish will only spend one winter at sea to minimize the risk of fish mortality. | |
| • Cleaner lumpfish will not be reused. | |
| • Specialized Feed and Feeding Procedures – using only an established feed adjusted to meet the requirement of triploid sterile salmon. | |
| • Feed wastage will be minimized via the use of established feeding tables/software used to determine feed type and amount and an automatic feeding system with video monitoring. | |
| • Salmon will be monitored during feeding and feed delivery will cease once they have reached ~80% satiation. | |
| • Sea Lice Control – Sea lice levels on salmon will be monitored weekly when water temperatures are above 4 °C and weather conditions allow. | |
| • Will use an adaptive management approach involving several methods to control sea lice in a given sea cage site and across BMAs. | |
| • Lumpfish will be used as a cleaner fish to minimize sea lice occurrence on salmon in all sea cages. | |
| • If monitoring indicates an increase in sea lice levels, Grieg NL will seek guidance from private and provincial veterinarians. | |
| • If sea lice levels require implementation of additional mitigation measure beyond the use of cleaner fish at a given sea cage site, Grieg NL will implement further preventative mitigation measures at other active sea cage sites in all BMAs. | |
| • Therapeautants will only be utilized as a last resort based on recommendations of health authorities. | |
| • Water Quality Monitoring – A routine program will be established for monitoring, measuring, and recording water quality at all active sea cage sites on a daily basis throughout the Project. | |

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| • In-situ data loggers will be installed on the barges at each sea cage site as well as on each individual cage. | |
| • Data will be wirelessly transmitted to centralized computer stations on the barges and at the control center in Marystown for real-time viewing or logged for historical collections. | |
| • Plankton samples will be completed weekly, analyzed and levels recorded. | |
| • Data collection will be used to evaluate the severity of any environmental issues such as fouling or changes in physio chemical data, leading to a response. | |
| • During transport of smolt from the RAS Hatchery to the sea cage sites, water quality in the hold of the well boat will be monitored. | |
| • Vaccinations – Salmon will be vaccinated as per the specific recommendations of provincial veterinarians. | |
| • The BKD and ISA vaccine will also be included based on consultations and recommendations with health authorities. | |
| • Lumpfish will receive vaccinations as recommended by health authorities prior to transfer to sea. | |
| • Prior to accepting lumpfish deliveries, Grieg NL will ensure the appropriate vaccine regime has been administered. | |
| • Mortality Removal and Treatment – An automatic system that removes dead fish from the bottom of the sea cage each day or more frequently will be used. | |
| • Mortalities will be retrieved and moribund fish will be euthanized if necessary. | |
| • The number of fish mortalities will be recorded daily. | |
| • When handling mortalities, personnel will be required to wear rain gear, gloves and boots which will be disinfected after each mortality disposal. | |
| • Personnel access to the ensilage container will be limited. | |
| • The ensilage will be transferred to shore once sufficient quantities are amassed. | |
| • If a mass mortality occurs, an Emergency Response Plan will be implemented. | |
| *Pathogen/Parasite Transfer between Farmed and Wild Atlantic Salmon* | Section 2.5.2.2 |
| • Feed wastage will be minimized and any mortalities removes as to not attract wild salmon. | |
| *Effects on Marine Habitat* | Section 2.5.2.2 |
| • Fallowing time of sea cage sites will be increased to a minimum of 16 months and a maximum of 19 months after harvesting, increasing the time for the benthic community to recover. | |
| • The Monitoring Protocol for Hard Bottom Benthic Substrates under Marine Finfish Farms in Newfoundland and Labrador will be followed. | |
| • Pesticides and disinfectants will not be used at sea cage sites. | |
| • Biodegradable detergent will be used during routine cleaning of the net collar and after harvesting and during fallowing. | |
| • Feed wastage will be minimized using a monitored feed system. | |
| • Will adhere to a schedule to clean the sea cage sites to minimize bio-fouling. | |
| • Cleaning schedule for cages and nets will be developed based on environmental conditions in Placentia Bay as well as routine monitoring. | |
| • Nets will typically be cleaned weekly and cages will be cleaned once or twice during heavy fouling periods. | |
| • Cages and nets will also be cleaned after harvesting is completed and prior to cages being transferred to other BMAs. | |
| • Routine checks of equipment utilizing underwater cameras, ROVs, and inspections by divers will be used to confirm the cleaning schedule of the sea cages. | |
| • Grieg NL will ensure the equipment has minimal fouling. | |
| *Entanglement* | Section 2.5.2.2 |
| • If a bird becomes entangled, established procedures to release the bird will be followed. | |
| • Grieg NL will have a Migratory Bird Handling Permit in place and will follow reporting requirements. | |
| • Sea cage mooring and buoy lines will be kept tensioned and no loose ropes in water. | |
| • Any entanglement of marine mammals, otters, wild fish, and sea turtles will be reported to DFO and action will be taken, in consultation with DFO (and the Whale Release and Strandings Group), to free or remove the animal. | |
| *Greenhouse Gas Emissions* | Section 2.5.2.2 |
| • The feed/accommodation barges will anchored and therefore, will only operate generators. | |
| • The newly constructed service vessels will have engines which are designed to minimize emissions and will comply with new Tier Three Regulations of Transport Canada. | |
| *Interactions with Other Users* | Section 2.5.2.2 |
| • Grieg NL will use several techniques to ensure other users of Placentia Bay are aware of the sea cage operations and to minimize the potential for interactions with users of the area. | |
| • Final placement of sea cage sites will be determined through the provincial lease process and in consultation with local fishers and other stakeholders. | |

| Monitoring and Mitigation Commitments | |
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| • Each sea cage site will be clearly marked according to regulatory requirements. | |
| • Sea cage sites will be delineated with a series of highly visible marker buoys, radar reflectors, and strobe lights. | |
| • Will have established transit routes with vessel speed limits (10 knots or 18.5 km/h) from crew change sites, resupply sites, and the RAS Hatchery to each of the sea cage sites. | |
| • Several communications tools will be used to make information on sea cage site and transit route locations and major project activities available to the public including Notice to Mariners, announcements on the Fisheries Broadcast, on-going meetings with local stakeholders, and notifications on Grieg NL and local town websites. | |
| *Site Security* | Section 2.5.2.2 |
| • Security Procedures and infrastructure will be in place at the sea cage sites. | |
| • Each active sea cage site will have Grieg NL personnel on site at all times with the exception of during extreme weather events. | |
| • Personnel will visually scan for security breaches. | |
| • A CCTV system will be installed around the sea cages and will be monitored primarily by personnel on the feed/accommodation barge and in the Security Control Room at the RAS Hatchery. | |
| • In the unlikely event of serious security breaches, Fisheries Officers from DFO will be contacted and respond to the scene. | |
| *Emergency Response/Contingency Plan* | Section 2.5.2.2 |
| • Grieg NL will have in place an Emergency Response Plan detailing procedures to respond to accidents, malfunctions, and emergencies at the sea cage sites and transport corridors to the sea cage sites. | |
| • Procedures will be in place for a security breach, mass fish mortality, escape/accidental release of fish, spills of hazardous substances, and response to a serious fish health incident. | |
| • Appropriate safety plans for personnel and vessel operations will be in place. | |
| *Species at Risk* | Section 2.5.2.2 |
| • Sightings of any species considered at risk observed at the sea cage sites and during transit to the sea cage sites will be recorded. | |
| • Personnel will receive training from experienced biologist(s) on the identification of the various bird, marine mammal, shark/tuna, and sea turtles and the associated data recording procedures. | |
| • Data will be submitted to DFO and ECCC-CWS as appropriate. | |
| • Transiting vessels to abide by safe distance regulations in accordance with specific breeding seabird colony area(s), and avoid disturbing birds to extent possible (especially during breeding seasons). | |
| • Minimize the amount of lighting at sea cage site to that needed for safe operations. | Section 7.3.2.2 |
| • Use downward-pointing and shaded lights on the barges to the extent possible. | Section 7.3.2.2 |
| • Search for stranded birds on vessels daily; implement ECCC-CWS release protocols. | Section 7.3.2.2 |
| • Cover vessel catchment areas. | Section 7.3.2.2 |
| • Vessels will maintain constant course and speed whenever it is practical to do so. | Section 7.3.3.2 |
| • Vessel crew will maintain watch for marine mammals/sea turtles and alter course and speed as appropriate to avoid marine mammals and sea turtles. | Section 7.3.3.2 |
| • Vessel crew will be prohibited from approaching marine mammals and sea turtles. | Section 7.3.3.2 |
| *Follow-up Monitoring (Biophysical VECs)* | Section 7.8 |
| • Water Quality Monitoring - Multi-year environmental monitoring program using ADCP and multiple probes at the semi-annual BMAs. | Section 7.8.1 |
| • If therapeutants or antibiotics are used, sediment samples will be collected where possible for analysis of presence of chemicals. | Section 7.8.1 |
| • If an accidental escape occurs, sampling of salmon from rivers, in collaboration with DFO, to determine fish origin (Grieg NL farm or not). | Section 7.8.2 |
| *Socio-Economic VECs (Follow-up Monitoring)* | Section 7.8.3 |
| • Work with local institutions to ensure training opportunities are available for actual and potential employees and contractors.<br>• Monitor efforts and success regarding diversity in hiring and retention by major contractors.<br>• Continue proactive program of communication with communities, local commercial fishers, stakeholder groups, and development groups. | |
| *Environmental Protection* | Section 8.2 |
| • If follow-up monitoring identifies unforeseen negative effects, an adaptive management approach will be implemented to address issues.<br>• Prior to Project commencement, develop an Environmental Protection Plan. | |

# 1.0 Introduction

The Placentia Bay Atlantic Salmon Aquaculture Project is proposed by Grieg NL Nurseries Ltd. and Grieg NL Seafarms Ltd. (the Proponent). The proposed Project is to build and operate a hatchery for Atlantic salmon (*Salmo salar*) in Marystown and to build and operate sea farms in Placentia Bay to grow salmon to market size. This document is the Environmental Impact Statement (EIS) as required by the Province of Newfoundland and Labrador's Department of Municipal Affairs and Environment under the *Environmental Protection Act* (*EPA*; Part 10, SNL 2002, cE-14.2). As per section 57 of the *EPA*, Final EIS Guidelines were issued to the Proponent on 9 March 2018 detailing the required information for the EIS (see Appendix A). The Final EIS Guidelines considered input received from stakeholders on Draft EIS Guidelines, which were issued in January 2018. To ensure that the requirements in the Final EIS Guidelines were addressed and that reviewers of this document can readily find required information, a Table of Concordance was prepared. The EIS is organized into Volume 1, the main body of the EIS, Volume 2, supporting appendices, and Volume 3, Component Studies. More specifically, Volume 1 includes:

- Executive Summary, including Table of Concordance
- Section 1: Proponent, Overview of Undertaking, and Purpose of the EIS
- Section 2: Proposed Undertaking
- Section 3: Environmental Assessment Methodology
- Section 4: Existing Environment
- Section 5: Consultations
- Section 6: Effects of the Environment on the Project
- Section 7: Effects of the Project on the Environment
- Section 8: Environmental Protection
- Section 9: References

Volume 3 includes the four required Component Studies: Wild Atlantic Salmon (LGL 2018a); Fish and Fish Habitat (LGL 2018b); Cultural, Recreational, and Commercial Importance of the Waters of Placentia Bay (Grattan et al. 2018); and Aqualine Midgard Sea-cage Study (Sullivan et al. 2018).

## 1.1 The Proponent

The Proponent is Grieg NL Nurseries Ltd. and Grieg NL Seafarms Ltd. These companies are owned by Grieg NL Salmon Ltd. (hereafter referred to as Grieg NL), a private company registered in Newfoundland and Labrador and based in Marystown. Grieg NL is 80% owned by the Norwegian based Grieg Group and 20% owned by the Newfoundland based Ocean Choice International (OCI).

Grieg NL's Chief Executive Officer is Mr. Knut Skeidsvoll and the contact information is as follows:

Name: Mr. Knut Skeidsvoll
Official Title: General Manager
Address: P. O. Box 457, 205 McGettigan Blvd., Marystown, NL, A0E 2M0
Telephone Number: (709) 279-3440
E-mail: GriegNL@griegnl.com

The principle contact person for the EIS is Mr. Perry Power and the contact information is as follows:

Name: Mr. Perry Power
Official Title: Human Resources Manager
Address: P. O. Box 457, 205 McGettigan Blvd., Marystown, NL, A0E 2M0
Telephone Number: (709) 279-3440
E-mail: GriegNLcontact@griegnl.com

Grieg NL has been actively developing the proposed Project in Placentia Bay since 2015. Although Grieg NL itself does not currently operate aquaculture projects, its parent company, the Grieg Group (e.g., Grieg Seafood ASA) has substantial experience. Grieg Seafood ASA is one of the world's leading fish farming companies, specializing in Atlantic salmon with active operations in Canada (British Columbia), United Kingdom (Shetland), and Norway (west and north coasts). Grieg Seafood has ~800 employees with over 140 of those employees working in British Columbia (BC). Since 2001, Grieg Seafood has been farming salmon on the east and west coasts of Vancouver Island and on the west coast of mainland BC. The company has a total of 22 marine farm sites in BC in addition to a land-based hatchery in Gold River, BC. The production capacity of all sites in BC is ~20,000 tonnes (gutted weight [GWE]). Grieg Seafood's production capacity at its aquaculture operations in Norway and the United Kingdom (UK) are ~57,000 and 22,000 GWE, respectively. In comparison, Grieg NL anticipates that at peak production, the Placentia Bay Atlantic Salmon Aquaculture Project will have a production capacity of 27,390 GWE.

Grieg Seafood has developed and employs modern fish farming technology to ensure safe, clean and top-quality food production. To secure knowledge sharing and to build on project successes, failures and lessons learned, Grieg Seafood has formed a competent team where employees meet regularly to share innovation and experience across the company. A key lesson learned from previous Grieg Seafood aquaculture projects was the need to implement a strategy for recycling fresh water within the hatcheries and for keeping salmon smolt in tanks longer than previously before exposing them to the sea. Over the past decade, Grieg Seafood has been expanding its hatchery operations in several locations in Norway and Shetland to accommodate larger smolt on land and implement Recirculating Aquaculture System (RAS) technology. With 27 grow-out licenses in Finnmark, one of the northernmost regions of Continental Europe, Grieg Seafood constructed in 2014 a new land-based post-smolt facility there with state-of-the-art equipment to grow smolt to a larger size prior to transfer to sea. A second post-smolt facility was constructed during fall 2017 to winter 2018 to increase capacity further. In Trosnavog Norway, Grieg Seafood has been expanding its operations with the construction of larger land-based RAS facilities to accommodate smolt to a size of 500–1,000 g prior to transport to sea. In 2016, construction of two additional land-based RAS facilities to expand on these operations began and are scheduled to be completed in 2018. In Shetland, UK, Grieg Seafood constructed a completely new RAS facility in 2015 to produce smolt upwards to 300 g prior to transport to sea. Grieg Seafood's experience with growing smolt to a larger size at land-based RAS has shown that the fish are more robust and achieve a shorter production cycle in sea, which also reduces exposure to sea lice and other biological threats. Grieg Seafood's experience will be shared locally and will provide Grieg NL access to a knowledge and experience base should any questions arise. Grieg NL will apply this approach, along with other advanced aquaculture techniques, in the proposed Placentia Bay Atlantic Salmon Aquaculture Project.

The Grieg Group, which owns 51% of Grieg Seafood ASA, has extensive knowledge from establishing new businesses with a focus on the marine and maritime element. The Group's most prominent success is the establishment of Grieg Seafood 25 years ago (1992), but over time several other projects were established. Some projects were unsuccessful, namely the establishment of cod farms, mussel farms and sea urchin farms. A key element of the failed projects is that they always provided substantial learning

opportunities useful in new projects. For example, the knowledge and the network established from cod and sea urchin farming projects were critical for the success of Rensefiskgruppen AS, Norway's largest, independent lumpfish farmer. Grieg Group owns the majority (60%) of Rensefiskgruppen, and considers it one of their biggest achievements in the past five years. Lumpfish are increasingly popular as a measure to reduce the sea lice pressure on salmon in sea cages, and Rensefiskgruppen continues to grow rapidly and currently employs more than 50 people in various small towns in Norway. Other success stories include Ocean Quality, a multinational sales company for salmon that employs more than 30 people selling more than 110,000 tons of salmon per year with a turnover of more than $800 million (Canadian) in 2016. The Grieg Group was also a large owner in Marine Farms and Fjord Seafood, which today has merged into Marine Harvest, the world's largest salmon farming company. The Grieg Group exited the companies before Marine Harvest was established, but the investment was a success and provided both knowledge and financial assets to support the growth of Grieg Seafood.

The Grieg Group continue to invest heavily in the aquaculture industry, and look forward to making Grieg NL a profitable and sustainable company that is in the business for the long term.

## 1.2 Purpose of the EIS

As outlined in the Final EIS Guidelines, the purpose of the EIS is to identify and assess the significance of biophysical and socio-economic effects of the Project taking into consideration mitigation measures. A key aspect of the EIS is to consult with the public and to respond to public concerns. It is understood that the information provided in the EIS and the Component Studies (see Volume 3) will be used to complement the comprehensive licensing and permitting processes and provincial and federal regulatory oversight currently in place for aquaculture projects in Newfoundland and Labrador.

The EIS was prepared by LGL Limited of St. John's, NL with input from Leslie Grattan and Associates Inc., Butland Communications, Oceans Ltd., and Mr. Bevin LeDrew. Grieg NL provided details on the Project Description, mitigation measures, and management plans. Details on key personnel responsible for preparing the EIS are provided in Appendix B.

# 2.0 The Proposed Undertaking

Grieg NL is proposing the Placentia Bay Atlantic Salmon Aquaculture Project. The Project has two primary components: a land-based RAS Hatchery located in the Marystown Marine Industrial Park and 11 sea cage sites located in the northern portion of Placentia Bay. A phased-approach will be used to ramp-up production of salmon.

## 2.1 Overview of the Undertaking

The Placentia Bay Atlantic Salmon Aquaculture Project has two primary components: a land-based Recirculating Aquaculture System (RAS) Hatchery located in the Marystown Marine Industrial Park and sea cage sites located in the northern portion of Placentia Bay that will be used to grow the salmon to market size (Figure 2.1). The development of the Project, including Construction and Operations/Maintenance of the RAS Hatchery and sea farms, will undergo a phased approach (Table 2.1) before reaching peak production of seven million salmon per year. It is anticipated that the RAS Hatchery will be operational in Year 2 and reach full production capacity (i.e., steady state) in Year 6. The first harvest at peak production at the sea farms is anticipated to occur in Year 8. For the purposes of this EIS, it is assumed that the RAS Hatchery and the sea farms will operate for 10 years at peak production.

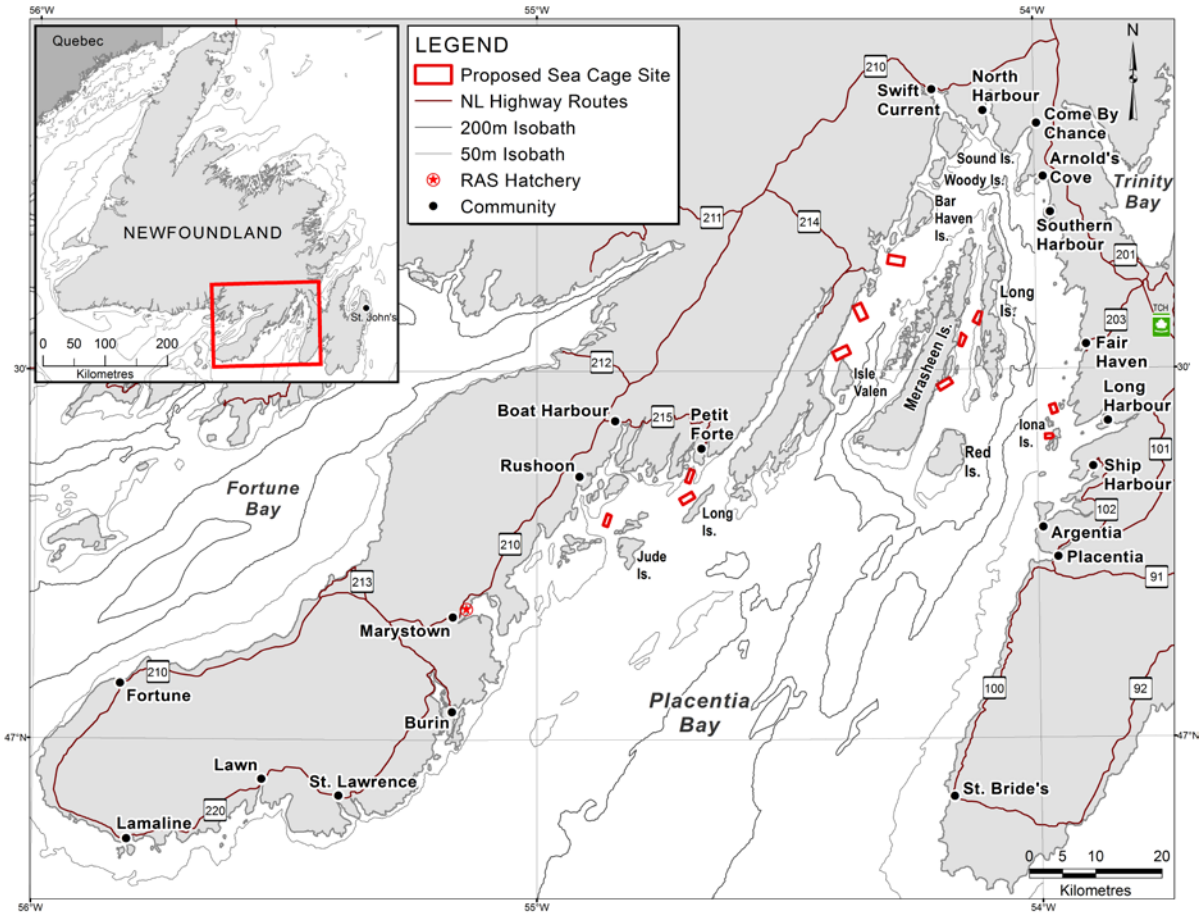



**Figure 2.1. Location of the proposed RAS Hatchery and sea cage sites in Placentia Bay.**

**Table 2.1. Summary of Project milestones.**

| Year | Project Milestone |
|---|---|
| 1 | EIS release and construction resumes |
| 2 | First shipment of eggs received in RAS Hatchery (Generation 1) |
| 3 | Generation 2 eggs received; First generation of smolts to sea (2 million) |
| 4 | Generation 3 eggs received; Second generation of smolts to sea (3 million) |
| 5 | Generation 4 eggs received; Third generation of smolts to sea (4 million; includes 1 million to seasonal lease site) |
| 6 | Generation 5 eggs received; Fourth generation of smolts to sea (6 million) |
| 7 | Generation 6 eggs received; Fifth generation of smolts to sea (7 million; steady state) |
| 8 | First harvest at peak production (7 million smolt) |

At the RAS Hatchery, smolt will be grown to sizes ranging from 350–1,400 g and then will be transferred to a well boat and delivered directly to sea cage sites. Eleven sea cage sites will be located within four Bay Management Areas (BMAs), which have been established for biosecurity purposes. Three of the BMAs are planned for semi-annual production and one BMA is planned for seasonal production. The semi-annual and seasonal sea cage sites will each have a maximum of 12 and 6 sea cages, respectively. Each of these sea cages can hold 160,000 salmon. At peak production, there will be seven active sea cage sites with 78 sea cages in operation per year.

Grieg NL has developed a salmon stocking schedule that takes into consideration Provincial requirements, water temperatures at the sea cage sites, and the benefits of limiting time at sea during the winter. As per the agreement with the Province (Memorandum of Understanding [MOU], dated 25 October 2015; Appendix C), only all-female sterile triploid Atlantic salmon will be used and a ramp-up of stocking is required prior to full production. All permits and approvals have been based on the use of all-female sterile triploid Atlantic salmon to be used for the Placentia Bay project by Grieg NL. In the unlikely event that the all-female triploid Atlantic salmon are unsuccessful in Placentia Bay, there is no contingency plan for egg supply. Only all-female sterile Atlantic salmon eggs will be used for the Placentia Bay Atlantic salmon project. As per the MOU stocking requirements, the sea cage sites will be stocked with a maximum of one million fish each for the initial stockings. Once each sea cage site has had one million fish reared in it, the number of fish can increase to a maximum of two million fish per sea cage site. Fallow periods of sea cage sites will be required and the three BMAs will rotate to ensure fallowing requirements are met or exceeded.

Once full production begins, the semi-annual sea cage sites will receive fish from the RAS Hatchery between May and October. These semi-annual smolt will range in size from ~350–800 g and will remain in the sea cages for 14–18 months for continued grow-out and will be harvested at a size of ~5 kg. The seasonal sea cage sites (Long Harbour BMA) will receive fish from the RAS Hatchery in May of each year at a size of ~1,200–1,400 g and remain in the sea cages for eight to nine months for continued grow-out and harvest at a size of ~4.5 kg. Each sea cage site will be attended by several vessels including a feed/accommodation barge, satellite feed barge, service vessel, crew vessel, and a work boat. Once salmon have reached market size they will be transferred to a dead hold vessel and then onto a third party for processing. Details on the construction, operations/maintenance, and decommissioning of the RAS Hatchery and sea cage sites are provided in Section 2.4.

## 2.2 Project Planning

The Project will take place in three primary phases:

- Construction;
- Operations and Maintenance; and
- Decommissioning and Rehabilitation.

Prior to Construction, Grieg NL has conducted project planning including consultations as well as the environmental assessment and permitting process (which is ongoing). Project planning is discussed further below.

### 2.2.1 Consultations

Consultations with the local stakeholders and government agencies played a key role in project planning. Consultations were initiated early in the Project and have included briefings and/or presentations to all area town councils, numerous regional associations, federal and provincial government departments, colleges and high schools, fishers union, as well as a number of public open houses on the Burin Peninsula. Additionally, Grieg NL has met with non-government organizations (NGOs).

Consultations with both the provincial and federal regulatory agencies also started early in the planning stage to facilitate the provision of a thorough Project Registration document (which was submitted to the Province on 19 February 2016; Registration No. 1834). Subsequent meetings with government agencies also assisted with planning the Project to ensure that regulatory requirements were understood and addressed in the EIS and subsequently included as part of the Project. Details on consultations are included in Appendix D, Consultation Report.

### 2.2.2 Project Principles

Grieg NL is committed to sustainable aquaculture. As part of the Grieg Group of Companies, Grieg NL will follow the principles of Grieg Seafood, which has identified key priority areas for sustainable aquaculture, all of which play a role in the planning and implementation of the Project. Key priorities include food safety and quality, fish health, minimizing effects on the environment, transparency and ongoing stakeholder engagement, maximizing local employment and benefits, and employee health, safety and working environment (see Grieg Seafood Sustainability Report 2017 *in* Appendix E).

Grieg Seafood is a member of the Global Salmon Initiative (GSI), a leadership initiative by global farmed salmon producers focused on making significant progress towards fully realizing a shared goal of providing a sustainable source of healthy protein to feed a growing population. The GSI members, which consist of salmon farmers that together produce more than 50% of the total salmon production in the world, all commit to yearly reporting company-wide data which are evaluated against key sustainability criteria. The results are presented every year in a transparent sustainability report (Appendix E). Grieg Seafood's chairman and largest owner Mr. Per Grieg, is a co-chairman for the GSI, which reflects a corporate and personal commitment to conduct business in a sustainable manner.

The Grieg Group companies, including Grieg Seafood are currently working to implement the UN (United Nations) Sustainable Development Goals (SDGs) into their corporate strategy. The SDGs are a collection of 17 global goals set by the UN and cover a broad range of social and economic development issues. Within these 17 goals are 169 targets. Implementation of the SDGs started worldwide in 2016 and has been referred to as "Localizing the SDGs". The goals apply to all countries and individual people, universities, governments, institutions and organizations which all work on implementing several goals at the same time. Grieg Group of companies, including Grieg Seafood has voluntarily begun to implement several of the targets identified within the UN SDGs into their strategies. Goal 14 "Life Below Water",

which focuses on the conservation and sustainable use of oceans, seas and water resources for sustainable development; Goal 2 “Zero Hunger”; and Goal 17 “Partnerships for the Goals” have all been identified as targets and are being incorporated into Grieg Group and Grieg Seafood’s corporate strategy. Grieg NL intends to embrace the same aims to follow the same company values, culture and strategy as Grieg Group companies and Grieg Seafood, where sustainability is a key component and identify and implement targets from the UN SDGs.

As described in Section 2.4, Grieg NL will use state-of-the-art technology at both its RAS Hatchery and sea cage sites. Grieg NL is also committed to acquiring accreditation and implementing Best Aquaculture Practices (BAP; see https://www.bapcertification.org/). BAP guidelines and procedures are designed to minimize effects on the environment and maximize socio-economic opportunities. Key elements of the proposed Project are consistent with a precautionary approach. Grieg NL proposes to use a number of mitigation measures that go beyond the common industry standard. These mitigations are described in detail in the following sections and include such approaches as the utilization of sterile triploid all-female salmon to minimize effects on wild salmon, the use of lumpfish to control sea lice, and fallowing protocols that exceed government requirements.

Grieg NL will ensure that project activities are conducted in full compliance with all applicable environmental, health and safety laws and regulations, by applying best available technologies and highest standards. Grieg NL is committed to the development and implementation of an Environmental Protection Plan (EPP), to help ensure a high level of environmental protection throughout the Project.

## 2.3 Regulatory Framework and Government Oversight

In Canada, the aquaculture industry is regulated and managed by both the federal and provincial governments. Grieg NL is required to adhere to these regulations. All land-based and sea cage operations require an Aquaculture Licence from the Provincial Department of Fisheries and Land Resources (DFLR [formerly DFA]). The licensing process requires referral to multiple federal and provincial agencies that must review the application and issue their own comments, permits and approvals before DFLR will consider any applications for a license. In addition, the application process for sea cage sites requires applicants to conduct consultations with stakeholders in the vicinity of the site prior to submission of the application. Furthermore, the Project must comply with municipal regulations related to the construction of the RAS Hatchery. A list of required key permits and approvals is provided in Table 2.2 which summarizes the following:

- Project activity requiring regulatory approval;
- Name of permit, license or regulatory approval;
- Name of legislation applicable in each case; and
- The regulatory agency responsible for each permit, license, and approval.

Grieg NL has used these regulations to assist in the development of the EIS and the Project proposal. Grieg NL is ultimately responsible for the preparation, submission and receipt of all required regulatory permits, approvals and certifications. The Proponent is also responsible for ensuring compliance with all applicable permits, approvals and certifications by its own employees, contractors and consultants.

**Table 2.2. Anticipated municipal, provincial, and federal approvals and permits for the Project.**

| Permit, License or Regulatory Approval | Activity Requiring Approval | Legislation | Regulatory Agency Responsible |
|---|---|---|---|
| **Government of Canada** | | | |
| DFO Approval | Any aquaculture activities | *Fisheries Act* | DFO |
| *Fisheries Act* Approval Scientific Permit | Construction near water | *Fisheries Act* | DFO |
| Aquatic Animal Health Import Permit | Import of fish eggs | National Aquatic Animal Health Program | Canadian Food Inspection Agency (CFIA) |
| *Navigation Protection Act* Assessment and Approval | Any work in navigable waters | *Navigation Protection Act* | Transport Canada |
| As per Transport Canada Regulations[a] | Transportation of explosives | *Transportation of Dangerous Goods Act* | Transport Canada |
| Migratory Bird Permit | Any activities that could cause mortality, disturbance or require relocation of migratory birds | *Migratory Birds Convention Act* | ECCC-CWS |
| **Government of Newfoundland and Labrador** | | | |
| Aquaculture Licence | Any aquaculture activities | *Aquaculture Act* | DFLR |
| Crown Land Permits | Leasing of land at the specified sea farm sites | *Aquaculture Act* | DFLR |
| Minister's Approval for the Introduction, Transfer and Transport of Fish | Transportation of fish from one site/facility to another | *Aquaculture Act* | DFLR |
| Application for Crown Land Title | Leasing of land for the land-based facility | *Lands Act* | DFLR |
| Certificate of Approval for Construction of Commercial Plant | Construction of the land-based facility | *Environmental Protection Act* | DFLR |
| Development Certificate | Construction and operation of the land-based facility | *Urban and Rural Planning Act* | DFLR |
| Application for Permit Water and Sewage Works | Obtaining/discharging water for use in construction and operation of the land-based facility | *Water Resources Act* | DFLR |
| Diesel Generator Registration Form | Operation of a generator | *Environmental Protection Act* and Air Pollution Control Regulations | DFLR |
| Water Use Licence | Obtaining water for use in the land-based facility | *Water Resources Act* | DFLR |
| Certificate of Approval for Industrial Facilities/Processes | Operation of the land-based facility | *Environmental Protection Act* | DFLR |
| Permit for Flammable and Combustible Liquid Storage | Storage of flammable and combustible liquids | *Environmental Protection Act* | DFLR |
| Certificate of Approval - Water Supply >4,500L/da | Obtaining water for use in the on-land facility | *Water Resources Act* | DFLR |
| As per Occupational Health and Safety Regulations[a] | Blasting at hatchery site | *Occupational Health and Safety Act* | Service NL |
| Notification to Minister of OH&S of start of construction for any project over 30 days duration | Construction of the land-based facility, including blasting | *Occupational Health and Safety Act* | Service NL |
| Building Accessibility Exemption Registration | Construction of the land-based facility | *Buildings Accessibility Act* | Service NL |
| Fire Commissioners Approval under the National Building / Fire / Life Safety Code | Construction of any buildings | | Service NL |
| Design Registration of Pressure Piping Systems | Operation of boilers, pressure vessels and compressed gas | *Public Safety Act* | Service NL |
| Petroleum Storage Tank Registration | Storage and Handling of Petroleum Products | *Environmental Protection Act* and *Fire* | Service NL |

| Permit, License or Regulatory Approval | Activity Requiring Approval | Legislation | Regulatory Agency Responsible |
|---|---|---|---|
| | | *Prevention Act* | |
| Electrical Permit | All electrical wiring and infrastructure installation | *Public Safety Act* | Service NL |
| Certificate of Plant Registration for Power, Heat, Refrigeration, Compressed Gas or Combined Plant | Various project related activities | | Service NL |
| **Municipal Government** | | | |
| Occupancy Permit | Permits must be in place for any development of the land-based facility | Town of Marystown Development Regulations | Marystown Municipal Government |
| Construction Permit | Permits must be in place for any development of the land-based facility | Town of Marystown Development Regulations | Marystown Municipal Government |
| Compliance with Marystown Municipal Plan | Permits must be in place for any development of the land-based facility | Town of Marystown Development Regulations | Marystown Municipal Government |

[a] The contractor conducting the blasting will be responsible for ensuring these regulations are followed.

### 2.3.1 Government of Canada

The key federal government departments involved in the oversight and management of aquaculture projects include Fisheries and Oceans Canada (DFO), Canadian Environmental Assessment Agency (CEAA), Canadian Food Inspection Agency (CFIA), Health Canada, Pest Management Regulatory Agency, and Transport Canada (TC).

The *Fisheries Act* and the *Aquaculture Activities Regulations* (*AAR*) guide aquaculture programs. These aquaculture laws, regulations and policies are available at DFO's website (http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/regs-eng.htm). Provisions within the *Fisheries Act* such as the fisheries protection provisions (Section 35) require that projects avoid causing serious harm to fish unless authorized by the Minister of Fisheries and Oceans Canada. This applies to work being conducted in or near waterbodies that support fish that are part of or support a commercial, recreational, or Aboriginal fishery. The pollution prevention provisions (Section 36) prohibits the deposit of deleterious substances into water frequented by fish.

In July 2015, the *AAR*, the first national aquaculture regulations, came into effect. Under authority of the *Fisheries Act*, the *AAR* provides greater environmental assurances and regulatory stability for businesses. The *AAR*s clarify conditions under which aquaculture operators may install, operate, maintain or remove an aquaculture facility, or undertake measures to treat their fish for disease and parasites, as well as deposit organic matter under Sections 35 and 36 of the *Fisheries Act*. The *AAR*s allow aquaculture operators to do so within specific restrictions to avoid, minimize, and mitigate any potential effects on fish and fish habitat. The Regulations also impose specific environmental monitoring and sampling requirements on the industry (currently only applicable to marine finfish cage sites). The *AAR* are complementary to existing provincial and federal legislative measures and build upon established siting criteria, mitigation measures, and production management measures.

The *AAR*s require aquaculture owners and operators to submit annual reports on their activities to the Regional Aquaculture Management Office (RAMO) no later than April 1 of the year following the year being reported on, and also require aquaculture owners and operators to notify DFO of: their intent to deposit pest control products; any morbidity events they observe; any exceedances of biological oxygen demanding thresholds; and, when they submit an application to a provincial or territorial authority for a new or expanded site.

Aquaculture Projects are not required to undergo a mandatory review under the fisheries protection provisions of the *Fisheries Act* by the Fisheries Protection Program. However, the DFO Projects Near Water self-assessment website directs proponents to the DFO RAMO if the project (new or existing) is in relation to aquaculture (marine or freshwater fish, including hatcheries, or shellfish). Projects are reviewed by RAMO to determine how to comply with the AARs. The RAMO is the key contact for provincial regulators and industry and plays the lead role in coordinating DFO review of proposals. The RAMO engages other DFO sectors to support the review, including Conservation and Protection, Resource Management, Policy and Economics, Fisheries Protection Program, Species at Risk Program, and Ecosystems and Ocean Sciences.

### 2.3.2 Government of Newfoundland and Labrador

The Newfoundland and Labrador DFLR is responsible for licensing all aquaculture operations (land and sea cage). For sea cage sites, this application process was developed by DFLR with full consultations and consideration of other departments, federal and provincial, to ensure that the information requirements meet the various departments' needs. The application package for a sea cage site aquaculture license includes site-specific data such as benthic characterization, current modeling, water quality data as well as site diagrams, a business plan and stakeholder consultations. DFLR may issue a site hold to an applicant to ensure the applicant can collect the necessary site-specific data and information to complete the application. The issuance of this hold is not an approval but rather assures the applicant that other proponents cannot submit an application for the same locations. Once the application for an aquaculture license for sea cage site package is complete, it is submitted to DFLR to be assessed internally by the Aquaculture Development Division. After the Aquaculture Development Division completes its review, the application is referred to external regulatory agencies including:

- DFLR Regional Services Division;
- Department of Environment and Conservation – Water Resources Division;
- Department of Municipal and Intergovernmental Affairs – Crown Lands Administration and Municipal Engineering;
- Department of Business, Tourism, Culture and Rural Development;
- DFO; and
- Transport Canada.

Once the application has been referred, the Proponent is required to advertise the aquaculture site license application and request comments from the public. Additionally, since 1999, DFLR, DFO and the salmonid industry have implemented a management strategy called the *Code of Containment for the Cage Culture of Salmonids in Newfoundland and Labrador* (COC; DFA 2014). The COC is a management strategy for cage culture of salmonids in Newfoundland and Labrador. This Code is predicated on a risk management approach and is consistent with the Oslo Resolutions, passed in 1994 by the North Atlantic Salmon Conservation (NASCO) in recognition of the need to minimize escapements and establish design standards for aquaculture cage systems. DFLR and DFO as well as the salmonid aquaculture industry have been actively applying the Code to marine cage grow out since its implementation in 1999.

Of note, Grieg NL has already received the following from both the Provincial and Federal Government:

- DFLR has conditionally approved an Aquaculture license application for the hatchery (COR/2016/2254) (Appendix F).
- A Sea Cage Site License application has not yet been submitted to DFLR but a site hold for the 11 sea cage sites in Placentia Bay was received in 2015 (Appendix G).

- CFIA have issued a permit to Grieg NL to import triploid (sterile) Atlantic salmon eggs. Following review and assessment of Stofnfiskur's facility by DFO and Provincial Animal Health Division (Appendix H).
- CEAA decided not to designate the Project for environmental assessment under the *Canadian Environmental Assessment Act*, 2012. This decision from the Minister of Environment and Climate Change was after careful consideration of the facts, the scientific advice provided by expert departments, including DFO, Environment and Climate Change Canada, and Health Canada, as well as consideration of the provincial and federal regulatory mechanisms that are in place to deal with the potential environmental effects of the Project.

### 2.3.3 Norwegian Standards

Grieg NL has voluntarily decided to adhere where appropriate to the Norwegian Standards for aquaculture (i.e., NS 9415.E:2009; see Volume 3, Appendix II *in* Sullivan et al. 2018), which outlines the requirements for site survey, risk analyses, design, dimensioning, production, installation and operation. This standard was developed and is currently in use in Norway for sea cage systems and is considered industry best practice.

## 2.4 Project Description

The proposed Project is to build and operate a land-based Recirculating Aquaculture System (RAS) Hatchery for Atlantic salmon smolt up to a size of 1,400 g in Marystown and to build and operate sea farms in Placentia Bay to grow the salmon to market size. Details on the construction, operations/maintenance, and decommissioning of the RAS Hatchery and sea farms are provided below. Note that the salmon will be delivered to a third-party fish plant for processing and therefore, the processing of salmon is not considered part of the Project.

The Project has been described previously in the *Registration of an Undertaking* document submitted to the Government of Newfoundland and Labrador in February 2016. Since submission of that document, the Project has undergone the following key changes:

- Farmed salmon will be all-female (triploid) for the full duration of the Project because the egg supplier can now meet order requirements (Appendix I-1 *in* Appendix I).
- The Workforce Employment Plan has been modified to reflect the delayed start in the Project and a better understanding of the job types required. The number of overall full-time personnel required has not changed.
- Additional chemicals for the RAS Hatchery are required and Health Canada provided an update on usage and disposal.

### 2.4.1 Project Rationale

The purpose of the Project is to produce high-quality farmed Atlantic salmon products for the North American market. By 2030, it is estimated that 62% of fish consumed globally will come from aquaculture projects (World Bank 2013). Recognizing the growing demand for farmed salmon, Grieg NL was invited by the NL provincial government to investigate salmon farming opportunities in the province. It was determined that Placentia Bay offers an excellent marine setting, a suitable and strategically located site to construct a facility for raising smolt from egg to 1,400 g, and an available work force to undertake a successful salmon farming project. These factors, combined with state-of-the-art aquaculture technology planned by Grieg NL, will allow salmon to be farmed in an environmentally and financially

sustainable manner. The proposed Project will increase the production and exportation of salmon products from Newfoundland and Labrador and provide local municipalities, the province of Newfoundland and Labrador, and Canada with substantial tax revenue. The proximity to the North American markets, particularly the northeastern United States (e.g., Boston), has positively factored into Grieg NL's decision to undertake the Project. The Project will also provide much needed sustainable employment to rural Newfoundland and Labrador. Finally, the Project will provide a profit to its shareholders, business opportunities to suppliers, and wholesome food to consumers.

#### 2.4.1.1 Rationale for Proposing European-strain Sterile Triploid Atlantic Salmon

Grieg NL strives for sustainability in all its aquaculture ventures. Grieg NL developed its business model for the Placentia Bay Atlantic salmon based on the premise that European-strain sterile triploid all-female Atlantic salmon will be purchased and used as the sole source of salmon eggs. This will minimize effects from salmon aquaculture and interactions with wild salmon populations. In March 2016, Grieg NL submitted a request to the CFIA and DFO to import sterile triploid Atlantic salmon eggs from a supplier, Stofnfiskur, in Iceland. Canada endorsed, the CFIA approved and the Canadian Science Advisory Secretariat (CSAS) reviewed the use of these sterile fish from Stofnfiskur to minimize effects as detailed within the NASCO through the 1992 North American Commission Protocols for the Introduction and Transfer of Salmonids (NAC (92)24), the 2002 Oslo Resolution (CNL 15.147), and the Williamsburg Resolution (CNL (06)48) (NAC/NASCO 1992).

Although the procedures and the benefits of producing sterile triploid Atlantic salmon have been known for decades, early culture reports indicated concerns in performance such as growth and survival (Carter et al. 1994; Galbreath et al. 1994; Cotter 2002) as well as other problems such as cataracts (Wall and Richards 1992) and skeletal deformities (Sadler et al. 2001). However, research into the nutrition and optimum culture conditions specific for triploid Atlantic salmon has significantly improved performance as well as reduced health concerns such as deformities and cataracts (Taylor et al. 2013, 2015; Sambraus et al. 2017a,b; Smedley et al. 2018). This knowledge along with development of diets specific to meet the needs of sterile triploid salmon has resulted in an increase in the interest on a commercial level of producing sterile Atlantic salmon. In addition to minimizing the impacts on wild salmon populations, sterile triploid Atlantic salmon have commercial advantages such as increased growth rates as well as consistently superior flesh quality year-round allowing for flexible harvesting schedules (H. Bronstad, NRS, pers. comm., 31 July 2017).

During normal reproductive development, organisms have three sets of chromosomes after fertilization and will typically shed one set of chromosomes. The result is an organism that is referred to as diploid (two sets of chromosomes). However, if this process is interrupted it is possible for an organism to retain this extra set of chromosomes and become triploid (three sets of chromosomes). This is a naturally occurring phenomena but can also be induced. The process of triploidy in Atlantic salmon is easy and inexpensive to induce and can be achieved by subjecting a fertilized egg to pressure during specific stages of development. The result is a fish that is sterile and unable to reproduce. This aspect along with other benefits has been seen by aquaculturists as a means to mitigate inter-breeding with wild populations should an escape occur.

In the majority of places where salmon farming occurs, there are rivers and migration routes for wild salmon. A majority of fish farmers of Atlantic salmon worldwide have encountered opposition and concerns around their operation due to potential genetic pollution of wild salmon in case of an escape from their operation. At present, the best method to eliminate all potential genetic interaction as well as any disturbance of spawning areas in wild salmon rivers is the use of triploid sterile all-female salmon. The process of triploidy in fish interferes with gonadal development and gametogenesis in many species

but can be differential between sexes (Cotter et al. 2000; Cuñado et al. 2002; Carrasco et al. 1998). This is evident with female and male Atlantic salmon. Triploid female Atlantic salmon rarely produce eggs but if they do, very few eggs are produced and the eggs are immature (undeveloped and un-fertilizable) (Benfey 2001). Triploid male Atlantic salmon may be capable of producing small amounts of spermatozoa, which can result in fertilization. These spermatozoa however, are aneuploid and incapable of generating viable offspring if used for fertilization (Cotter et al. 2000; Piferrer 2009). So although gonad development may occur on rare occasions in triploid Atlantic salmon, the process of induced triploidy renders gametes from triploid Atlantic salmon as genetically sterile. Despite the development of this process over 30 years ago (Benfey and Sutterlin 1984), there have been some obstacles and challenges to overcome as well as concerns surrounding the performance and economic viability of using sterile triploid Atlantic salmon on a commercial scale. However, recent improvements and a shift towards encouraging commercial production of triploids in Norway and the UK has improved the viability of this process as a means to mitigate genetic interactions with wild salmon.

Since the mid-1980s when the production of all-female and sterile rainbow trout accounted for over half of the production in the UK and commercial techniques were explained (Bye 1986), the use of sterile all-female trout in this industry has increased. A large portion of this production is for the smoke market in France, UK and Spain, and for portion production predominately in Italy, Spain and Poland. Total triploid production in 2013 was approximately 70,000 MT (Hansen et al. 2007). Triploid production of rainbow trout is also common in North America. Nearly half of the triploid trout produced in North America is to enhance sport fisheries and angling opportunities for inland fisheries without affecting the genetic population of wild trout by interbreeding (Isaac 2017). Alaska for instance releases over one million sterile rainbow trout annually for this purpose (ADFG n.d.). Although some states still choose to stock with fertile diploid trout, states such as Idaho, North Carolina and California only use sterile triploid rainbow trout for stock enhancement, conservation and recreation.

Although the concept of sterile triploid has been embraced since the 1980s for rainbow trout, Atlantic salmon has been slower to use this approach in North America. However, locations such as Tasmania and Scotland have been using sterile triploids for decades. Tasmania has been using sterile triploid Atlantic salmon as part of their commercial operations since the late 1980s and it now produces 55,000 MT annually (TSGA 2018). However, Tasmania has chosen to use triploids, not to prevent genetic interactions with wild fish, but rather to ensure better growth and flesh quality relative to diploid salmon whose flesh quality is inferior as they “mature”.

Norway in recent years has seen tremendous growth in the use of sterile triploid Atlantic salmon in its commercial industry. Production of triploid Atlantic salmon went into a commercial phase there beginning in 2012; and between 2015 and 2017, approximately 45 million sterile Atlantic salmon eggs were provided to the Norwegian industry by two Norwegian suppliers, Stofnfiskur/SalmoBreed and AquaGen. One of the reasons production accelerated is due to the issuing of “green licenses”. These licenses rewarded companies using triploid sterile Atlantic salmon to remove the potential genetic impact on the wild salmon from escaped farmed salmon. Several companies in Norway are now using triploid salmon as part of their new strategy towards avoiding genetic pollution of the wild stock. All these companies have had record high return on their profit during the last three years and harvest quality on triploid and diploid has proven equal (H. Bronstad, NRS, pers. comm., 31 July 2017).

In Norway, both small and large companies have been transitioning to the use of sterile triploid Atlantic salmon production to take advantage of “green license” concessions as well as improve the industry and attain higher levels of sustainability. Three companies that can be used as an example of this is Eide Fjordbruk in Rogaland and Hordaland, Norway; Linga Laks in Hordaland, Norway and Norwegian Royal Salmon (NRS) with locations in Troms and Finnmark, Norway.

Eide Fjordbruk is a small farming company in Norway which has approximately 59 employees and is producing annually approximately 10,000 MT. Eide Fjordbruk began production of sterile triploid Atlantic salmon in 2013 and the operating revenues and profit (Norwegian Krone [NOK]) for 2014–2016 can be seen in Table 2.3 (Proff n.d.[a]).

**Table 2.3. Eide Fjordbruk operating revenues and profit (NOK) for 2014–2016.**

| | 2016 | 2015 | 2014 |
|---|---|---|---|
| Operating Revenue | 495,583 | 210,187 | 94,478 |
| Operating Profit | 222,149 | 21,802 | 9,314 |
| Revenue before Tax | 221,003 | 22,003 | 31,774 |

Linga Laks is another small farming company in Norway with approximately 63 employees and producing approximately 14,000 MT annually. Linga Laks also started its production of sterile triploid Atlantic salmon in 2013 and as can be seen in Table 2.4 has seen its revenue and profit increase during the production years 2014–2016 (Proff n.d.[b]).

**Table 2.4. Linga Laks operating revenue and profit (NOK) 2014–2016.**

| | 2016 | 2015 | 2014 |
|---|---|---|---|
| Operating Revenue | 632,690 | 477,005 | 345,558 |
| Operating Profit | 212,841 | 100,443 | 74,689 |
| Revenue before Tax | 210,238 | 97,383 | 71,708 |

NRS is a relatively large salmon farming company with approximately 150 employees and producing approximately 66,000 MT annually. NRS began production of sterile triploid Atlantic salmon in 2014 through their acquisition of "green licenses" (NRS 2016). As can be seen from Table 2.5, NRS has also seen a steady increase in revenues over the period 2014–2016.

**Table 2.5. Norway Royal Salmon (NRS) operating revenue and EBITDA (NOK) 2014–2016.**

| | 2016 | 2015 | 2014 |
|---|---|---|---|
| Operating Revenue | 4,224,340 | 3,210,548 | 2,599,799 |
| Operating Profit | 66,808 | 69,971 | 59,110 |
| Revenue before Tax | 701,676 | 255,591 | 199,475 |

Grieg NL has developed a good relationship with NRS and hosted a knowledge exchange trip in 2017 to discuss their experiences and gain insight on a commercial level to the challenges as well as the benefits of utilizing sterile triploid Atlantic salmon. Grieg NL and NRS both agree that collaborating on their experiences will assist both companies to benefit and have agreed to continue to communicate as Grieg NL moves forward in Newfoundland and NRS moves forward in Norway and Iceland. NRS, like Grieg NL, believes in the sustainability and benefits that can be achieved with the use of triploid Atlantic salmon and are committed to the continued use and improvements of triploid Atlantic salmon in the aquaculture industry on a global scale.

Despite some previous commercial concerns surrounding the use of triploid versus diploid Atlantic salmon, recent research and industry results show that triploid Atlantic salmon perform equal or better than diploid salmon. The Norwegian Department of Fishery in a five year study on the large-scale production of triploid salmon under commercial conditions with AquaGen of Norway concluded that triploid and diploid salmon perform equally (Fiskeridirektoratet 2016). Five aquaculture companies in

Norway were involved in the study and they received triploid Atlantic salmon to culture alongside diploid Atlantic salmon. The factors compared included growth rate, survival, deformities and fillet quality. The Norwegian Department of Fishery, stated in 2016 that results of the study indicated that triploids grew faster than diploids in freshwater, the growth during the first year at sea was equal for triploid and diploid, mortalities of triploids were low during the first year at sea, and harvest fillet quality of the triploids was superior.

A recent study conducted in Tasmania showed similar results of equal performance between diploids and triploids (Nuez-Ortin et al. 2017). The study compared the performance, fatty acid composition and proteome response of all female triploids and diploid Atlantic salmon. Based on the results of this test, it was concluded that with optimal husbandry conditions, all-female populations of diploid and triploid Atlantic salmon showed no difference in these factors (Nuez-Ortin et al. 2017). Previously, a study conducted in New Brunswick in 1992 through the Salmon Genetics Research Program of the Atlantic Salmon Federation showed that after eight months post-fertilization the growth rates of triploid and diploid Atlantic salmon showed no differences. The study concluded these results provided support for the use of triploid Atlantic salmon in the New Brunswick aquaculture industry (McGeachy et al. 1995).

The equal performance of diploids and triploids is not surprising given that the same criteria for broodstock selection are used for both. Both triploid rainbow trout and triploid Atlantic salmon eggs are from the same broodstock as diploids. For the Norwegian/Icelandic broodstock program, the choice and development of families/special qualities in regard to disease, parasites, growth, temperature and other traits are the same for both triploid and diploid.

Grieg NL intends to use the salmon broodstock company Stofnfiskur, established in 1991, with roots back to the beginning of the Atlantic salmon broodstock program. Stofnfiskur is part of Benchmark Genetics, an innovative company in the aquaculture and agriculture sectors. Benchmark Genetics has two Atlantic salmon breeding programs today; namely Stofnfiskur and SalmoBreed. The programs are family based and combined they have more than 1,500 families of Atlantic salmon at any given time in their systems. Through their broodstock programs, the aim is to achieve maximum gain on important production traits while restricting inbreeding. Different test groups are made for different tests to have valuable data input to the breeding calculations. Today they test families for sea lice, yield (fillet quality, texture, colour, fillet size, etc.), and different challenge tests (SRS, PDV, IPNV, ISAV) to provide a broad background on the genetic material available.

Individual pit tags are used for marking a high number of sibling groups of the broodstock candidates which are collectively termed “informants”. A typical group of informants consists of an equal number of individuals per family, normally in the size order of 5,000–10,000 fish depending on the various tests. In all tests the performance of fish is measured by compiling large amounts of data that go into a central breeding database which is evaluated by a geneticist. Tests are typically conducted for every new generation.

One of the most important benchmarks is the testing of the informant groups under commercial production and conditions. The aim is to have data on actual performance of the fish under industrial conditions. When these groups are reaching harvest weight, the fish are subjected to a series of tests measuring a range of sampling weights as well as quality measures. Novel technologies such as Near Infrared (NIR) and spectroscopy technology as well as CT scanning (under development) are providing valuable information in the selection of the best breeding candidates. In addition to the testing of sibling groups, there is also a mass selection on the actual breeding candidates directly based on a phenotypic selection. This means that it is only the fittest and most suitable fish that will be used to obtain eggs or sperm. Both Quantitative Trait Loci (QTL) and genomic selection are used for marker assisted selection.

Currently, suppliers of fertilized eggs for the industry are using information on diploids to design the genetic make-up of the all-female triploids. The reason for this is that there are no important breeding traits in diploid salmon that are different for an all-female triploid salmon. All information and documentation for breeding programs show that 2n (diploid) families when tested perform equal to their 3n (triploid) siblings. This is based on results from the extensive European Union (EU) project SalmoTrip (2008–2010; CORDIS 2013) and other published material such as the latest SAV challenge test where 2n and 3n were similar in performance (Moore et al. 2017). Moore et al. (2017) compared the susceptibility of diploid and triploid Atlantic salmon to common infections such as salmonid alphavirus (SAV). After 35 days, both groups reached 100% prevalence of infection; however, the prevalence accumulated more slowly in the triploid group. In conclusion, the triploid salmon in this study were not more susceptible to SAV than diploid salmon. Although not currently a concern in Newfoundland, Amoebic Gill Disease (AGD), caused by the protozoan amoeba *Neoparamoeba perurans*, is a concern for countries such as Tasmania, Ireland, Scotland and Norway. Chalmers et al. (2017) compared the response of diploid and triploid Atlantic salmon to experimental challenges and concluded ploidy did not significantly affect the manifestation or severity of AGD. Frenzl et al. (2013) compared diploid and triploid Atlantic salmon susceptibility to infection with sea lice *Lepeophtheirus salmonis*. Tank trials were conducted in Scotland and Norway and a commercial cage trial in Scotland. In all trials, it was concluded that triploid Atlantic salmon are not more susceptible to sea lice infestations than diploids. Thus, triploids can be considered equal or comparable to diploids for commercial production regarding susceptibility to common disease and parasite infections such as SAV, AGD as well as sea lice.

Sambraus et al. (2017b) investigated temperature and its interaction with oxygen level effects on triploid Atlantic salmon performance. The performance indicators included aspects such as feed intake, growth, metabolism and physiological status. Half the eggs collected from each female were subjected to hydrostatic pressure to induce triploidy and all eggs were cultured under the same conditions with diploids and triploids separated for comparison. Culture temperature comparisons were between 3˚C and 18˚C for both groups. Although triploids, as compared to diploids, had higher feed rates in the lower temperature range (3–9˚C), feed rates decreased between 15˚ and 18˚C while diploid feed rates remained constant at these temperatures. Compared to diploids, reduced feed rates were also observed for triploids when exposed to low oxygen concentration (60% $O_2$ saturation) and a cold temperature (6˚C). At low oxygen concentration (60 % $O_2$ saturation) and warm temperatures (18˚C), triploids had higher mortality than diploids. There was little significant difference observed between the groups regarding the other performance indicators. It was concluded that triploid Atlantic Salmon can be substituted for diploid Atlantic salmon in geographical areas with temperatures typically less than or equal to 15˚C and with sufficient oxygen concentrations.

Hansen et al. (2015) also compared performance of diploid and triploid Atlantic salmon at various temperatures and reduced oxygen concentration (70% $O_2$ saturation). No difference was observed between the diploid and triploid groups with regard to length and weight measurements, but triploids had significantly higher mortality at 70% $O_2$ saturation compared to diploids. Hansen et al. (2015) concluded that triploid Atlantic salmon were negatively impacted on important production parameters (feed intake, mortality, etc.) when cultured at high seawater temperatures (19˚C) and this was compounded when oxygen saturation levels were lower (70% saturation). In conclusion, triploid Atlantic salmon are more suited to culture in areas that have temperature profiles that are moderate in the summer months and not subject to periods of low oxygen saturation (hypoxia).

Over the two years Grieg NL has been measuring water quality in Placentia Bay, the temperature has typically been below 15˚C. Water temperatures have reached a high of 17˚C in August 2016 but have not been for extended periods and only in the upper 10 m of the water column (see Table 4.6 *in* LGL 2018a). In 2017, the temperatures remained at or below 15˚C. Likewise, the oxygen concentration of Placentia

Bay over the 2016 and 2017 sampling period indicates that hypoxia should not be a concern. Oxygen concentrations are predominately near or above 100% saturation and consistently much above 6 ppm (see Table 4.7 *in* LGL 2018a), which is considered an indicator of hypoxic conditions (Mansour et al. 2008). These results support Grieg NL's decision that Placentia Bay will provide optimum culture conditions for triploid Atlantic salmon.

Differences between male and female triploid Atlantic salmon have been observed regarding maturation and spawning behaviours. Although both are effectively 100% sterile, triploid males may mature sexually and exhibit spawning behaviours (Fjelldal et al. 2014; Glover et al. 2016). Consequently, farmed male triploid Atlantic salmon escapes could potentially impact wild salmon populations by migrating to rivers (Cotter et al. 2000) and disrupting local spawning behaviour or even coaxing fertile wild females to spawn with a sterile fish (Fjelldal et al. 2014). Female triploid Atlantic salmon on the other hand do not exhibit sexual maturation or spawning behaviours (Cotter et al. 2000) and therefore is the preferred choice for Grieg NL to ensure that any potential interactions with wild salmon populations will be mitigated.

The potential for an escaped adult triploid Atlantic salmon to return to freshwater and attempt to spawn is considerably lower than a diploid Atlantic salmon (Cotter et al. 2000; Fjelldal et al. 2014). Glover et al. (2016) studied escapees captured in 17 rivers in Norway between 2007 and 2014. The study concluded that the propensity for triploid Atlantic salmon to migrate into freshwater following an escape is significantly lower than for diploid Atlantic salmon escapes. With only 0.18% of the escapees being triploid while salmon cultured in Norway during this same period was 10-fold higher, indicates significantly reduced motivation of triploids to migrate to freshwater. In addition, when recaptured in freshwater the triploids were observed in the lower or estuarine sections of the river and not on the spawning grounds. Based upon these observations, it was concluded that the commercial production of triploid Atlantic salmon would function as an effective barrier for interactions of farmed and wild populations during spawning and reduce the numbers of farmed Atlantic salmon escapees entering rivers.

After careful consideration of the current research and development as well as experiences and improvements in the industry regarding culturing sterile triploid all-female Atlantic salmon, Grieg NL concluded that the use of sterile triploid all-female Atlantic salmon was the ideal choice for its proposed operations in Placentia Bay. The main factors for moving into full scale production of sterile triploid all-female Atlantic salmon in Placentia Bay for Grieg NL are as follows:

1. Sterile triploid all-female Atlantic salmon perform better than diploid Atlantic salmon in the fresh water stage. In the sea, its performance is equal if not better than diploid salmon in cold environments such as Placentia Bay. The primary benefit is that an all-female sterile triploid salmon eliminates the genetic impact on wild salmon populations if there is an escape. Sterile triploid females will not mature (sexually) or possess a desire to migrate to freshwater.
2. Commercial economically available feed specialized and proven for triploid Atlantic salmon from salmon feed providers ensures all the nutritional requirements are met to produce a fish that is healthy. Since the sterile triploid all-female Atlantic salmon do not mature, their food energy is primarily used for growth.
3. A year-round commercial supply of sterile triploid all-female Atlantic salmon eggs using the best broodstock available for commercial salmon farming enables adequate stocking and optimal utilization of the smolt window available in Placentia Bay. With stringent procedures, protocols and numerous certifications, a guarantee of sterile triploid all-female (see Appendix I) eliminates possibilities for genetic impacts on the wild salmon in Newfoundland.
4. Water parameters such as temperature and dissolved oxygen (DO) in Placentia Bay are ideal culture conditions for sterile triploid all-female Atlantic salmon.

Based on these factors, Grieg NL has determined that the use of sterile triploid all-female Atlantic salmon for its operations in Placentia Bay is a means to sustainably provide healthy and nutritious seafood while minimising environmental impacts, supporting economic growth and contributing to the development of local communities.

### 2.4.2 Prospective Site and Study Area

The Project will be located in the Marystown Marine Industrial Park and in four BMAs situated in the northern portion of Placentia Bay. An overview of Placentia Bay is provided in Section 2.4.2.2.

#### 2.4.2.1 Terrestrial

The Town of Marystown is located on the Burin Peninsula, adjacent to Mortier Bay, Placentia Bay, Newfoundland and Labrador (see Figure 2.1 earlier). The land-based components of the Project (i.e., RAS Hatchery) will be situated in Marystown's Marine Industrial Park, which is accessed from Highway Route 210 via Kaetlyn Osmond Drive (Figure 2.2). Grieg NL has acquired Lots 7, 9, 11, 13, and 15 (total area of 10.25 hectares) in the Marine Industrial Park. The lots are already serviced with three phase power, municipal water and sewer, and a paved access road. The site for the RAS Hatchery has been mostly cleared and grubbed and infrastructure will be constructed as described in Section 2.4.3.1.




**Figure 2.2. Location of the proposed land-based facility (RAS Hatchery) in Marystown.**

All construction sites and storage areas for the RAS Hatchery and sea farms will be located at the Marine Industrial Park. Third-party suppliers for both the RAS Hatchery and sea farms, including assembly and servicing of equipment such as sea cages and nets, are planned to be located at the Marine Industrial Park.

### 2.4.2.2 Marine

Grieg NL has proposed 11 sea cage sites in Placentia Bay which will be located in four BMAs. BMAs are recognized as an effective approach to disease management, to mitigate pathogen presence and spread, as well as enhance biosecurity by establishing discreet regions for individual companies; the BMA approach has been adopted in other provinces in Canada (Chang et al. 2007). The delineation of BMAs is based on an assessment of quantitative and qualitative environmental variables including detailed oceanographic data. Coastal oceanographic data collection is ongoing with DFLR to assist in the delineation of BMAs in Newfoundland for aquaculture. The establishment of the four BMAs in Placentia Bay is a production strategy that Grieg NL has proposed to the DFLR as a means of separating salmon year classes as well as separating Grieg NL sites from other fish farming companies currently in operation on the South Coast of Newfoundland. Grieg NL has proposed BMAs to DFLR as depicted in Figure 2.3, which includes the Rushoon BMA, Merasheen BMA, Red Island BMA and the Long Harbour BMA (Table 2.6). Any changes in these BMAs will have to be requested by Grieg NL and approved by DFLR and relevant federal departments. The BMA delineations are “imaginary” boundaries used by Grieg NL to reduce risk of disease transmission and increase biosecurity. These boundaries are used to clearly define movements of personnel and equipment in a biosecure manner.

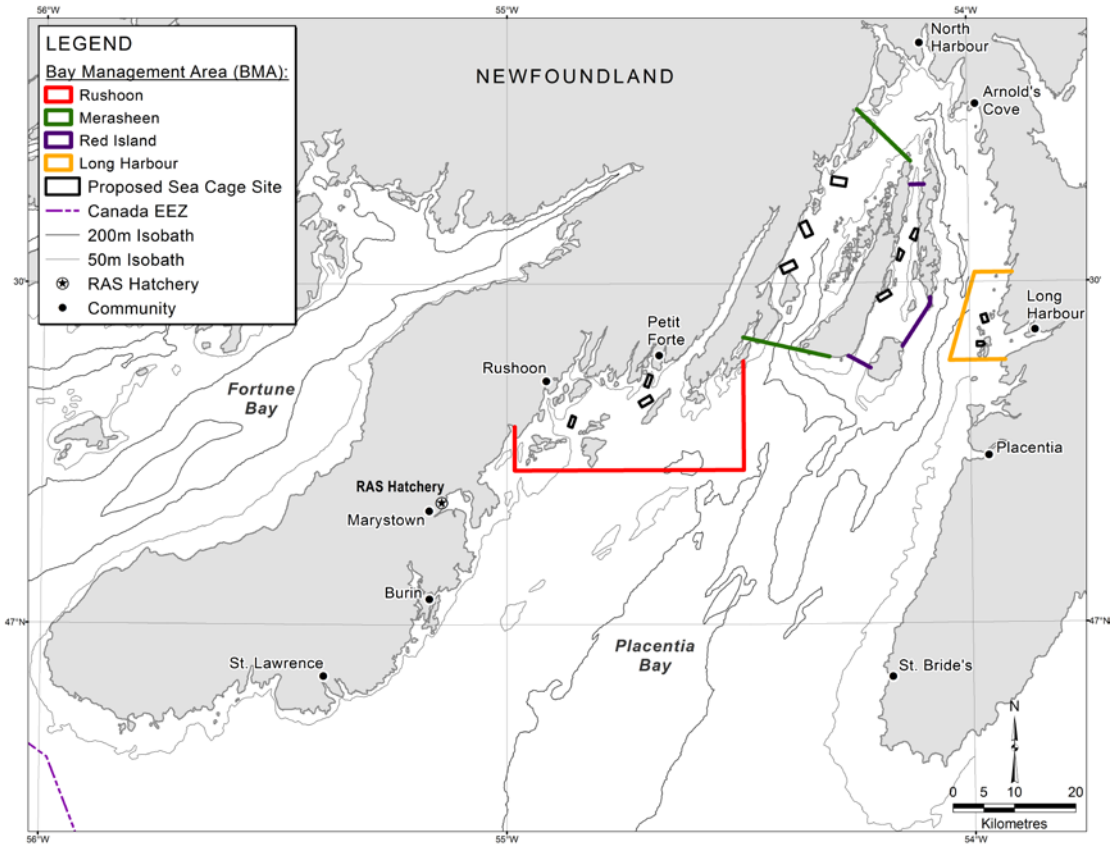



**Figure 2.3. Locations of the BMAs and proposed sea cage sites.**

**Table 2.6. Location (corner coordinates) of the 11 sea cage sites where sea farms are proposed.**

| **Rushoon BMA** | | | | | |
|---|---|---|---|---|---|
| Oderin Island | | Long Island | | Gallows Harbour | |
| Latitude (°N) | Longitude (°W) | Latitude (°N) | Longitude (°W) | Latitude (°N) | Longitude (°W) |
| 47.307183 | -54.859800 | 47.327167 | -54.715417 | 47.367567 | -54.694350 |
| 47.304450 | -54.851400 | 47.336533 | -54.691333 | 47.365417 | -54.685633 |
| 47.289783 | -54.859100 | 47.328750 | -54.684600 | 47.348467 | -54.694650 |
| 47.291950 | -54.867783 | 47.319300 | -54.708600 | 47.350633 | -54.703333 |
| **Merasheen BMA** | | | | | |
| Valen Island | | Chamber Island | | Ship Island | |
| Latitude (°N) | Longitude (°W) | Latitude (°N) | Longitude (°W) | Latitude (°N) | Longitude (°W) |
| 47.534133 | -54.379367 | 47.586733 | -54.366367 | 47.656483 | -54.293717 |
| 47.523383 | -54.371900 | 47.591650 | -54.350517 | 47.652800 | -54.262167 |
| 47.514217 | -54.400850 | 47.572100 | -54.337183 | 47.641283 | -54.265167 |
| 47.524917 | -54.408183 | 47.567117 | -54.353000 | 47.644983 | -54.296717 |
| **Red Island BMA** | | | | | |
| Darby Harbour | | Red Island | | Butler Island | |
| Latitude (°N) | Longitude (°W) | Latitude (°N) | Longitude (°W) | Latitude (°N) | Longitude (°W) |
| 47.489467 | -54.174650 | 47.549583 | -54.150017 | 47.577617 | -54.108183 |
| 47.482167 | -54.168367 | 47.544467 | -54.139983 | 47.578550 | -54.115717 |
| 47.472200 | -54.193333 | 47.532083 | -54.148367 | 47.561017 | -54.114200 |
| 47.479750 | -54.199783 | 47.533183 | -54.155117 | 47.565500 | -54.126100 |
| **Long Harbour BMA** | | | | | |
| Iona Island | | Brine Island | | | |
| Latitude (°N) | Longitude (°W) | Latitude (°N) | Longitude (°W) | | |
| 47.411767 | -53.984367 | 47.450417 | -53.975567 | | |
| 47.411767 | -53.971100 | 47.452783 | -53.964150 | | |
| 47.409099 | -53.967838 | 47.441600 | -53.958983 | | |
| 47.408198 | -53.967838 | 47.439200 | -53.970350 | | |
| 47.405417 | -53.973083 | | | | |
| 47.405417 | -53.984400 | | | | |

Within three of the four BMAs, there are three sea cage sites; one BMA (Long Harbour) has two sea cage sites, for a total of 11 sites. In 2015, Grieg NL was given a site hold for all 11 sea cage sites and this was reconfirmed by the DFLR in late 2016 (Appendix G). Following the release of the Project, Grieg NL will submit to DFLR 11 individual sea farm site applications for approval as per the licensing process (DFA 2015). Nine of these sites will have a semi-annual production schedule while two will have seasonal production (Long Harbour BMA; see Section 2.4.4.2 for additional details). Grieg NL is proposing up to 12 sea cages at each sea cage site stocked with ~160,000 fish per cage. Table 2.7 and Figures 2.4–2.6 provide further details on the sea cage sites. Additionally, satellite images of each of the 11 proposed sea cage sites are provided in Appendix Q.

**Table 2.7. Summary of the proposed sea cage sites.**

| BMA | Proposed Sea Cage Site | Dimensions & Orientation | | | | Water Depth (m) | | Bottom Type [b] | Closest Community |
|---|---|---|---|---|---|---|---|---|---|
| | | Length (km) | Width (km) | Area (km$^2$) | Orientation [a] | Average | Min-Max | | |
| Rushoon | Oderin Island | 1.77 | 0.70 | 1.24 | NE-SW | 85.5 | 39-98 | Hard | Rushoon |
| | Long Island | 2.10 | 1.00 | 2.12 | WSW-ENE | 112.6 | 75-180 | Hard | Petit Forte |
| | Gallows Harbour | 2.00 | 0.70 | 1.40 | NE-SW | 93.7 | 140-170 | Hard | Petit Forte |
| Merasheen | Valen Island | 2.40 | 1.32 | 3.16 | WSW-ENE | 89.7 | 58-308 | Hard | Davis Cove |
| | Chamber Island | 2.40 | 1.31 | 3.15 | NE-SW | 200.4 | 16-308 | Hard | Davis Cove |
| | Ship Island | 2.41 | 1.30 | 3.13 | WNW-ESE | 217.8 | 144-159 | Soft | Davis Cove |
| Red Island | Darby Harbour | 2.18 | 0.96 | 2.08 | WSW-ENE | 186.1 | 16-147 | Hard | Fair Haven |
| | Red Island | 1.69 | 0.73 | 1.19 | NNE-SSW | 112 | 18-250 | Hard | Fair Haven |
| | Butler Island | 1.77 | 0.80 | 1.39 | NE-SW | 85.2 | 10-143 | Hard | Southern Harbour |
| Long Harbour | Iona Island | 1.25 | 0.71 | 0.78 | E-W | 79.9 | 10-110 | Hard | Long Harbour |
| | Brine Island | 1.31 | 0.90 | 1.17 | NNW-SSE | 93.4 | 45-120 | Hard | Long Harbour |

[a] Sea cage sites were orientated in a particular direction to minimize the influences of wind. For all BMAs with the exception of the Long Harbour BMA, the least suitable wind direction for sea farm operations are winds from the south and south east. Winds from the west and northwest are least favourable for the Long Harbour BMA.

[b] Bottom type as per the classification in AAR-Annex 9 (http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-gd-eng.htm#annex9).

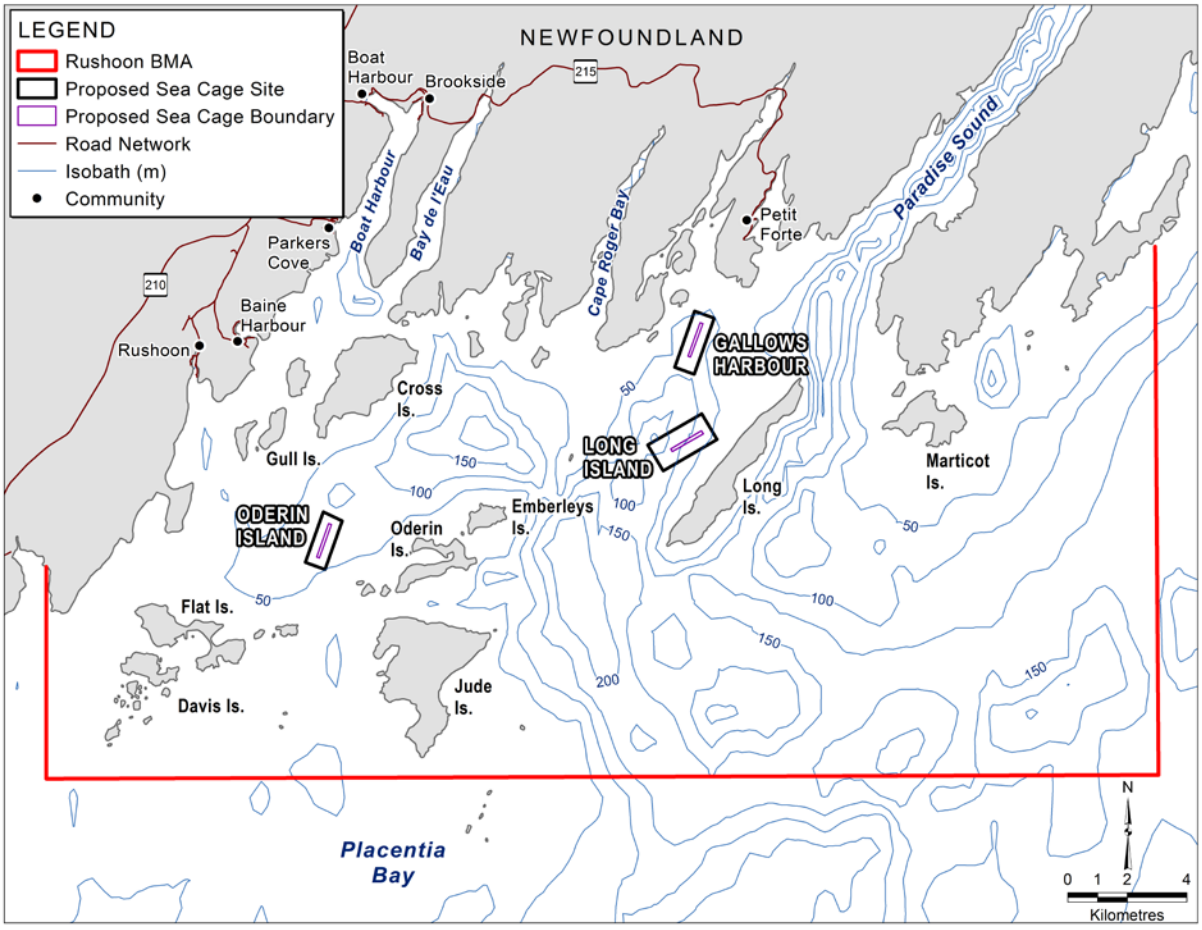



**Figure 2.4. Location of proposed sea cage sites and sea cages within the Rushoon BMA.**

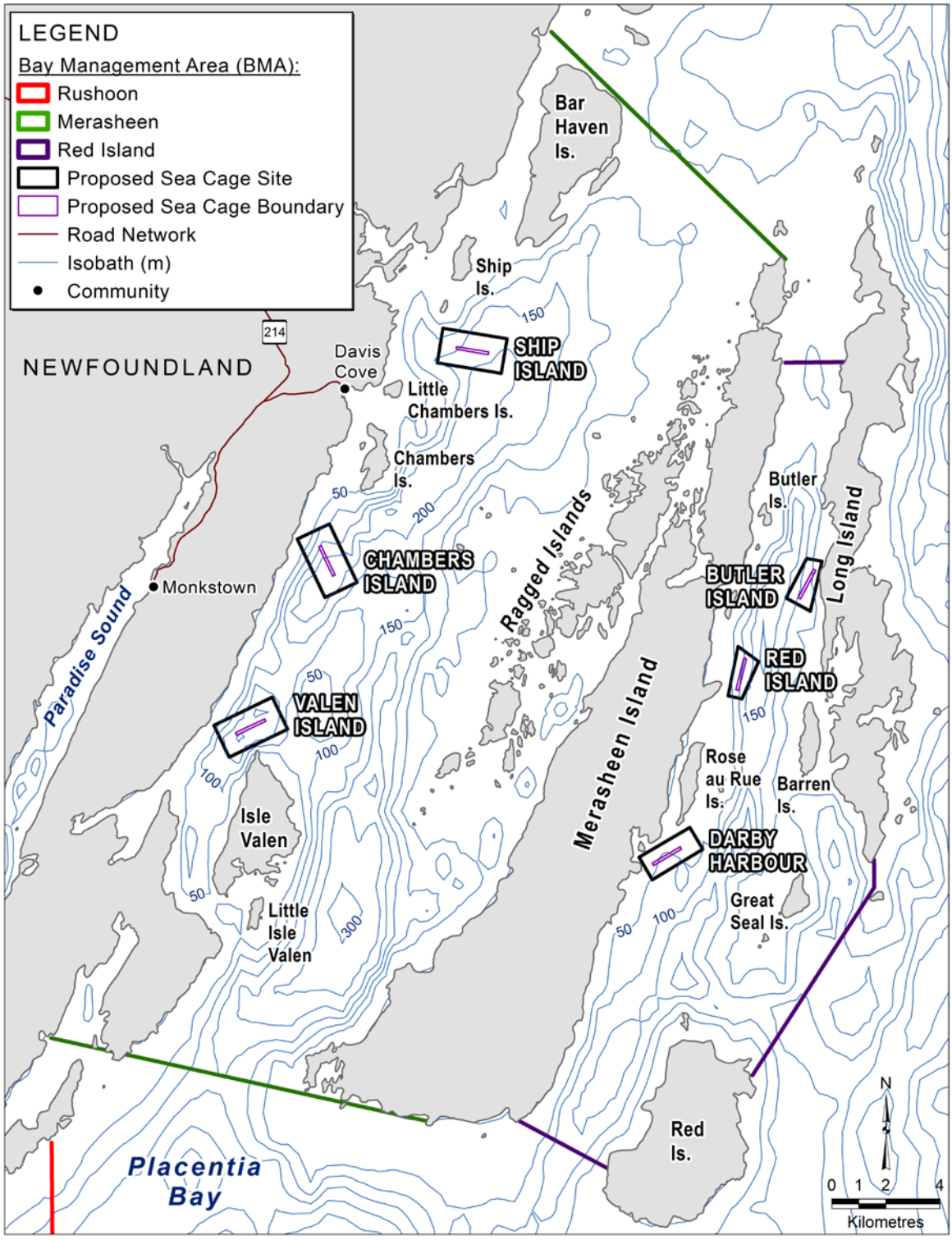



**Figure 2.5. Location of proposed sea cage sites and sea cages within the Merasheen and Red Island BMAs.**

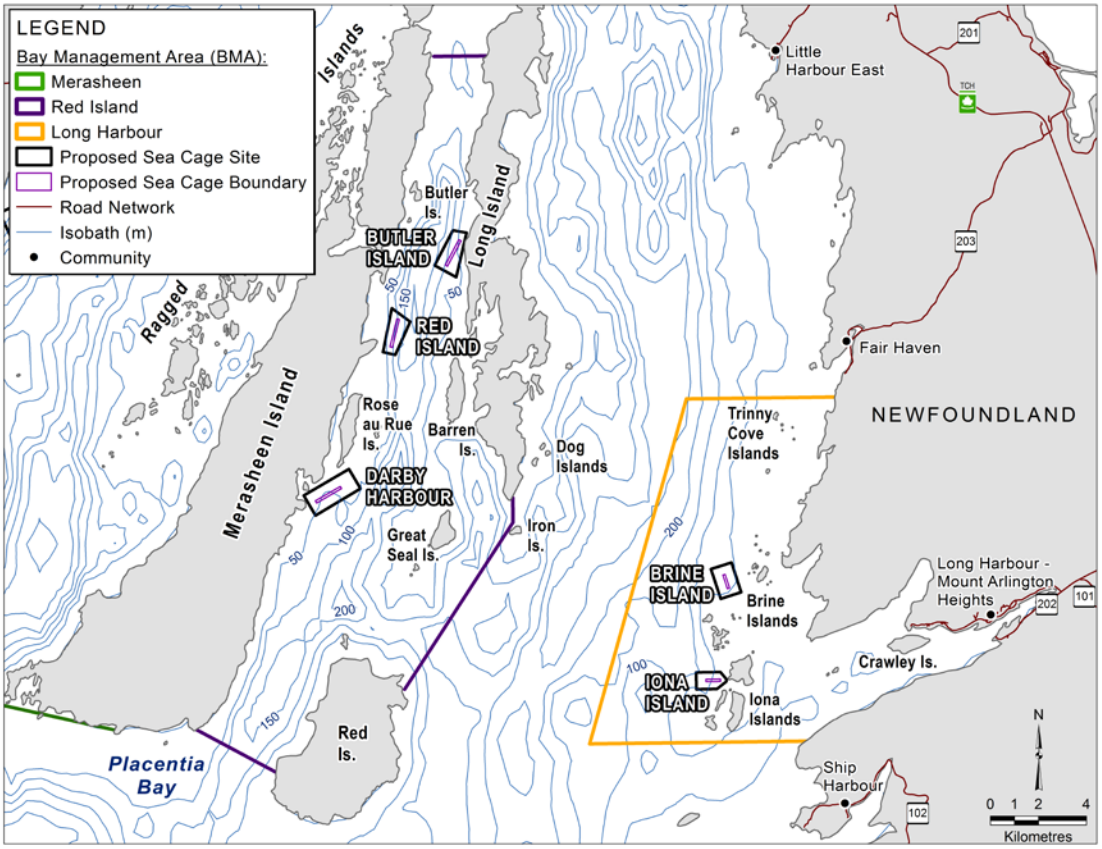



**Figure 2.6. Location of proposed sea cage sites and sea cages within the Long Harbour and Red Island BMA.**

### 2.4.3 Land-based Facility (RAS Hatchery)

There are three primary components of the land-based facility (i.e., RAS Hatchery), which will be based in the Marystown Marine Industry Park, adjacent to Mortier Bay (Figures 2.7–2.9):

- First-Feeding Facility
- Smoltification Facility
- Post-Smolt Facility

Collectively, these facilities are referred to as the Recirculating Aquaculture System or RAS Hatchery. The RAS Hatchery will be constructed in phases (see Section 2.4.3.1) and will have a total area of 30,000 $m^2$ and the capacity to produce seven million smolt per year when at full production. The First-Feeding Facility (sometimes referred to as the "nursery") is the smallest of the three facilities, measuring 54 m x 37 m and it is comprised of two main sections—incubation/hatching room and first-feeding tanks. The Smoltification Facility, measuring 61 m x 111 m and consisting of 14 tanks, is designed to hold fry and fingerlings for four months, until they reach ~50 g. At this size, the fish are transferred to the Post-Smolt Facility where they are housed until they grow to a pre-determined size (350–1,400 g) before transfer to the well boat for delivery to the sea cages. This facility consists of three

main buildings (A, B, C), each measuring 150 m x 80 m. Overall, there are 18 tanks organized (six in each post-smolt building) in the post-smolt facility. Building and tank separation are designed to enhance biosecurity (see Section 2.4.3.2).

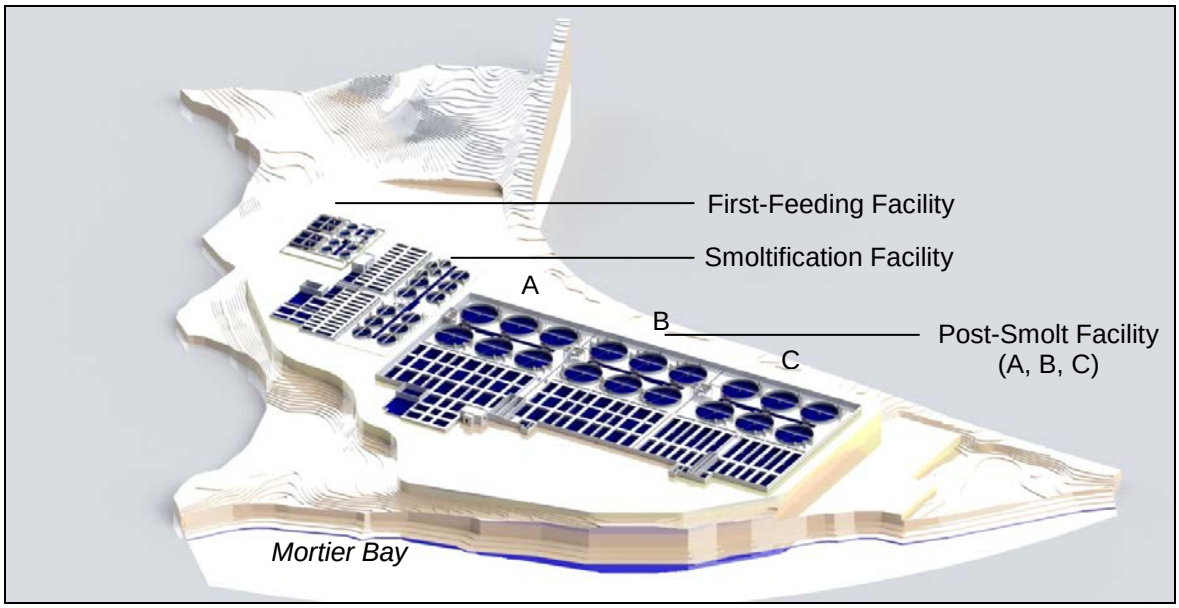



**Figure 2.7. General layout of RAS Hatchery.**

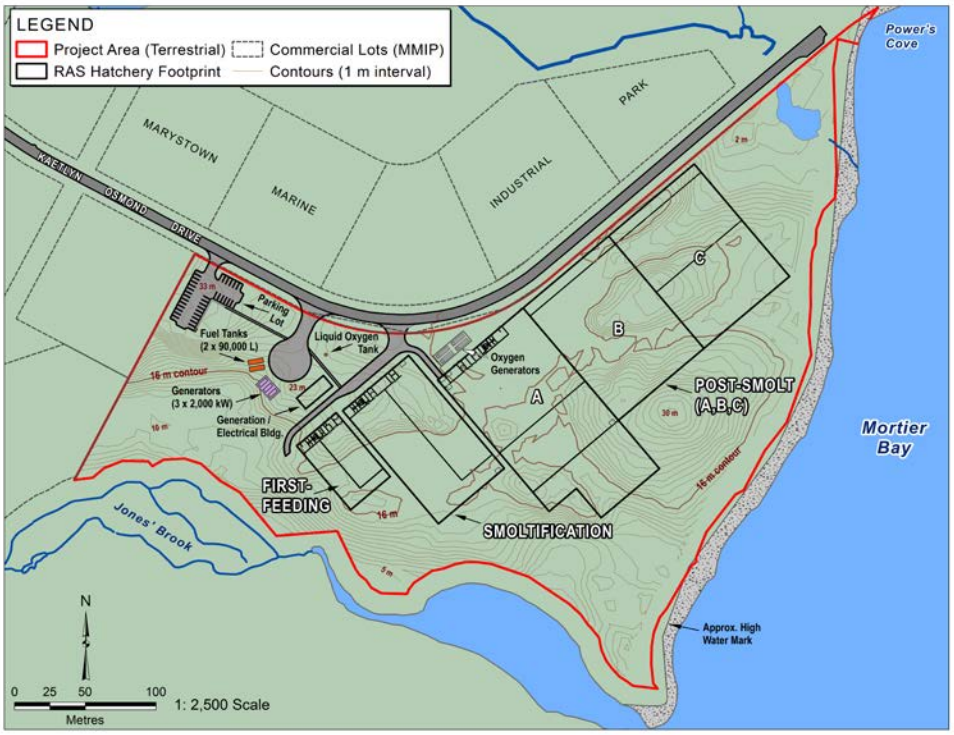



**Figure 2.8. Schematic of RAS Hatchery in the Marystown Marine Industrial Park.**




**Figure 2.9. Schematic of the RAS Hatchery overlaid on satellite imagery (taken prior to site clearing).**

### 2.4.3.1 Construction

Site clearing for the RAS Hatchery began in late summer 2016 and was temporarily halted in July 2017. The trees were cleared and the land grubbed. Additional site preparation is required (see below) prior to the commencement of facility construction. The facilities will be constructed in two phases (Figure 2.10). Phase I will include the First-Feeding Facility, the Smoltification Facility and the first Post-Smolt Facility (A). This phase will begin once approval is given and the project is released from the EIS. Construction of the First-Feeding Facility will be completed 13 months after construction begins. The Smoltification Facility will be completed four months after the First-Feeding Facility is completed and Post-Smolt Facility A will be completed six months after the Smoltification Facility is completed. Overall, Phase I is expected to be ~two years in duration. Phase II will also span two years (anticipated Year 4–5 of the Project) and during this phase Post-Smolt Facilities B and C will be constructed (Figure 2.10).

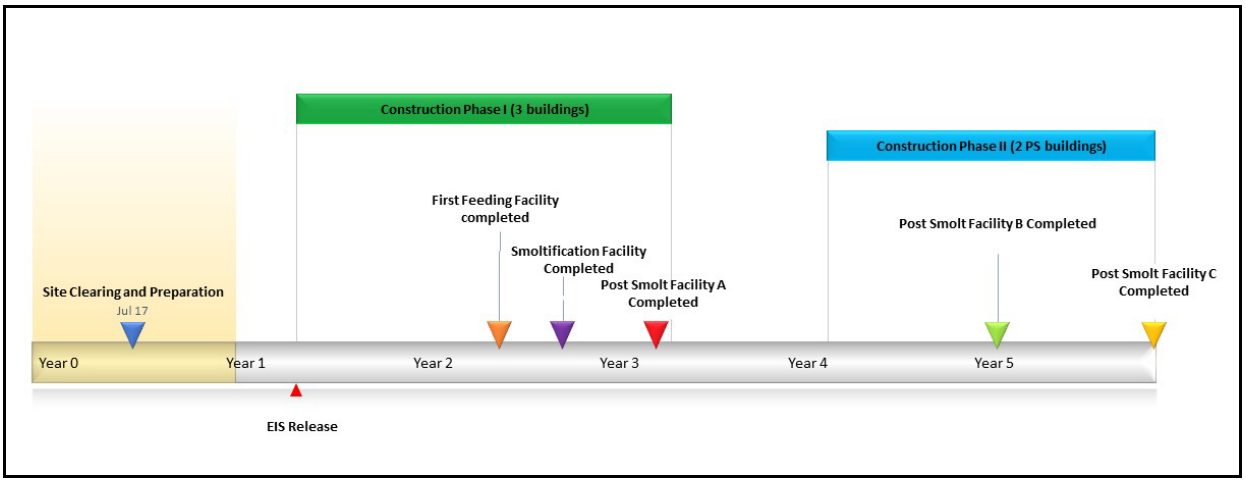



**Figure 2.10. Construction timeline for the Grieg NL land-based facility.**

Pre-fab building materials will be used to construct the RAS Hatchery facilities. Several North American manufacturers are being considered to supply the materials. The final selection will be made based not only on price but also on the manufacturer's commitment to reducing their impact on the environment (e.g., using 80% recycled steel). The RAS Hatchery will be designed to obtain certification under the globally-recognized Leadership in Energy and Environmental Design rating system (LEED; see https://new.usgbc.org/leed).

### *Site Clearing and Preparation*

Site clearing for the land-based facility was completed during late summer and fall of 2016 (Figure 2.11) by Wally Drake's Trucking Ltd., based in Marystown. Grubbing of the site was undertaken during summer 2017 by Pennecon Heavy Civil Ltd. (Pennecon), based in Paradise, NL. Appropriate mitigation measures were in place for managing erosion and sedimentation and for site clearance for breeding birds (see Section 2.5). Additional measures will be undertaken to rehabilitate and stabilize construction sites (see Section 2.5.1.1).

Some grubbing and leveling of the site is still required and will commence immediately upon Project approval. Upon mobilization, the contractor will begin with the unsuitable material (USM) removal combined with any common excavation. Once sufficient bedrock has been "uncovered", drilling and blasting will be required to level areas. The contractor will work to ensure that the chosen explosives (i.e., powder factors) and drill patterns produce a rock of workable size for future use in cut and fill operations and for backfilling. It is anticipated that blasting operations will occur over a three to four month period. Appropriate mitigation measures will be in place for blasting operations (see Section 2.5). All driveways accessing the land-based facility will be constructed across existing culverted sections of the drainage ditch on Kaetlyn Osmond Drive. Access roads around the land-based facility site will not cross any bodies of water so additional culverts are not required.

Excavation and borrow pits will not be required as there are sufficient rock and till materials on site. Any surplus rock or till will be stockpiled according to current regulations, at a location designated by the Town of Marystown. The stockpiled materials will be used during future developments in the Marine Industrial Park. Of note, there will be no road access to any sea cage sites.

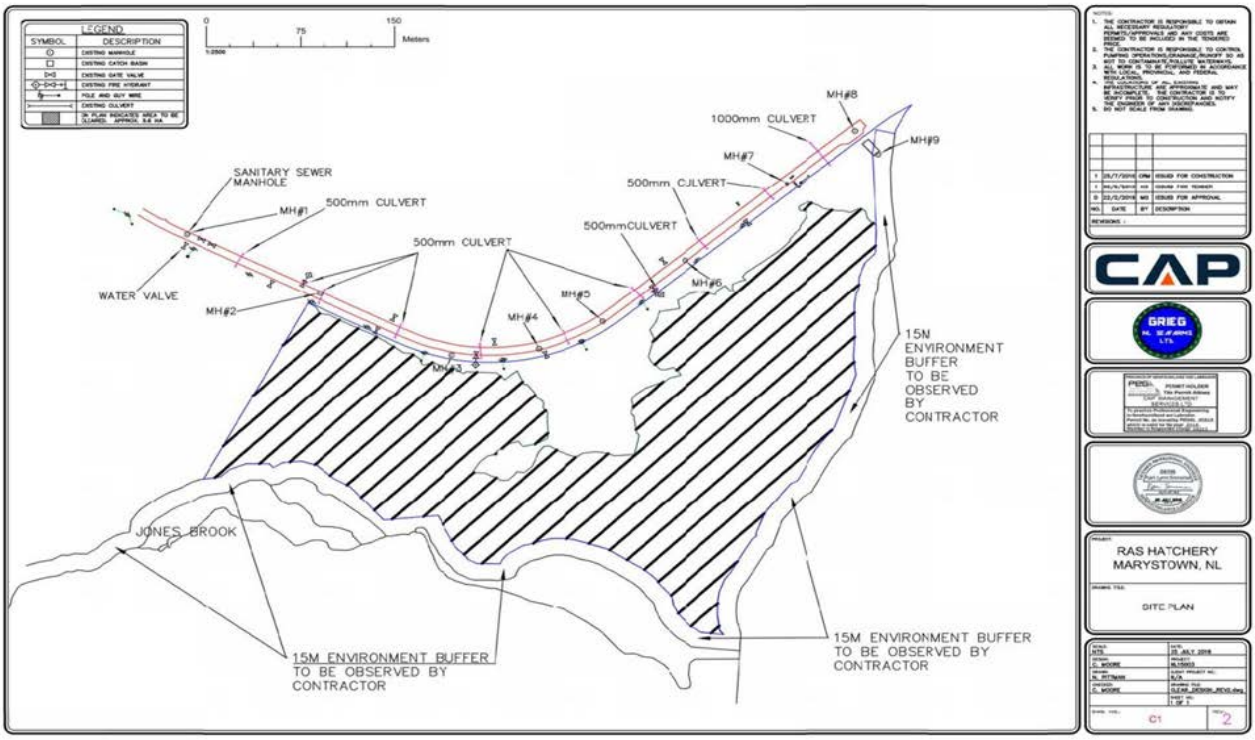



**Figure 2.11. Location of Grieg NL's land-based facility in the Marystown Marine Industrial Park. The hatched area depicts the area which has been cleared and grubbed to date.**

### *Equipment Used*

Equipment utilized during the construction phase would be typical of most building type construction projects of this size. Equipment would generally be diesel fueled (resulting in typical diesel emissions) and would consist of the following:

- Loaders
- Excavators
- Air tracks
- Crane/Boom Trucks
- Tele-Handlers
- Diesel/electric pipe fusing machines
- Pit trucks
- Dozers
- Grader
- Tandem dump trucks
- Semi dump trucks
- Asphalt pavers
- Diesel Generators

### *Hazardous Materials*

A variety of fuels and potentially hazardous materials will be used during construction activities which could include petroleum, oil, lubricants, cleaners and solvents, flammable gases (i.e., acetylene), antifreeze, paints, epoxies, and explosives. Grieg NL is aware of the concerns regarding the use of hazardous materials and their potential uncontrolled release into the environment through leakage or accidental spillage and the subsequent adverse effects. Grieg NL will insist that contractors follow all required regulatory policies and procedures and industry best practices including the following:

- Procedures for the handling of fuels and other hazardous materials as well as contingency plans for spills will be present in hard copy at receiving, storage, transfer and disposal areas.
- Transportation, storage and use of fuels and all other hazardous materials at the construction site will be conducted in compliance with all relevant laws and regulations.
- A complete inventory of the hazardous materials on the job site shall be maintained according to the Workplace Hazardous Materials Information System (WHMIS) Regulations. This inventory shall be made available to regulatory agencies upon request, and shall be kept readily available in case of any emergency.
- All contractors will be required to observe strict compliance with the requirements of WHMIS regarding employee training, use, handling, storage, and disposal of hazardous materials and regarding labeling and provision of Material Safety Data Sheets (MSDS) as required by WHMIS legislation.
- All contractors will be required to observe strict compliance with the requirements of the most recent version of the *Transportation of Dangerous Goods Act*.
- Contractors will be required to submit a detailed EPP prior to the start of construction.

### *Waste and Waste Management*

Both solid and liquid wastes will be generated during construction of the RAS Hatchery. The amount of waste generated and requiring disposal will be minimized to the extent possible. All wastes will be handled according to procedures in Grieg NL's Waste Management Plan (Appendix J).

By using pre-fab buildings, only the necessary amount of materials required for building construction will be sent to the construction site and there will be minimal waste associated with cutting materials or workmanship errors. Fiber rebar (i.e., basalt fiber reinforced polymer) will be considered for use in concrete reinforcement to reduce steel waste with excess fiber rebar being chipped for compaction and disposal. A refuse wood site will be identified for local use for disposal of wood pallets and other excess wood materials. Wood products will be chipped for disposal whenever possible. Scrap steel and plastic products such as piping will be retained by Grieg NL for use in facility repairs. Where this is not practical due to materials being damaged or too small, steel products will be recycled through local companies. Plastic products will be recycled where possible with disposal only when no other option remains.

Typical liquid wastes that may be used on site during construction activities will include petroleum, oil and lubricants; chlorinated and non-chlorinated solvents (e.g., cleaner-degreasers); waste petroleum products (e.g., used engine/motor oil); glycol (e.g., antifreeze), paints, epoxies, and concrete additives. Any hazardous waste will be managed by a licensed hazardous waste disposal contractor. All wastes will be handled according to procedures in Grieg NL's Waste Management Plan (Appendix J).

### 2.4.3.2 Operations and Maintenance

It is anticipated that the RAS Hatchery will be operational in Year 2 and reach full production capacity (i.e., steady state) in Year 6. For the purposes of this EIS, the facility is planned to operate for 10 years at full capacity, i.e., seven million salmon smolt per year. Table 2.1 (in Section 2.1) provides an overview of key Project milestones.

The Recirculating Aquaculture System (RAS)[1] is considered state-of-the-art and operates by filtering water from the fish tanks so it can be reused. The system uses 300 L/min versus the 500,000 L/min, which is typical in a flow-through system that is not reusing any water to accomplish an equivalent production (seven million smolt). The RAS allows complete year-round control of fish growing conditions with systems that are flexible and energy efficient. The RAS can control water quality while also minimizing the entry of pathogens. Waste and other debris pass through a series of treatments before being partially or totally reused. Any discharged material is nutrient rich and can be utilized in a number of industries including agriculture fertilizer.

A feed storage room will hold feed for typically one week of use, supplied as bags for the First-Feeding Facility. The feed for the smoltification and post-smolt facilities will be supplied through a system from large feed silos (see Figure 2.13 later). The facility is enclosed in an insulated steel-fabricated structure designed to maintain optimal growth conditions for salmon. Air movement in and out of the facility as well as pressure is controlled and filtered. Doors are controlled by the central access system where each worker will have the required credentials (embedded into an identification [ID] tag) to enter their work area, and may not enter other areas to prevent cross-contamination. Entrance to production halls require strict biosecurity measures, and are designed accordingly.

Note that Grieg NL is in the process of finalizing Standard Operating Procedures (SOP) for both RAS Hatchery and sea cage operations (see Appendix K for a list).

***Overview of Hatchery Procedure***

The production cycle of farmed Atlantic salmon in Newfoundland is typically up to three years with the smolt leaving the hatchery after ~8–12 months and a weight of 100 g for continued growth up to 22 months at sea. Grieg NL will increase the production cycle in the RAS Hatchery and culture the salmon from 12–16 months to produce salmon between 350–1,400 g before transfer to sea and reduce time in sea to ~16 months or less. For Grieg NL's Project, all-female salmon eggs will be purchased and rendered sterile prior to shipping and therefore, cannot be used for broodstock. Currently, there are no broodstock produced in Newfoundland for the salmon and trout industry.

Eyed eggs will be tested and certified for diseases, sterility and all-female (see Appendix I) prior to being shipped to Newfoundland (from Stofnfiskur's facility in Iceland). Upon arrival in Newfoundland, the eggs will be transported by truck to the Marystown facility where they will undergo a disinfection process as a precautionary step, prior to entering the facility. The eyed eggs are incubated for ~eight weeks before they hatch. Alevins (sac fry) continue to develop for 3–4 months before reaching approximately 15 g. A yolk sac provides the newly hatched alevins with nutrients to develop until they are large enough to begin feeding on specialized starter feed for young salmon. The incubation of the eggs, hatching and development of the alevins will occur in the First-Feeding Facility (Table 2.8).

[1] The RAS is supplied by AMG Norway, a subsidiary of the AquaMaof Group (based in Israel). For 20 years, AquaMaof has been providing comprehensive integrated aquaculture solutions for aquaculture projects in over 50 locations around the world.

**Table 2.8. Summary of various salmon development stages at the RAS Hatchery.**

| Location | Salmon Development | | |
|---|---|---|---|
| | Life Stage | Time (months) | Size (g) |
| RAS Hatchery | | | |
| First-Feeding Facility | Eyed eggs to Alevins | 2–3 | egg to 15 |
| Smoltification Facility | Fingerlings to Smolt | 3–4 | 15–50 |
| Post-Smolt Facility | Smolt | 6–10 | 50–1,400 |
| At Sea | Smolt | 7–16 | 350–5,000 |

At 15 g, the salmon (often referred to as fingerlings at this size) will be transferred to the Smoltification Facility to continue to grow and become a smolt. This process is typically 4–5 months in duration. At the end of this period, the smolt will weigh ~50 g and could go to sea. However, since Grieg NL is prolonging the growth period in the RAS Hatchery, the smolt, instead of being transferred to sea, will be transferred to the Post-Smolt Facility for continued growing. Smolt will remain in the Post-Smolt Facility until they reach between 350–1,400 g before transfer to sea (see Table 2.8).

Grieg NL has developed a salmon stocking schedule that takes into consideration Provincial requirements and conditions at the sea cage sites. The plan is based on a MOU with the Province of NL (Appendix C) and allows Grieg NL to ramp up and construct facilities in two phases. This reduces initial investment cost of the RAS Hatchery providing time to generate revenue prior to expansion of the Post-Smolt Facility to include buildings B and C. A summary of the planned stocking schedule is provided in Table 2.9 and additional details are provided in Section 2.4.4.2.

**Table 2.9. Planned stocking numbers (maximum) for RAS Hatchery and sea cages for ramp-up (Generation 1–4) and steady-state (Generation 5).**

| Month Eggs Received | Eggs In | Month to Smoltification | To Smoltification | Month to Post-Smolt | To Post-Smolt | Month to Sea | To Sea | Smolt Size to Sea (g) |
|---|---|---|---|---|---|---|---|---|
| September | 1,220,000 | December | 1,098,000 | April | 1,040,904 | July | 999,788 | 350 |
| October | 1,220,000 | January | 1,098,000 | May | 1,040,904 | September | 999,788 | 544 |
| **Gen. 1 (Total)** | **2,440,000** | | **2,196,000** | | **2,081,808** | | **1,999,577** | |
| June | 1,220,000 | September | 1,098,000 | January | 1,040,904 | May | 999,788 | 544 |
| August | 1,220,000 | November | 1,098,000 | March | 1,040,904 | July | 999,788 | 544 |
| October | 1,220,000 | January | 1,098,000 | May | 1,040,904 | September | 999,788 | 544 |
| **Gen. 2 (Total)** | **3,660,000** | | **3,294,000** | | **3,122,712** | | **2,999,365** | |
| February | 1,220,000 | May | 1,098,000 | September | 1,040,904 | May | 999,788 | 1400 |
| June | 1,220,000 | September | 1,098,000 | January | 1,040,904 | June | 999,788 | 800 |
| August | 1,220,000 | November | 1,098,000 | March | 1,040,904 | July | 999,788 | 544 |
| November | 1,220,000 | February | 1,098,000 | June | 1,040,904 | October | 999,788 | 544 |
| **Gen. 3 (Total)** | **4,880,000** | | **4,392,000** | | **4,163,616** | | **3,999,153** | |
| February | 1,220,000 | May | 1,098,000 | September | 1,040,904 | May | 999,788 | 1400 |
| June | 2,440,000 | September | 2,196,000 | January | 2,081,808 | June | 1,999,577 | 800 |
| August | 2,440,000 | November | 2,196,000 | March | 2,081,808 | July | 1,999,577 | 544 |
| November | 1,220,000 | February | 1,098,000 | June | 1,040,904 | October | 999,788 | 544 |
| **Gen. 4 (Total)** | **7,320,000** | | **6,588,000** | | **6,245,424** | | **5,998,730** | |
| February | 1,220,000 | May | 1,098,000 | September | 1,040,904 | May | 999,788 | 1400 |
| June | 2,440,000 | September | 2,196,000 | January | 2,081,808 | June | 1,999,577 | 800 |
| August | 1,220,000 | November | 1,098,000 | March | 1,040,904 | July | 999,788 | 544 |
| October | 2,440,000 | January | 2,196,000 | May | 2,081,808 | August | 1,999,577 | 350 |
| November | 1,220,000 | February | 1,098,000 | June | 1,040,904 | October | 999,788 | 544 |
| **Gen. 5 (Total)** | **8,540,000** | | **6,588,000** | | **6,245,424** | | **6,998,518** | |

### *Acquisition of Salmon Eggs*

Grieg NL will acquire fertilized all-female sterile triploid Atlantic salmon eggs from Stofnfiskur (based in Iceland), an approved exporter to Canada of Atlantic salmon eggs. As discussed previously, CFIA issued Grieg NL an egg import permit, recognizing Stofnfiskur as an approved exporter to Canada, in March 2016 (Permit No. Q-2016-00213-4; Appendix H) and Grieg NL has continued to renew this permit every three months as per the regulations. Details on Stofnfiskur's qualifications and procedures for developing fertilized female triploid Atlantic salmon eggs are provided in Appendix I. Identification of the egg source for the European-strain salmon that Grieg NL has been approved to import is also provided in Appendix I.

Fertilized all-female triploid eggs (roe) will be shipped via Air Cargo at 350 degree day[2] development in styrofoam containers. Prior to shipments, eggs will be tested and certified as disease free, triploidy and all-female. Upon arrival, the boxes of eggs will be transported to the RAS Hatchery in Marystown. Total transportation time from Stofnfiskur, Iceland to Marystown will be ~25 hours. Upon arrival, all containers of eggs will enter a disinfection room where they will be rinsed, disinfected (with an iodine solution) and de-boxed. All equipment encountering the eggs or egg container prior to disinfection will also be disinfected. Records of time, source, and location of eggs will be maintained.

Eggs will be imported from Stofnfiskur as per the schedule shown in Table 2.10. Additional eggs are ordered to compensate for mortality to ensure that stocking numbers will follow the numbers agreed upon with the Province in a MOU.

**Table 2.10. Egg importation schedule during ramp up (Years 2–5) and steady phase (Year 6 onward). Shipments in February will be used for seasonal productions.**

| Year | Order Month | Planned No. of Smolt to Sea | Extra to allow for mortality (%) | No. of Eggs Received |
|---|---|---|---|---|
| 2 | September | 1,000,000 | 22 | 1,220,000 |
| 2 | October | 1,000,000 | 22 | 1,220,000 |
| **Total** | | **2,000,000** | | **2,440,000** |
| | | | | |
| 3 | June | 1,000,000 | 22 | 1,220,000 |
| 3 | August | 1,000,000 | 22 | 1,220,000 |
| 3 | October | 1,000,000 | 22 | 1,220,000 |
| **Total** | | **3,000,000** | | **3,660,000** |
| 4 | February | 1,000,000 | 22 | 1,220,000 |
| 4 | June | 1,000,000 | 22 | 1,220,000 |
| 4 | August | 1,000,000 | 22 | 1,220,000 |
| 4 | November | 1,000,000 | 22 | 1,220,000 |
| **Total** | | **4,000,000** | | **4,880,000** |
| 5 | February | 1,000,000 | 22 | 1,220,000 |
| 5 | June | 2,000,000 | 22 | 2,440,000 |
| 5 | August | 2,000,000 | 22 | 2,440,000 |
| 5 | November | 1,000,000 | 22 | 1,220,000 |
| **Total** | | **6,000,000** | | **7,320,000** |
| 6 | February | 1,000,000 | 22 | 1,220,000 |
| 6 | June | 2,000,000 | 22 | 2,440,000 |
| 6 | August | 1,000,000 | 22 | 1,220,000 |
| 6 | October | 2,000,000 | 22 | 2,440,000 |
| 6 | November | 1,000,000 | 22 | 1,220,000 |
| **Total** | | **7,000,000** | | **8,540,000** |

[2] One degree-day is the mean temperature, above 0°C, experienced for a period of 24 h. For example, a salmon egg incubated at an average daily temperature of 10°C for 62 days, from fertilization to hatching, is said to have hatched in 620 degree-days.

### *Egg Incubation*

Each batch of eggs will have a set of incubator trays (Figure 2.12), which are in a separate room from the first-feeding tanks. There will be a total of 16 incubation and hatching units (which house the incubator trays), each capable of holding 360,000 eggs. Water circulated through the incubation systems will flow into a treatment system and recirculated through the trays. The treatment system will maintain the highest water quality and oxygen saturation with minimal water exchange, water will be ultra-violet (UV) disinfected before entering the trays. During incubation, eggs will be monitored and any nonviable eggs promptly removed to eliminate fungal growth.



**Figure 2.12. Incubator trays used to culture Atlantic salmon eggs to hatching.**

### *First-Feeding*

At approximately 850-degree days, eggs hatch and the yolk sac larvae are transferred to first-feeding tanks. A total of eight first-feeding tanks are organized in four modules capable of complete water separation between systems. Fry remain in the first-feeding tanks until they reach ~15 g at which time they are transferred to the Smoltification Facility.

### *Smoltification*

The Smoltification Facility is designed to hold fry and fingerlings for four months, until they reach ~50 g and are suitable in size for transfer to the Post-Smolt Facility. The Smoltification Facility has 14 tanks and is independent from the First-Feeding Facility, with separate biosecurity measures. The Smoltification Facility has an independent denitrification system (DNS) suppling purified and disinfected water for re-use. The DNS is designed to treat solids and dissolved waste in the water discharged from the production cycle and reduce nitrates and other compounds that can accumulate in the water.

### *Post-Smolt Growth*

The Post-Smolt Facility is designed to hold the smolt until they reach a size of 350–1,400 g and are suitable in size for transfer to the well boat. The Post-Smolt Facility is independent from the Smoltification Facility, with separate biosecurity measures. The Post-Smolt Facility is divided into three sections (designated A, B, C) due to biosecurity considerations. Modules A, B, and C, each have a

separate building with independent services such as dressing rooms, control room, feed storage, disinfection room, electrical room, and sumps. There are 18 tanks organized in three modules capable of complete water separation between modules.

### *Feed Type*

The feed to be used in the RAS Hatchery as well as in the sea cage sites is a standard well-proven commercial diet adjusted to meet the requirement of triploid sterile salmon. Production for triploid feed is well established both in Norway and in Europe and is used both in salmon and trout production. One of the functions of feed is to promote the formation of bone (mineralization). If the diet does not promote the optimum development from start feeding, the risk of development of deformations increases. As with all organisms, salmon have corresponding, specific feed requirements through all life stages until they reach harvest size. The feed for triploid sterile salmon contains several important components that target the needs for triploid sterile salmon and in combination result in a rapidly-growing salmon without deformations. Some of the main advantages of using all-female triploid sterile salmon, as proposed by Grieg NL, is the rapid growth in fresh water which produces a larger and earlier smolt for the marine side of the production.

The main ingredient in fish feed is marine contents (fish oil, fish meal, algae), vegetables and minerals. Some feed companies also use smaller amounts of hydrolyzed protein. Many major feed providers have commercial lines of feed for triploid sterile salmon. The focus on feed developed specifically to meet the nutritional requirements of triploid sterile salmon reduces mandible and spinal deformities as well as the development of cataracts, which has previously been an issue with triploid sterile salmon (IMR 2015). Typical world-wide providers for salmon feed are companies such as BioMar, Skretting, EWOS and Aller Aqua. An example of feed formulated for triploid sterile salmon is Tri-X from BioMar. Grieg NL intends to utilize a major supplier for all its triploid sterile salmon feed in the RAS Hatchery (and at the sea cages). All the feed will be CFIA approved as well as EU approved.

Feed technical quality is of great importance in the RAS Hatchery due to the need for optimum water quality in the system. During the last six to seven years, feed companies have put forth considerable efforts to increase the technical feed quality to meet the demands for this product worldwide in RAS facilities. The use of sustainable raw material has also forced the feed companies to put considerable Research and Development (R&D) effort into both biology and techniques to meet fish needs as well as the feeding systems requirement and environmental considerations. The break-down of feed size and contents for use in the RAS Hatchery is provided in Table 2.11.

The RAS Hatchery feed requirement will increase from 1,000 MT for first generation of salmon produced up to 3,000 MT for each generation produced under the steady phase. From first feeding up to smolt and post-smolt stage the feed conversion ratio (FCR) as well as the daily feeding percent changes. As the fish grow, the FCR increases and the daily feeding percentage decreases. For the RAS Hatchery, the average FCR will be ~0.9 and 1.0 for Economic FCR (EFCR).

### *Feeding*

The feeding system in the RAS Hatchery is comprised of feed silos (Figure 2.13), transfer conveyors, a centralized dispensing tank as well as long range conveyors. Feed comes in a variety of pellet sizes and with different content depending on the size and life stage of the fish. The feed will be stored in different silos based on size with the exception that feed for the First-Feeding Facility will be stored in 25 kg bags in a designated store room within the First-Feeding Facility. Grieg NL will designate a feed silo, one for each feed size, which will contain approximately one week of feed. The use of silos minimizes the

attraction of wild animals, eliminates the chance of disease transfer from wild animals, and minimizes the lethal control of pests/predators. Each silo is dynamically weighed and weight broadcasted to a central programmable logic controller. Silos are fed from large bags via a hopper loader.

**Table 2.11. Summary of feed contents and pellet size for salmon growth stages in the RAS Hatchery.**

| Pellet Size (mm) | Fish Size (g) | Protein (min) | Oil (min) | Moisture (max) | Fibre (max) | Ash (max) | Digestable Energy (MJ/kg) |
|---|---|---|---|---|---|---|---|
| ***First-Feeding*** | | | | | | | |
| 0.3 | <0.15 | 58% | 18% | 8.5% | 0.5% | 10% | 19.9 |
| 0.5 | 0.15–0.5 | 55% | 18% | 8.5% | 1.0% | 10.5% | 19.4 |
| 0.7 | 0.4–1.0 | 55% | 18% | 8.5% | 1.0% | 10.5% | 19.4 |
| 1.0 | 0.9–3.5 | 55% | 18% | 8.5% | 1.0% | 10.5% | 19.4 |
| ***Smoltification*** | | | | | | | |
| 1.2 | 3.5–5.0 | 50% | 20% | 8.0% | 1.0% | 12% | 18.5 |
| 1.8 | 5.0–20 | 50% | 20% | 8.0% | 1.0% | 12% | 18.5 |
| 2.3 | 20–60 | 50% | 20% | 8.0% | 1.0% | 12% | 18.5 |
| ***Post-Smolt*** | | | | | | | |
| 2.3 | 30–75 | 50% | 20% | 8.5% | - | 13% | 18.8 |
| 3.0 | 60–200 | 50% | 20% | 8.5% | - | 13% | 18.8 |
| 2.3 | 30–75 | 48% | 27% | 8.5% | - | 10.5% | 20.6 |
| 3.0 | 60–200 | 48% | 27% | 8.5% | - | 10.5% | 20.4 |
| 4.0 | 100–400 | 48% | 27% | 8.5% | - | 10.5% | 20.3 |
| 6.0 | 400–1,000 | 45% | 30% | 8.0% | - | 9% | 20.1 |



**Figure 2.13. Feed silos used to hold salmon feed for transfer to facilities for feeding.**

Transfer conveyors are used to transfer the feed from the silos to a centralized dispensing tank. These are paddle type conveyors to minimize abrasion and breakage of feed pellets. Centralized dispensing tanks weigh the required amount for one feeding for each tank. After the dispensing tank reaches the required weight with the required feed type, it is transferred to the fish tank. Low energy, quiet, paddle-type long-range conveyors will transfer the feed from the weighing tank to the selected fish tank. Several actuated flap openings on the conveyor will direct the feed to the right tank. These conveyor systems are designed to minimize dust and breakage of the feed. The feed is designed for RAS which reduces the problem of dust in the water when feeding. An automatic feeding system based on feeding tables/software and cameras/people ensure no spill or waste of feed.

### *Water Quality Maintenance*

Water quality will be monitored and maintained at optimal conditions for growth during first-feeding, smoltification, and post-smolt production. A routine program will be established for monitoring, measuring, and recording water quality in all buildings of the RAS Hatchery. Each tank is equipped with an in-situ dissolved oxygen probe, each module (i.e., group of tanks) has in-situ temperature and pH monitoring. In the event of issues providing oxygen to the tanks, each tank is equipped with emergency oxygen diffusers. Waste and other debris in the tanks will undergo a series of treatments before being partially or totally reused (see *Water Supply for Facility* and Appendix J for details). Incoming water will be filtered with a fine filtration system (2 micron). The incoming filtered water will then be mixed with flow water returning to the DNS. All outgoing water from the DNS will pass through an UV unit before returning to the tanks.

### *Fish Transfer between Tanks and Buildings*

Salmon will be reared in smooth fiberglass reinforced polymer (FRP) tanks from first-feeding to post-smolt stages. Each tank is equipped with a perforated central stand-pipe with flow control cover, a stand-pipe screen, a sediment trap, and a port for fish harvesting or collecting dead fish. The tanks are partially underground and the sediment trap is protected with an adequate mesh to prevent fish entry.

Each building is equipped with a fish pump (Figure 2.14) and a counting system (Figure 2.15) that counts fish and keeps accumulated records. The system is flexible and allows transfer of fish between tanks and between buildings. Fish are transferred (via water) through the fish port to a fish pump located in the transfer sump between the tank rows. Fish are slowly pumped to a grader installed on an elevated platform. Fish are counted and sorted, then transferred via fish transfer pipes to any production tank or to the Smoltification Facility or the Post-Smolt Facility. Fish transfer pipes will be flexible hoses that will be connected when in use and stored when not in use. Each building will have a fixed pipe leading to the outside that the flexible hoses will be easily connected to when transfers are required. The flexible hose will run above ground during transfer then it will be cleaned, disinfected and stored after transfer is complete. Piping connecting to exterior will be designed in a manner to ensure biosecurity and will only be opened once flexible piping is connected and ready for transfer. In addition, there will be camera monitoring along the transfer line and fish counters at both the outflow and inflow end to confirm no fish losses during transfer.



**Figure 2.14. Fish transfer pump used to move fish between tanks and facilities.**



**Figure 2.15. Fish grader used to sort and grade fish to optimize growth.**

Prior to each transfer fish health will be checked by a veterinarian. Each transfer (from First-Feeding to Smoltification, and Post-Smolt stages) will be done with minimal stress on the fish and elimination of any potential escapes when transferring internally. Records will be maintained for each transfer stating date, time, number, and weight of fish. Fish will be handled only for the purposes of grading, weight sampling, and vaccination. Where appropriate, fish will be anesthetized to minimize stress and trauma during handling. All handled fish will be closely monitored for a period post-handling.

***Fish Health***

Procedures for verifying and maintaining fish health at the RAS Hatchery are detailed in Section 2.5.2.2. In summary, at each stage of salmon development mitigation measures and monitoring will be in place to maintain fish health including routine husbandry practices, biosecurity measures, use of specialized feed, feed storage and delivery, use of a water quality system, removal and treatment of fish mortalities, and health checks and procedures. Grieg NL will develop and implement a Fish Health Management Plan and all personnel will be trained in its proper procedures. Details on health checks and procedures are included here.

Both active (in response to health issues) and passive (routine checks) health surveillance of fish will be ongoing. Grieg NL will use a private veterinarian to respond to signs of health issues and to conduct routine monitoring prior to each transfer of fish to a new facility. The private veterinarian will be responsible for fish health and will oversee the surveillance program. Grieg NL staff and management will work closely with this private veterinarian to communicate any indications of behaviour or physical changes that may indicate a health or disease concern in the fish. Personnel will monitor fish health including indicators of disease (i.e., infectious salmon anemia [ISA], furunculosis, Vibrio, infectious pancreatic necrosis [IPN], *Yersinia ruckeri*, and bacterial kidney disease [BKD]), parasites, fungus, wounds or ulcers as well as deformities, changes in feeding behaviour (or FCR) and indicators of readiness for saltwater (e.g., Na+, K+, ATPase). These examinations are often a combination of visual inspections as well as blood samples. Each transfer between hatchery facilities (First-Feeding, Smoltification, and Post-Smoltification) will be done with minimal stress on the fish. Records will be maintained for each transfer including date, time, number, and weight of fish. Where appropriate (e.g., during vaccinations), fish will be anesthetized to minimize stress and trauma during handling. General anesthesia (e.g., TMS (MS – 222; 3-aminobenzoic acidethyl ester methanesulfonate) will be

prescribed by a veterinarian and administered in a tank that is part of a vaccination machine (see below). All handled fish will be closely monitored for a period post-handling. Any antibiotics used will be administered in the feed. In addition to the network of Grieg NL staff, management and a private veterinarian, Grieg NL will also participate in routine checks by a provincial veterinarian as part of the Province's passive surveillance program. A provincial veterinarian will monitor fish health at the RAS Hatchery. Grieg NL's private veterinarian will liaison with provincial veterinarians as required. After the smolt have been transferred to the Post-Smolt Facility and prior to transfer to sea, they will be vaccinated as per the specific recommendations of provincial veterinarians (see Section 2.5.2.2 for details on typical vaccinations). Grieg NL is planning to utilize an automated fish vaccination system (Figure 2.16). The vaccination machine consists of two vaccination modules, each equipped with four vaccination stations. An image processing system measures each fish and generates information that is used to calculate the point of injection as well as determine the depth of injection for each individual fish. A sensor on the needle monitors the injection process and the vaccine dosage for each fish. As a result, the mortality rate is less than 0.02%. Once it has been determined that sufficient smoltification has transpired, a health check by a provincial veterinarian will be conducted within 45 days before transfer to sea. This check will sample a number of fish from each tank that is being transferred to sea. Fish will not be transported if there are any health concerns and until the transfer permit approved by DFO, DFLR and CFIA is received.

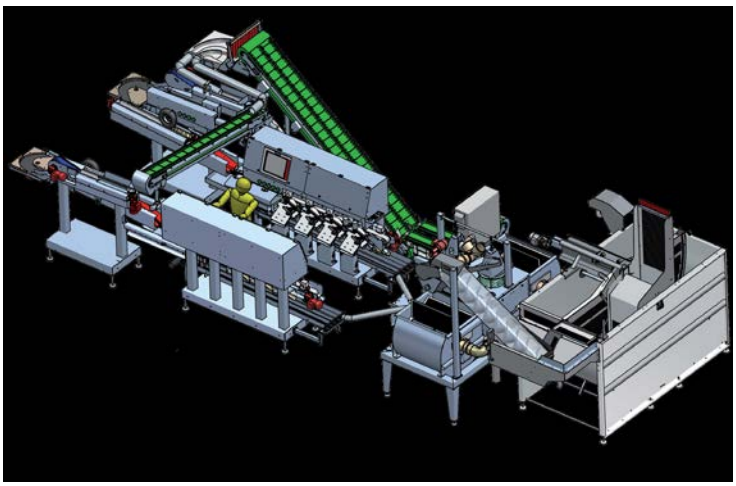


**Figure 2.16. Vaccination machine.**

***Mortalities***

Fish mortalities as well as moribund fish will be visually assessed and collected at a minimum, daily, via a port on each tank. In addition, fish that are not growing as fast as the population will be culled (removed) during procedures such as grading and vaccination. These culls will be euthanized and treated as mortalities. A mortality vacuum system will be utilized within each facility in the RAS Hatchery. This vacuum system is equipped with a funnel receptacle (Figure 2.17) to biosecurely transport the fish into a grinder that chops the mortalities into small pieces while a doser adds acid to produce a slurry called ensilage with a pH of 4.5 or lower. The generation of ensilage is a standard practice in aquaculture for effectively handling and storing dead fish while preventing disease transmission, reducing odors and reducing pests. Ensilage produced in all facilities will be collected into a centralized holding tank and stored there until sufficient quantities are acquired to justify transport to either a local company in

Newfoundland that will use the product as a commercial fertilizer and/or animal feed additive or a feed supply company located in Denmark (see Appendix J).

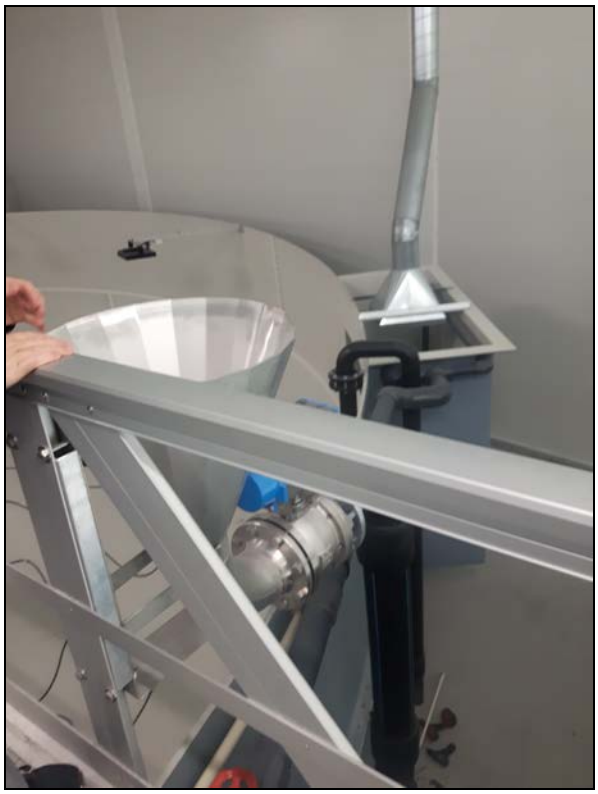


**Figure 2.17. An example of a vacuum funnel located next to a tank for collecting and transporting dead fish to an ensilage tank.**

Predicted mortalities in the RAS Hatchery are summarized in Table 2.12. These percentages are based on experience at other Atlantic salmon facilities with sterile/triploid eggs from Stofnfiskur (R. Seim, SalmoBreed, pers. comm., 2017).

**Table 2.12. Predicted mortality rates during the land-based production of Atlantic salmon.**

| Month in Hatchery | Example Month | Primary Activity Affecting Mortality Rate | Salmon Stage/ Size | Mortality Rate | Survival per Month | Total Survival Rate | Total Mortality Rate |
|---|---|---|---|---|---|---|---|
| 1 | June | Incubation/Receiving | Egg | 6.0% | 94.0% | 94.0% | 6.0% |
| 2 | July | Hatching | Egg | 6.0% | 94.0% | 88.4% | 11.6% |
| 3 | August | First Feeding | 2 g | 1.3% | 98.7% | 87.2% | 12.8% |
| 4 | September | First Feeding | 4 g | 1.3% | 98.7% | 86.1% | 13.9% |
| 5 | October | First Feeding | 13 g | 1.3% | 98.7% | 85.0% | 15.0% |
| 6 | November | First Feeding | 31 g | 1.3% | 98.7% | 83.9% | 16.1% |
| 7 | December | Vaccination | 40 g | 4.2% | 95.8% | 80.3% | 19.7% |
| 8 | January | Grow | 50 g | 0.5% | 99.5% | 79.9% | 20.1% |
| 9 | February | Grow | 111 g | 0.5% | 99.5% | 79.5% | 20.5% |
| 10 | March | Grow | 208 g | 0.5% | 99.5% | 79.1% | 20.9% |
| 11 | April | Grow | 350 g | 0.5% | 99.5% | 78.7% | 21.3% |
| 12 | May | Grow | 550 g | 0.5% | 99.5% | 78.3% | 21.7% |

### *Fish Transfer to Well Boat*

Smolt will be transferred to a well boat via a double pipe (~150 m in length) leading from the Post-Smolt Facility to Mortier Bay. The pipeline will be constructed such that a protective sacrificial pipe surrounds the transfer pipe. This protects the transfer pipe from wear and abrasions. A reinforced, continuous hose extending ~50 m from the shoreline to the well boat will be used to transfer the fish (similar to the hose shown in Figure 2.18). The hose will sit at the water's surface and will be continuously monitored by personnel. Fish will be counted via video monitoring (and a counter) as they exit the hatchery and as they enter the well boat. The day prior to transport, all equipment which will be used (i.e., pipes, hoses, pumps, counters) will be checked and prepared including checking the pipe and hose for breaches. A check list will be followed on the day of transfer for personnel at the hatchery (and the sea cage sites). Transfer of fish to the well boat will only occur during calm conditions. The well boat will use an anchoring point in Powers Cove, Mortier Bay when connecting to fish transfer pipes from the Post-Smolt Facility.

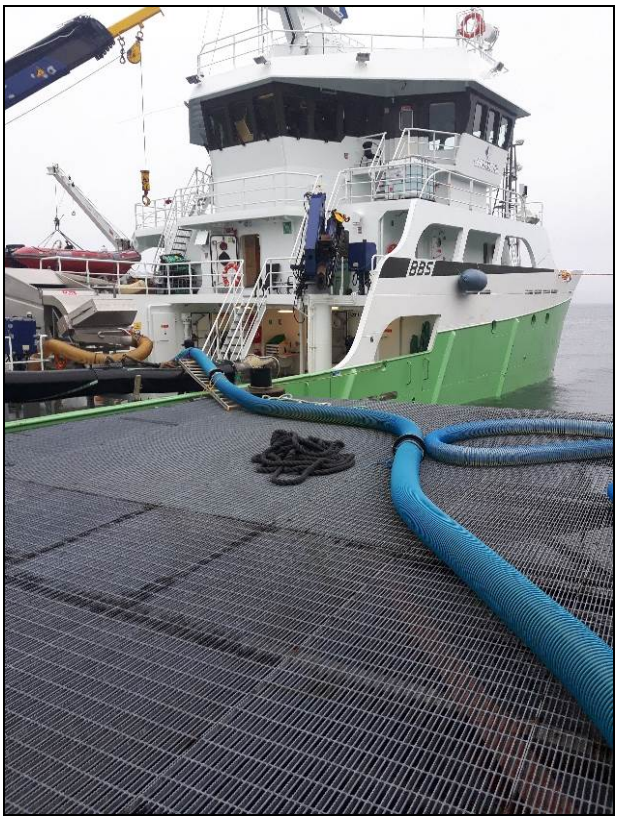


**Figure 2.18. Example of reinforced hose used to transfer smolt from the hatchery to a well boat.**

The transfer of smolt will be in such a way as to minimize fish stress, prevent escapes, and prevent injury through proper equipment use and transfer procedures. Once it has been determined that sufficient smoltification has transpired, a health check by a veterinarian will be conducted. This check will sample a number of fish from each tank that is being transferred to sea. Fish will not be transported if there are any health concerns or until the transfer permit from DFLR, DFO and CFIA is received.

***Water Supply for Facility***

Potable water will be supplied to the facility for use in the kitchens, bathrooms and cleaning of the facility. Potable water will be used for drinking water, food preparation and any washing water. All potable water required for the facility will be taken from the Town of Marystown's municipal water system. This water comes from Clam Pond and has been treated by the town of Marystown to comply with Government of Canada Drinking Water Quality (CDWQ) standards[3].

Water required for aquaculture operations will be supplied by a nearby well. The well is located in the town of Marystown near the intersection of McGettigan Boulevard and Centennial Road (47.180115°N, 55.142401°W). Surface water flow, groundwater movement, and aquifer recharge zones are described in the Aquifer Testing Report (see Sections 5.2 and 6.3 *in* Appendix L).

The water will be used to fill the RAS Hatchery tanks and as make-up water to replenish the small amount of water that is lost during operations and to supply water to the hatching units (maximum 300 L/min). The water has been tested for water quality and compared to Health Canada's Guidelines for CDWQ and to the Canadian Council of Ministers of Environment Water Quality (CCMEWQ) Guidelines for the protection of freshwater and marine aquatic life[4]. It should be noted that the water is not intended for use as potable water but for approval by the Department of Environment and Conservation the water will need to be considered potable and therefore compared against CDWQ standards. All well information along with water quality results and comparison tables are presented in Appendix L. The results show that the water satisfies both guidelines except that:

1. The water has a phosphorous concentration of 150µg/L which exceeds the CCMEWQ trigger value of 100µg/L for hyper eutrophic.
2. The turbidity values of 5.9 NTU and 0.6 NTU collected during the beginning and end of the pumping test exceeded the CDWQ maximum turbidity guideline of 0.1 NTU.

The elevated phosphorous is not considered a concern as the RAS Hatchery system is a closed loop system and the phosphorous is expected to precipitate out of solution in the presence of magnesium, calcium and sodium present in the water. The elevated turbidity is expected to reduce as the well is in use; however, a filtration system will be installed to ensure that all water falls below the 0.1 NTU maximum turbidity limit outlined in the CDWQ. Grieg NL will adhere to recommendations made in the Aquifer Testing Report for the well (see Section 9 *in* Appendix L) to ensure the long-term security of its water supply for the RAS Hatchery. Water levels in the well will be monitored via the installation of a level monitoring system and routine (i.e., monthly) water samples will be drawn from the well and tested for deviations from samples collected during the well tests.

Incoming water will be filtered with a fine filtration system (2 micron). The incoming filtered water will then be mixed with flow water returning to the DNS (Figure 2.19). All outgoing water from the DNS will pass through an UV unit before returning to the culture tanks.

[3] https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table-health-canada-2012.html
[4] http://st-ts.ccme.ca/en/index.html

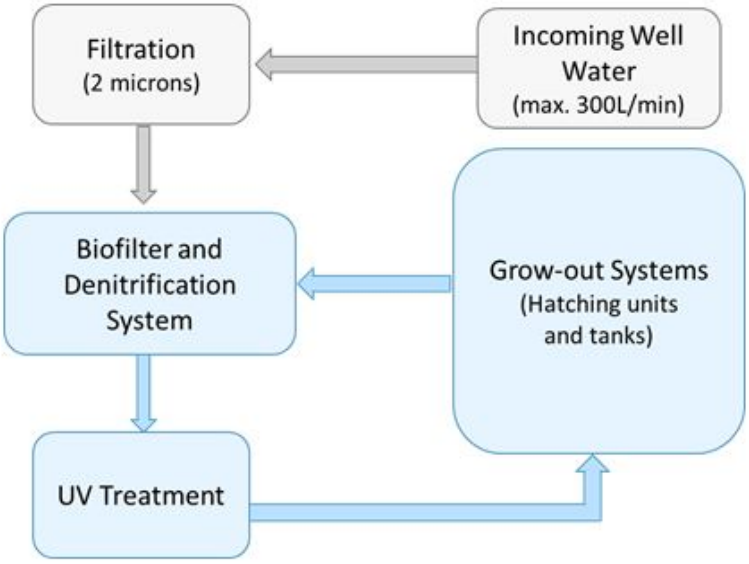



**Figure 2.19. Water flow into and within the RAS Hatchery.**

***Hazardous Materials***

Several hazardous materials will be used during operations including diesel, oil, lubricants, cleaners and solvents, flammable gases (i.e., acetylene), antifreeze, paints, and epoxies. Grieg NL does not intend to use or store gasoline. Diesel will be used in the backup generators located at the RAS Hatchery. Two 90,000 L fuel tanks (diesel) are proposed for the RAS Hatchery. Service NL will be contacted in Clarenville, NL to register these tanks and receive instructions from an Environmental Protection Officer as to which contingency plan documents are required (D. Neifer, Environmental Protection Officer, Service NL, pers. comm., 6 April 2018). Fuel delivery to the RAS Hatchery will be from a third-party supplier. Tanks will be located on a concrete pad with a containment barrier surrounding them to prevent spills to the surrounding environment. Acid (typically formic acid) used for generating ensilage will be stored in a 1,000 L Intermediate Bulk Container (IBC) housed inside an insulated storage room located at the RAS Hatchery. Ensilage at the RAS Hatchery will be held in an underground storage tank and can be pumped into IBCs or directly into a stainless-steel liquid transport truck for transport to an approved waste disposal facility.

Grieg NL is aware of the concerns regarding the use of hazardous materials and their potential uncontrolled release into the environment through leakage or accidental spillage and the subsequent adverse effects. A Spill Management Plan has been prepared that details procedures to follow in the event of a spill (Appendix M). All personnel will be required to follow regulatory policies and procedures and industry best practices.

***Waste and Waste Management***

The RAS Hatchery will produce a variety of wastes during operation including sanitary waste and wastewater, fish waste, fish mortalities, uneaten fish feed, petroleum products, operational debris and cleaning products. A general description of each waste type as well as waste management methods are summarized in Table 2.13. More detailed information on each waste including the handling, storage and disposal can be found in the Grieg NL's Waste Management Plan (Appendix J).

**Table 2.13. Waste generated by RAS Hatchery and management methods.**

| Waste | Description | Waste Management Methods |
|---|---|---|
| Sanitary waste and wastewater | All wastes and wastewater produced by humans or human activities including feces, urine, and washing water. | A BMS Blivet is located in the Marine Industrial Park to provide treatment to sanitary sewer. |
| Fish waste | All waste produced by the fish including fish feces and ammonia. | This waste will be separated out of solution and treated by mechanical and biological treatment. The collected waste will be mechanically dewatered with the water returning to the RAS; the sludge (~20% dry solid content) will be collected by truck by Burin Peninsula Waste Management Corporation (BPWMC) or other approved purchaser. |
| Fish mortalities | All fish that have died in the facility. | A mortality vacuum and ensilage system will be implemented to transfer dead fish from each facility to a centralized ensilage tank. Ensilage will be disposed in the most economical manner (fertilizer, composting or other viable options). |
| Uneaten fish feed | All feed that is fed to the fish but not eaten. | This waste will be separated out of solution and treated by mechanical and biological treatment. The collected waste will be mechanically dewatered with the water returning to the RAS; the sludge (~20% dry solid content) will be collected by truck by BPWMC (or other approved purchaser). |
| Antibiotics, anesthetics, vaccines | These products will be used to maintain fish health. | Any antibiotics, anesthetics, or vaccines (or diluent) requiring disposal, as well as biomedical waste such as needles will be handled according to biomedical waste disposal guidelines and municipal regulations. |
| Petroleum products | All petroleum-based products used in the facility including oils, fuels, and greases. | Management practices in place to reduce the amount, frequency and risk associated with the use of these products.<br>Reuse products when possible (e.g., waste oil can be collected and burned).<br>Choose environmentally friendly options when possible (e.g., food grade grease/oil). |
| Paints | All paints used to paint the facility. | Reduce the use of these products and only paint areas as needed. Unused paint will be recycled when possible. |
| Operational debris | All operational debris produced at the facility including general waste, electronic waste, feed bags, pallets, and litter. | Reduce the amount of waste generated when possible (e.g., buy feed and products in bulk, buy products with less packaging).<br>Reuse when possible (e.g., pallets can be reused for transportation within the facility or broken down for chipping).<br>Recycle when possible (e.g., cardboard, feed bags, aluminum cans, plastic bottles, electronic waste, etc.).<br>On site waste will be disposed in accordance with BPWMC. |
| Cleaning products | All products used to clean the facility including soaps, disinfectants, bleaches, and detergents. | Management practices in place to reduce the amount and frequency of these products and to ensure proper dilution after use before disposal.<br>Choose environmentally friendly options when possible. |

### *Chemical Use*

Chemicals will be used to maintain water conditions in the fish tanks, clean and disinfect equipment, and as required (and prescribed by a veterinarian) for fish health. As a condition of the initial EIS release, Grieg NL provided Health Canada with a list of substances, agents or chemicals (Appendix N) that may be used during the Project. This included information on the names and types of possible substances to be used (both approved and a number which are still under development), their purpose, and the specific aspect of the operation in which they will be utilized (including those which will be used regularly and

routinely, and others that may be required in certain circumstances, such as in the event of fish health issues). The list of proposed substances also provided an estimate of the likely quantities/rates at which each product may be used. Health Canada notified Grieg NL that it was satisfied with the proposed list of substances (A. Denning, Health Canada, via email on 14 October 2016). Since the original submission to Health Canada, additional substances (namely sodium chloride and sodium hydroxide for adjusting salinity and alkalinity, respectively) have been identified as further information about operational procedures became available. This updated substance list was approved by Health Canada on 8 March 2018 (A. Denning, Health Canada, via email on 8 March 2018). Health Canada will be made aware of any additional substances identified in future and their approval will be acquired. Disposal procedures for chemicals are outlined in Grieg NL's Waste Management Plan (Appendix J).

***Biosecurity***

Grieg NL will maintain the highest standards in biosecurity at the RAS Hatchery. A biosecurity plan will be in place prior to operation of the RAS Hatchery. Proper cleaning and disinfection is crucial to eliminating cross-contamination between tanks and between buildings within a hatchery setting. Cleaning and disinfection will take place between events such as fish grading, between year classes, the transfer of fish from one building to another, or a fish health event. Smaller equipment that is used daily will be cleaned and disinfected at the end of each personnel shift. All tools and equipment will be cleaned and disinfected prior to transfer between buildings or sites. Depending on the size of equipment to be disinfected a power washer may be used to clean as thoroughly as possible. All surfaces will be scrubbed or a disinfectant sprayed onto all surfaces. Electrical equipment will be wiped down with disinfectant wipes and heat applied.

Biosecurity was a key factor in designing the RAS Hatchery building. There will be separate, biosecure rooms/buildings for each stage of salmon development. The Post-Smolt Facility is divided into three modules due to biosecurity considerations. Modules A, B, and C, each have a separate building with independent services such as dressing rooms, control room, feed storage, disinfection room, electrical room, and sumps. In addition to daily husbandry practices noted above, protocols will be in place to enhance biosecurity as personnel, equipment, and fish move between rooms and/or buildings. Air movement in and out of the facility as well as pressure is controlled and filtered. Doors are controlled by a central access system where each worker must have the required credentials (embedded into an ID tag) to enter their work area, and may not enter other areas to prevent cross-contamination. Entrance to production halls (i.e., where grow-out tanks are located) require strict biosecurity measures, and are designed accordingly. Personnel will have separate work clothes for each facility and will be required to change upon entering a new building. Disinfection procedures for personnel and their clothing will also be in place. These and other procedures will be outlined in Grieg NL's Fish Health Management Plan (Appendix K)

### 2.4.3.3 Decommissioning and Rehabilitation

For the purposes of this EIS, we have assumed that the Project will have a lifespan of 10 years after peak salmon production is reached. A decommissioning plan will be developed with input from appropriate regulatory agencies that outlines procedures for shutting down Grieg NL operations at the RAS Hatchery. It is premature at this stage to determine whether the facility would be sold, demolished, or converted for another use. However, the decommissioning plan will clearly lay out the approach and details regarding removal of all fish and fish products, waste, chemicals, equipment and infrastructure.

Decommissioning of the RAS Hatchery will be completed in several stages. A staged approach will allow for organized rehabilitation of the project site and appropriate environmental control. Key steps in the decommissioning process will include:

- Removal of all remaining fish and fish products;
- Cleaning and disinfecting of all equipment and buildings on the site so that repurposing may take place;
- Removal and appropriate disposal of all hazardous chemicals, reagents and materials;
- Removal of all salvageable equipment, materials and supplies;
- Removal and appropriate disposal of all non-salvageable equipment, materials and supplies; and
- Re-usable equipment and machinery will be transported to other locations and the land and infrastructure in the Marine Industrial Park will be repurposed for future operations.

The development of the decommissioning plan will be revised and updated regularly on an as-needed basis as the Project moves through the Operations phase. All legislation and guidelines set by the Federal and Provincial Governments that may apply to the RAS Hatchery site at the decommissioning and rehabilitation stage will be reviewed and followed.

### 2.4.4 Sea Farms

The key components of the Project in the marine environment include those directly owned by Grieg NL and vessels which will be provided by third-party suppliers. Project components that will be owned by Grieg NL include:

- Sea cages
- Barges
- Service vessels
- Work boat
- Crew vessel

Third party vessels will include:

- Well boat
- Service vessels
- Feed supply vessel
- Dead hold vessels

The numbers of sea cages and vessels will ramp up as the Project reaches full production capacity (Table 2.14). At full production (steady state), a maximum of 78 sea cages at seven sea cage sites will be utilized and 27 vessels could be in use at any one time. Eighteen of the 27 vessels will be owned by Grieg NL and third-party suppliers will operate 8–9 vessels. All vessels will be certified, inspected, and have appropriate safety plans and equipment in place.

**Table 2.14. Number of sea cages and vessels required for the Project. Full production (steady state) and hence, maximum number of vessels will be reached in Year 8.**

| Year | Total No. of Sea Cages and Vessels in Use Per Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Grieg NL Owned | | | | | | Third-Party Suppliers | | | |
| | Sea Cages | Feed/ Accomm. Barges | Satellite Barges | Service Vessels | Work Boats | Crew Vessels | Service Vessels [a] | Well Boats | Dead Hold Vessels | Feed Supply Vessel |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 12 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 0 | 1 |
| 4 | 33 | 2 | 6 | 2 | 2 | 2 | 4 | 1 | 1 | 1 |
| 5 | 45 | 3 | 6 | 3 | 3 | 3 | 5 | 1 | 1 | 1 |
| 6 | 55 | 3 | 6 | 3 | 3 | 3 | 5 | 1 | 1 | 1 |
| 7 | 73 | 3 | 6 | 3 | 3 | 3 | 5 | 1 | 1 | 1 |
| 8 | 78 | 3 | 6 | 3 | 3 | 3 | 5 | 1 | 1 | 1 |
| **Max. at Steady State** | **78** | **3** | **6** | **3** | **3** | **3** | **5** | **1** | **1** | **1** |

[a] It is possible that on occasion Grieg NL will employ the services of a larger multi-purpose service vessel to assist with operations such as net changes and towing sea cages to sea cage sites.

### *Sea Cages*

The sea cages used to house fish at sea will be state-of-the-art, heavy-duty Aqualine Midgard Systems (designed by Aqualine AS in Norway; see Volume 3, Sullivan et al. (2018) for a review of the sea cage). The Midgard System has been modelled, tested in the field, and there are currently over 1,000 of these systems in use in locations such as northern Norway, Iceland, the Faroe Islands, and Canada (BC). These locations are harsh and cold environments similar to Newfoundland. Most of these locations that a Midgard system is in use follow strict aquaculture policies and documentation that requires any fish escapes to be reported to authorities and documented. To date there have been no reported fish escapes during production of 350 million fish (~2 million tonnes) in locations using the Midgard system. Each sea cage will consist of the following primary components: cage net, floating collar, gangway, sinker ring (tube), winches, and fish mortality removal system (Figure 2.20). Additionally, for mitigation purposes all sea cages will be equipped with anti-bird netting and will be attended by a Remotely Operated Vehicle (ROV) and operator as well as camera monitoring above and below the surface (see Section 2.5.2.2 for additional details). Grieg NL may also use sea lice skirts and a sub-sea feeding apparatus to assist with controlling sea lice as required (see Section 2.5.2.2 for more details).



**Figure 2.20. Schematic showing the sea cage system proposed by Grieg NL (Aqualine Midgard System).**

Each sea cage will hold ~160,000 fish and weigh ~35 tonnes and is certified by DNV GL and subjected to simulation tests developed by Aqualine and SINTEF. DNV GL is a globally leading quality assurance and risk management company operating in more than 100 countries. They provide classification, certification technical assurance, software and independent expert advisory services to the maritime, oil and gas, power, renewables industries as well as, supply chain and data management services. Aqualine has been certified by DNV GL for the floating collars used in the Midgard system (see Appendix O). SINTEF Ocean is an independent research organization that supports research and development in many maritime industries including fishing, aquaculture and oil and gas. With expertise in hydrodynamics and construction engineering, SINTEF Ocean offers model and full scale testing in their Ocean Basin. Total environment simulations including wind, waves and currents provide testing in realistic conditions. Aqualine's Midgard system has been tested by SINTEF in their Ocean Basin system in a number of simulated wave conditions and current speeds (see Appendix O report from SINTEF and certificates from Aqualine).

The cage net will have a diameter of 50 m, extend 45 m below the water surface, and have a dry weight of 3,116 kg. The netting is made of black UV stabilized material (i.e., Aqualine Ultima/Ultra SG netting which is made with high-density polyethylene [HDPE] material). The mesh size from knot to knot is 17.5 $mm^2$. The netting is affixed to attachment ropes on the outside and it is drawn into an apex at the bottom and affixed to a stainless steel gyro (see Figure 2.20). By fastening the cage net onto brackets, an even distribution of the net load into the system is ensured. The cone-shaped net which extends ~13 m below the base of the net, will allow fish to descend deeper into the net without increasing the stocking density (i.e., number of fish/$m^3$). The bottom of each sea cage will have reinforced netting which minimizes the risk of tears.

A common method employed on sea cage systems to control predation is the use of a physical barrier to protect the farmed fish from airborne predators. The Midgard predator system has a dedicated predator net system. Grieg NL intends to utilize a bird net on all of its cages. The bird net and bird poles (20 fiberglass poles each ~5 cm in diameter; Figure 2.21) provides sufficient tension to eliminate sagging; this minimizes predation on the fish by birds and reduces the interface of the netting when fish are feeding. The sides of the bird net can be raised and lowered like a window blind to quickly and easily access the cage. The bird net extends ~5 m above the surface of the water. Grieg NL may also use a predator net as depicted in Figure 2.22; this is discussed in Section 2.5.2.2.

The floating collar surrounds the net and consists of two floating rings (tubes) with a gangway (Figure 2.23), equipped with anti-slip construction and handrails, between to allow for safe maneuvering around the sea cage. The gangway and handrail extend ~1.2 m above the water's surface. The main supporting system consists of steel/plastic brackets connected to steel rods, chains, and fibre ropes which handles the forces around the circumference of the floating collar. Bushings between the steel brackets and floater tubes reduce friction and the floater tubes can move freely inside the brackets (rotation and longitudinal). The loads from the mooring system are distributed around the circumference of the net and are handled by separate steel mooring brackets. There is expanded polystyrene in both floater tubes to maintain the buoyancy in case of any damage or puncture. Personnel may also be equipped with trip and fall devices and/or Personal Locator Beacons (PLBs) for added safety.

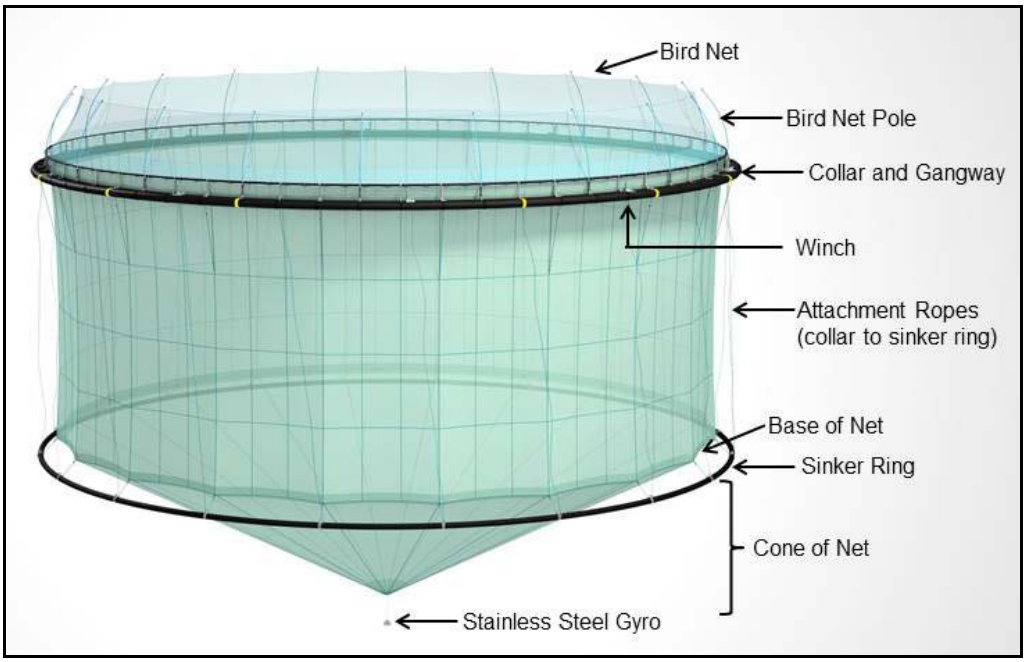



**Figure 2.21. Bird net and poles to be used as predator control on the sea cages.**

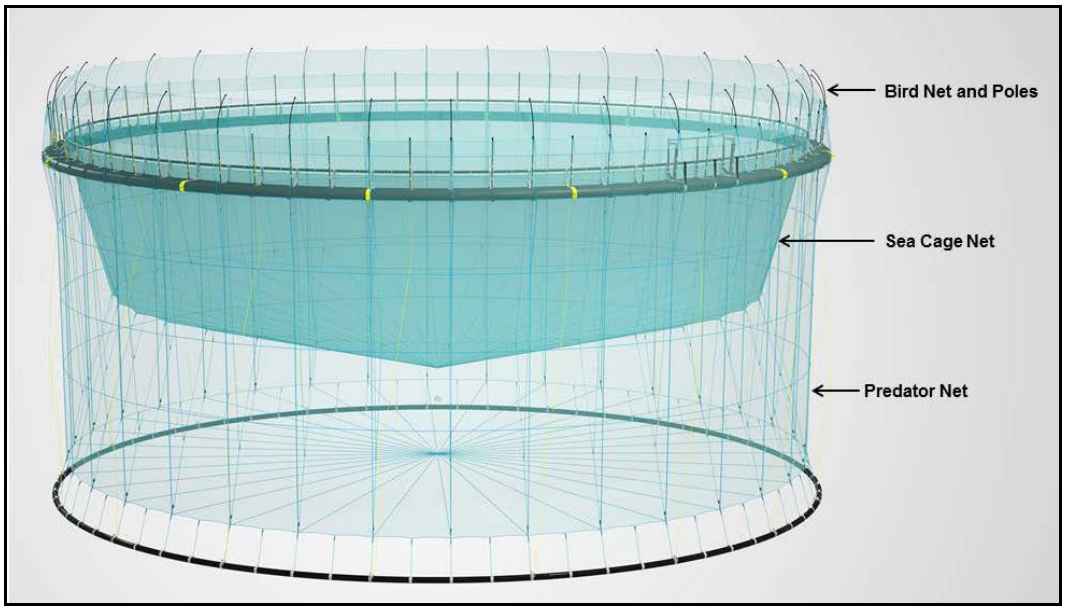



**Figure 2.22. Schematic showing the predator nets.**

**Floating Collar: General Specifications**

- Each Cage consists of Double Floating Rings
- Material PE100
- Floating Tubes Outer Diam. 500mm
- SDR13.6 – Wall Thickness 36.8mm
- Internal Circumference 160mm for cage
- Walkway sections
- Steel Hot Dip Galvanized Brackets for Tube Connections, 48 pcs
- Steel Mooring Brackets for Anchoring Connections, 12 pcs
- Structural Load Bearing System all around the circ, unique Aqualine
- Including Hand rails, PE80, Diam. 140mm, SDR11 (12.7mm)
- Plastic Fenders attached to brackets to avoid damages on workboats
- Inside Fenders to prevent net abrasion
- Full set of Hook Protector made of HDPE (HSE device)



**Figure 2.23. Specifications and photo of a floating collar showing floating rings (tubes) and gangway.**

The sinker ring hangs directly from the cage net base rope net with a series of 20 suspension ropes and extends ~2 m below the base of the net and the cone extends another 15 m below. Integrating the cage net and sinker ring provides optimum cage net tensioning and fish rearing capacity. The sinker tube is constructed of polyethylene plastic, has a diameter of 40 cm, and a submerged weight of ~60 kg/m.

Each sea cage is equipped with 10 customized power winches which allows for a more efficient and safe work area. Each winch works by lifting and lowering the sinker tube which allows for the entire net to be lifted simultaneously in a single operation without service vessels, cranes and personnel, resulting in no strain on personnel or the netting. With a uniform lifting of the bottom of the net by winches, this reduces "pockets" forming where fish can gather and become trapped leading to a large number of instant mortalities. This is one advantage of the Midgard system compared to other cage/net system with regard to handling the net with live fish in. This system also results in less stress on the fish. The winch is powered by an electric motor (230 V, 50 Hz) with a watertight construction with a 1.5 kW engine that operates at a speed of 1,430 rpm (Figure 2.24). This motor can power the winches to lift the net at a rate of 1 m per minute (rated line pull per winch of 2,200 kg each x 10 winches).

Grieg NL is proposing a centralized system called Mortex to automatically and routinely collect dead fish from the sea cages. The system consists of one or two main pipelines from the sea cages to a dewatering system (i.e., separates water from the fish) on the feed barge (Figure 2.25). The Mortex system will attach directly to the cone of each net and dead fish will be pumped daily via a fully enclosed pipeline system to the feed barge. By collecting mortalities daily this will decrease predator attraction to the cages and minimize disease risk (see Section 2.5.2.2 for more details).



**Figure 2.24. Winch motor operated by sea cage personnel from the sea cage gangway.**

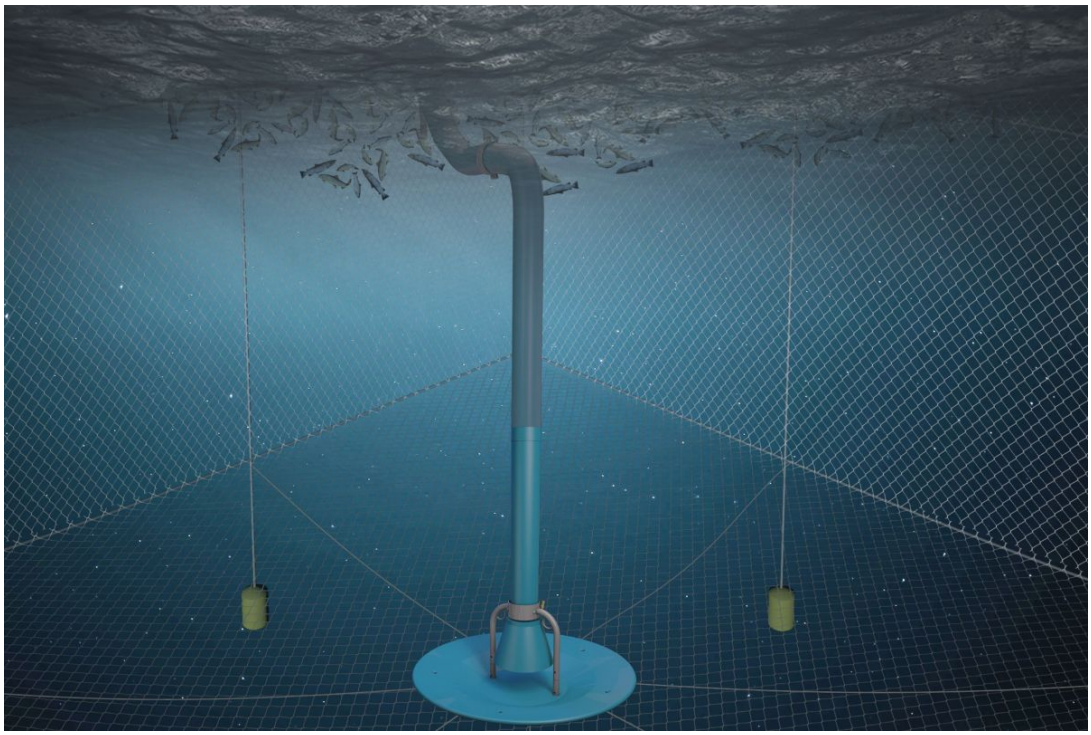


**Figure 2.25. Mortality removal system (i.e., Mortex) in the bottom of the sea cage to collect and transfer fish mortalities to surface.**

***Barges***

Each active BMA will have three to five on-site barges that will be used to feed the fish. When the Project is at full production, there will be a primary feed/accommodation barge that has a feed holding capacity of 600 tonnes located in one sea cage site with each of the other two sea cage sites within a BMA attended by satellite feed barges with a feed holding capacity of 300 tonnes each. The number of satellite barges (one or two) at each sea cage site will vary depending on the feeding demands. As the fish grow and additional feed is required, a second satellite barge will be used to increase feed holding capacity from 300 tonnes (with one satellite) to 600 tonnes (with two satellites). It is anticipated that all barges will be designed by AKVA Group, the leading international supplier of feed barges, and will be state-of-the-art. The barges are DNV GL certified and designed for significant wave heights of 6 m. Unlike most barges which have a flat bottom, the AKVA designed feed barges have a V-shaped keel which is a similar design concept as industrial fishing vessels and increases vessel stability. Grieg NL is planning to have the barges constructed in Newfoundland. They will be towed from the construction site in Newfoundland to the sea cage sites.

The primary feed/accommodation barge will have a length, width, draft, and maximum height above sea level (asl) of 44 m, 12 m, 1.9 m, and 7.9 m, respectively (Figures 2.26 and 2.27). The feed/accommodation barge will be anchored on site via an approved mooring system (see Figures 2.36 and 2.37 *in* Section 2.4.4.1). This barge will be able to accommodate maximum 16 personnel (8 double-berths), a fully-equipped galley, and a lounge area. It has the capacity to desalinate and recycle wastewater to reduce water use and discharge. This barge will be staffed continuously. Feed will be stored in cargo holds within the barge and feed will be moved to the sea cages via a series of feed lines (Figure 2.28) made out of HDPE. The feed/accommodation barge has the capacity to store 925 $m^3$ (600 tonnes) of feed, which is sufficient to feed fish in 12 sea cages for 10–16 days depending on fish size. Feed will be resupplied by a feed supply vessel. The feed/accommodation barge can store a maximum of 30,000 L of fuel in one tank (28 $m^3$). There will be camera systems on all sites providing 24-hour surveillance that can be viewed on the feed/accommodation barge, as well as at a centralized monitoring station in the RAS Hatchery and remotely via cell phone for approved Grieg NL personnel. Staff will remain on site with crew changes approximately every seven days.

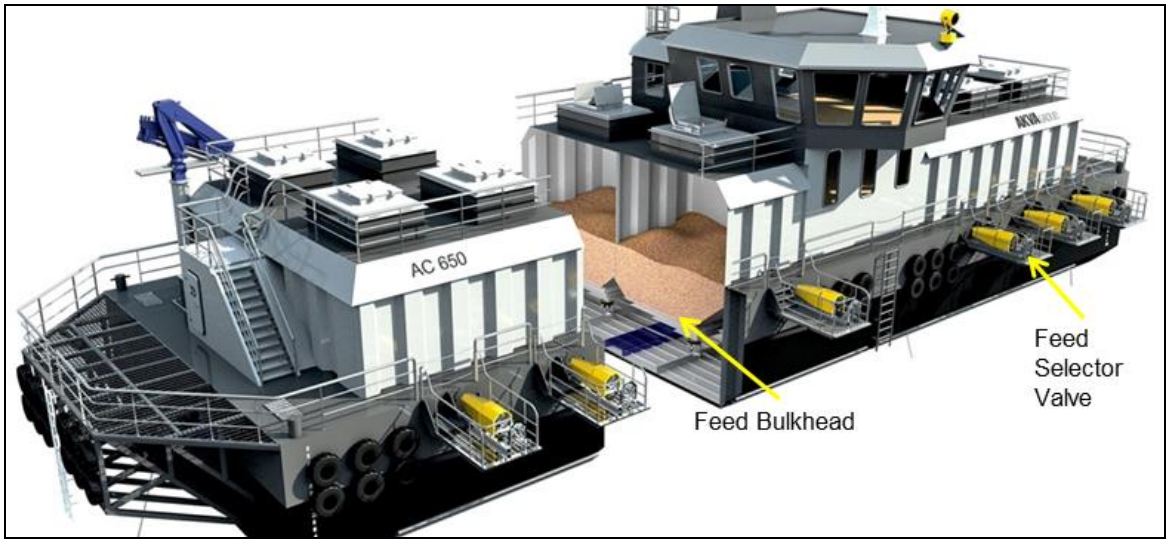



**Figure 2.26. A typical feed/accommodation barge cross-sectioned to show how feed is stored in bulkheads as well as the feed selector valves.**

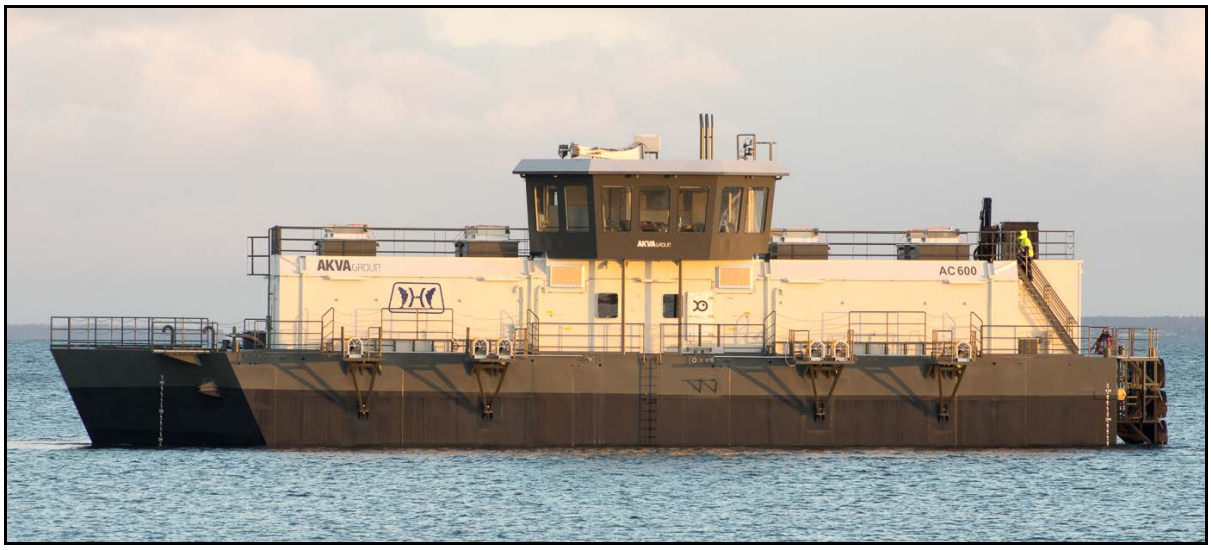



**Figure 2.27. A feed/accommodation barge.**




**Figure 2.28. A feed barge showing feed lines to sea cages.**

The satellite feed barges will have a length, width, draft, and maximum height asl of 28.4 m, 10 m, 0.83 m, and 4.5 m, respectively (Figure 2.29). These barges will be anchored on site via an approved mooring system. Personnel will not be housed on these barges but will be attended to by personnel based

on the feed/accommodation barge. The satellite feed barge can store a maximum of 21,900 L of fuel in two tanks (each 10.95 $m^3$). Feed will be stored in cargo holds within the barge and feed will be moved to the sea cages via a series of feed lines. The satellite feed barge has the capacity to store 300 tonnes of feed, which is sufficient to feed fish in 12 sea cages for 5–8 days depending on fish size. Feed will be resupplied by a feed supply vessel.

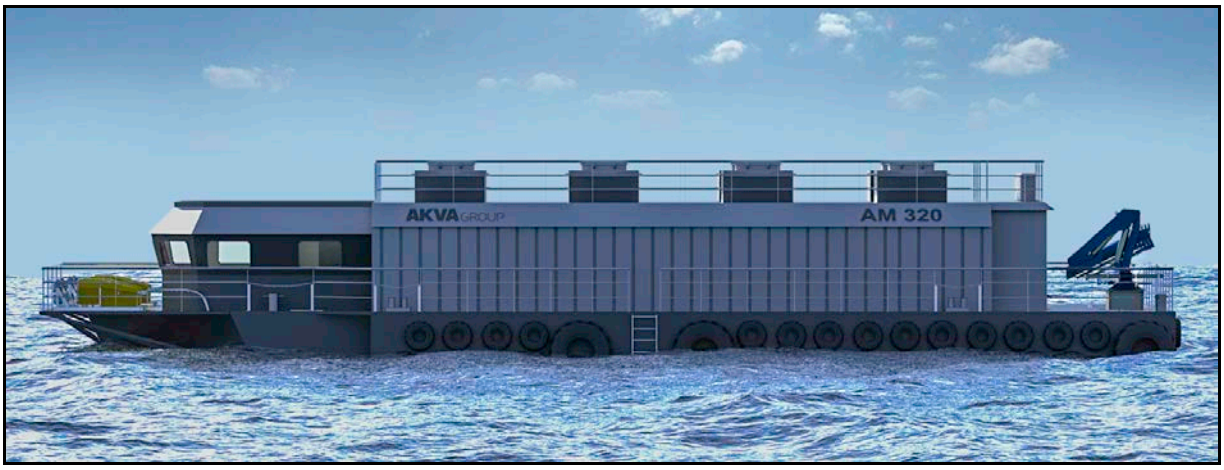



**Figure 2.29. A typical satellite feed barge.**

***Well Boat***

A single vessel called a "well boat" will be used to transport fish from the RAS Hatchery to the sea cages (Figure 2.30). There will be no transport of fish via land. Eliminating transport of fish via truck over land will reduce stress on the fish. The well boat will be operated by a third party and meet the transport requirement for Grieg NL`s production of smolt. It has a customized hold, i.e., well in the bottom, specifically designed to hold fish at optimum conditions (i.e., temperature, salinity) and which allows for regular monitoring of water quality. The well boat will typically travel at speeds of 8 knots (14.8 km/h) and will not operate in rough sea conditions. Transport of live salmon by well boat is a standard aquaculture method used worldwide including in Newfoundland. A well boat will also be used to transport cleaner fish from a third-party supplier to the sea cage sites.

***Service Vessels***

Seven service vessels, two owned by Grieg NL and five owned by a third party service provider, will be used to support operations at the sea cage sites. The service vessels will supply materials and assist with net and cage cleaning, removal of ensilage waste, net changing, and fish harvesting. The proposed service vessels have been designed by Tri Nav Marine Design (based in St. John's, NL; Figure 2.31) with a length, width, and draft of 11.9 m, 7.3 m, and 2.7 m, respectively. The wheel house is elevated (1.8 m) and will have an unobstructed 360-degree view to facilitate approach to the sea cages. The vessels will also have large holds which can be used to carry extra feed if needed. Each service vessel will be equipped with a deck crane that can lift 1,200 kg at ~9 m extension that will primarily be used to transfer supplies to the feed barges, assist with ROV placement, and net cleaning. The vessels will also be equipped with bow thrusters which increase the ability to maneuver around the cages in a much safer way than traditional vessels. The service vessels are equipped for push and pull purposes (via a customized propulsion system and propellers) and will be equipped with towing bridles. Of note, the service vessel

engines will comply with the new Tier Three Regulations of Transport Canada (and with Annex VI of MARPOL 73/78).




**Figure 2.30. A well boat picking up salmon at a sea cage.**



**Figure 2.31. Representation of a service vessel that will provide support to the sea farms.**

Typically once a year, Grieg NL will employ the services of a larger multi-purpose service vessel (provided by a third-party service provider) to assist with operations such as net changes and towing sea cages to sea cage sites (Figure 2.32). The multi-purpose vessel will have a length, width, and draft of 24.9 m, 11.5 m, and 3.2 m, respectively.




**Figure 2.32. Multi-purpose service vessel that will periodically assist with operations such as net changes.**

### *Crew Vessels*

Crew vessels will be used to transport personnel between the sea cage sites and designated crew change sites (proposed at Petit Forte and Long Harbour). Designated crew change sites will have "inflow" and "outflow" areas for increased biosecurity. There will be one crew vessel per BMA and each crew vessel will act as a backup for the other BMAs. The exact type of crew vessel has not been determined but it is anticipated that Grieg NL will use a vessel like the Polarcirkel boat (Figure 2.33)[5], which is ~9.8 m in length and suited for extreme weather conditions. The crew vessels will be equipped with navigation capability to operate in night-time and foggy conditions and will have the capability to travel at fast speeds should the need arise (e.g., in an emergency situation).

### *Workboats*

Workboats will be used by personnel to travel between feed barges and sea cages within a BMA and also to assist in the day-to-day operations at the sea cage sites. Each BMA will be equipped with one workboat. Rigid Buoyancy Boats, 6.4 m in length, will serve as the workboats (Figure 2.34). These vessels are self-bailing, have rigid pontoons filled with polystyrene, and have a V-shaped hull, which provides excellent seaworthiness.

[5] There are more than 2,000 Polarcirkel boats currently in use in the aquaculture industry, oil and gas industry, emergency services and military as well as in the Arctic. All Polarcirkel boats are tested in extreme weather conditions and are equipped with technology and features for safe operations in harsh environments.



**Figure 2.33. An example of a potential crew vessel.**




**Figure 2.34. A rigid buoyancy boat that will serve as a workboat.**

### 2.4.4.1 Construction

The Construction Phase of the sea farms will entail the installation of moorings, the assembly and installation of sea cages, and service vessels and barges to be purchased. This will be required for each of the three semi-annual BMAs as well as the seasonal BMA. This process will occur over four to six years (Figure 2.35).

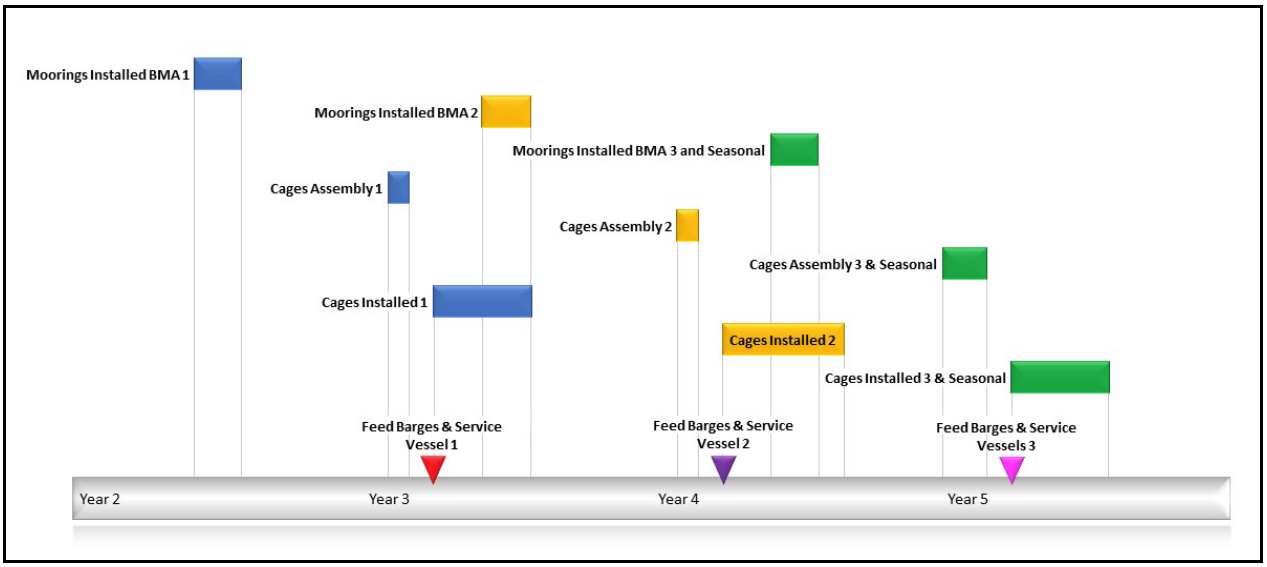



**Figure 2.35. Construction timeline for sea farms.**

### *Sea Cage Construction and Installation*

Materials for the sea cages will be purchased from Aqualine in Norway. Construction and installation of all sea cage systems and associated moorings will be completed by Aqualine and a third-party supplier, with oversight by Grieg NL. The primary vessels for handling the installation and anchoring operation will be the service vessels. A total of three vessels will be involved in the installation.

The floating collar is assembled through a series of customized brackets. All parts required for assembly of the floating collars will arrive well in advance of the planned operation to ensure sufficient time for assembly. The assembled collars then will be towed (without the cage net attached) by a service vessel at a speed less than three knots (5.6 km/h) to the sea cage sites and will be installed about one month before being stocked with fish. These operations will require the use of three service vessels which will each have a 60–100 t/m crane capacity. Detailed information regarding the transport, installation, inspection and maintenance of the floating collars is provided in Appendix III of Sullivan et al. (2018; see Volume 3).

The mooring system will be specifically designed for each of the 11 sea cage sites by Aqualine in consideration of oceanographic data collected (bathymetry, currents). The mooring system is designed in a grid fashion (longitudinal and transversal lines; Figures 2.36 and 2.37) with sea cages connected to each other and securely anchored to the seafloor via a series of plough anchors made of galvanized steel (Figure 2.38). Each plough anchor has a footprint of 1 $m^2$. Brackets, shackles, bridles (ropes), grid plates, chain and floats all comprise part of the mooring systems as depicted in Figures 2.36 and 2.37 as well as Figure 2.39. In addition, the feed barges will be moored at sea cage sites using a system designed by Aqualine specifically for each barge. Detailed information regarding the transport, installation, inspection and maintenance of the mooring system is provided in Appendix P. Two service vessels with cranes will be required to install the moorings. Moorings will be installed during the summer prior to sea cage installation (i.e., ~one year in advance). Once moorings are set, they are not relocated when sea cages are moved between sea cage sites.

**(A)**

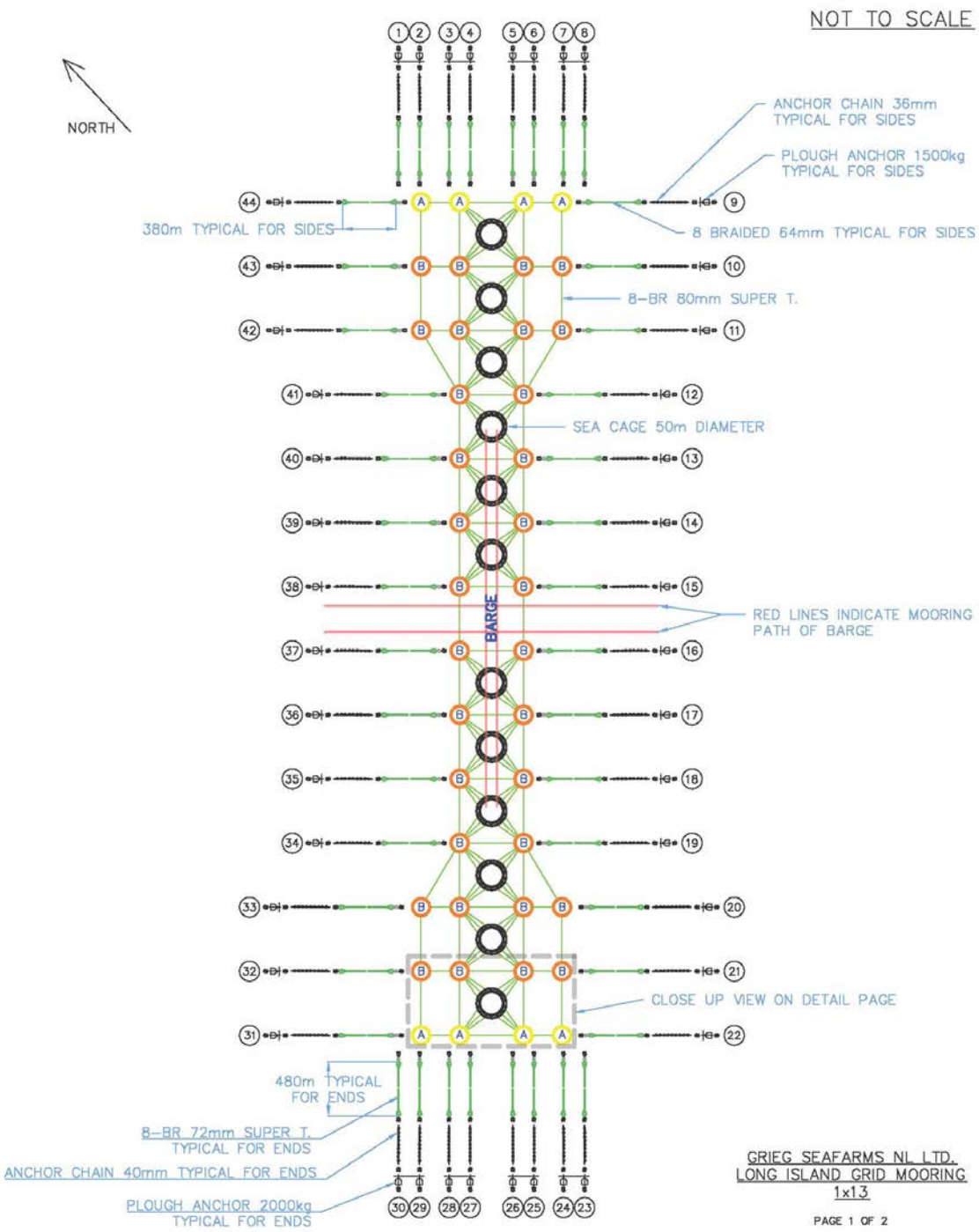



**Figure 2.36. Grid mooring system (A) and associated schematic legend (B) for sea cages and feed and/or accommodation barge at a semi-annual sea cage site (e.g., Long Island sea cage site in the Rushoon BMA).**

**(B)**

| DETAILS FOR LONG ISLAND GRID MOORING – 1x13 | | |
|---|---|---|
| DETAIL NUMBER | DESCRIPTION | QUANTITY |
| 1 | GRID PLATE 16 HOLES 40mm | 40 |
| 2 | CHAIN FOR BUOYS 19mm 8 METER | 40 |
| 3 | BUOYS | |
| | A 4400 LITRE BUOYS | 8 |
| | B 2200 LITRE BUOYS | 32 |
| 4 | BRIDLE PARTS | |
| | 22mm CHAIN SLING WITH 34mm MASTERLINK | 144 |
| | 3 STRAND 64mm AQUALINE ROPE | |
| | LENGTH SIDE ROPES 44m | 96 |
| | LENGTH CENTRE ROPE 40m | 48 |
| 5 | MOORING SHACKLE MBL 90t | |
| 6 | MOORING SHACKLE MBL 60t | |
| 7 | MOORING SHACKLE MBL 40t | |
| 8 | MASTERLINK GALV. 34mm | |

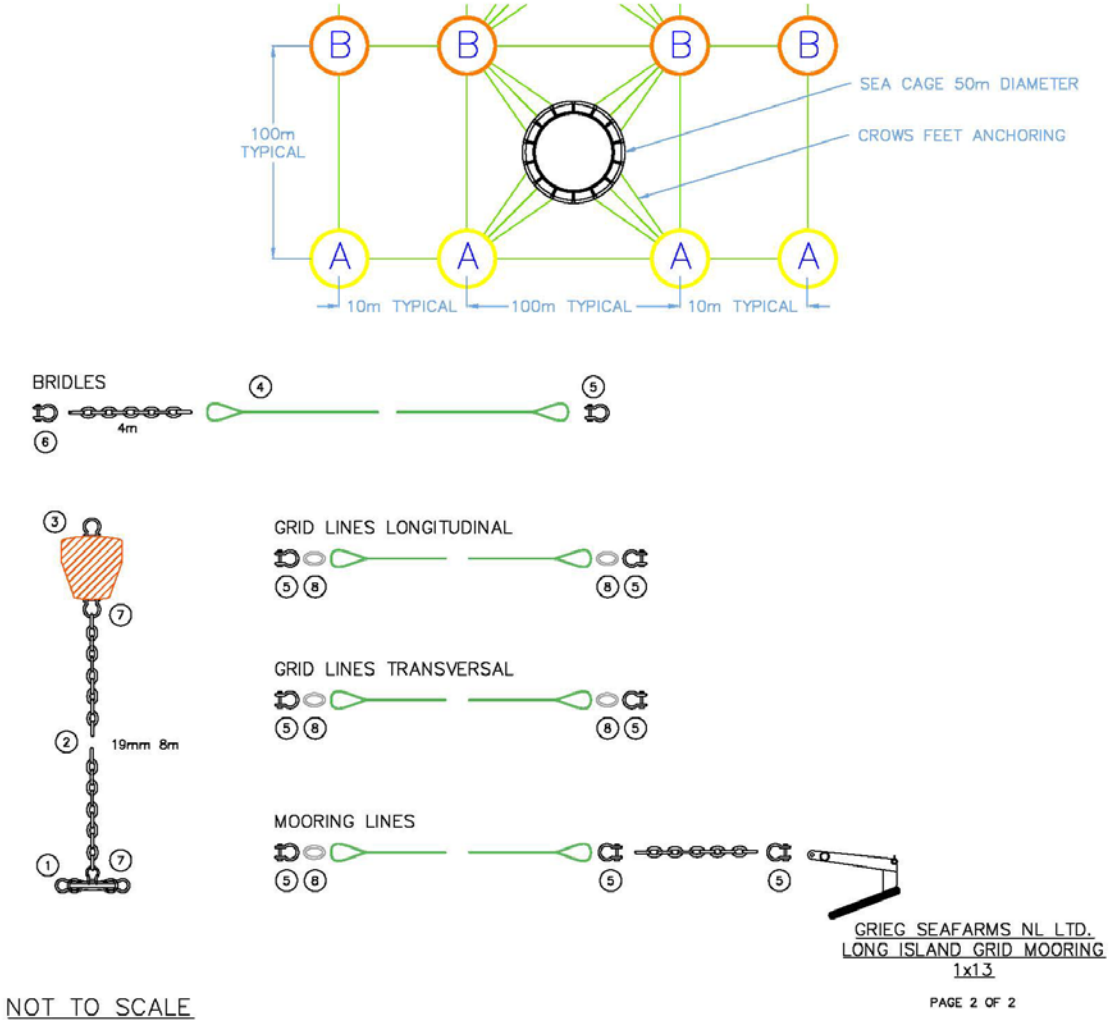



**Figure 2.36 (Continued). Grid mooring system (A) and associated schematic legend (B) for sea cages and feed and/or accommodation barge at a semi-annual sea cage site (e.g., Long Island sea cage site in the Rushoon BMA).**

**(A)**

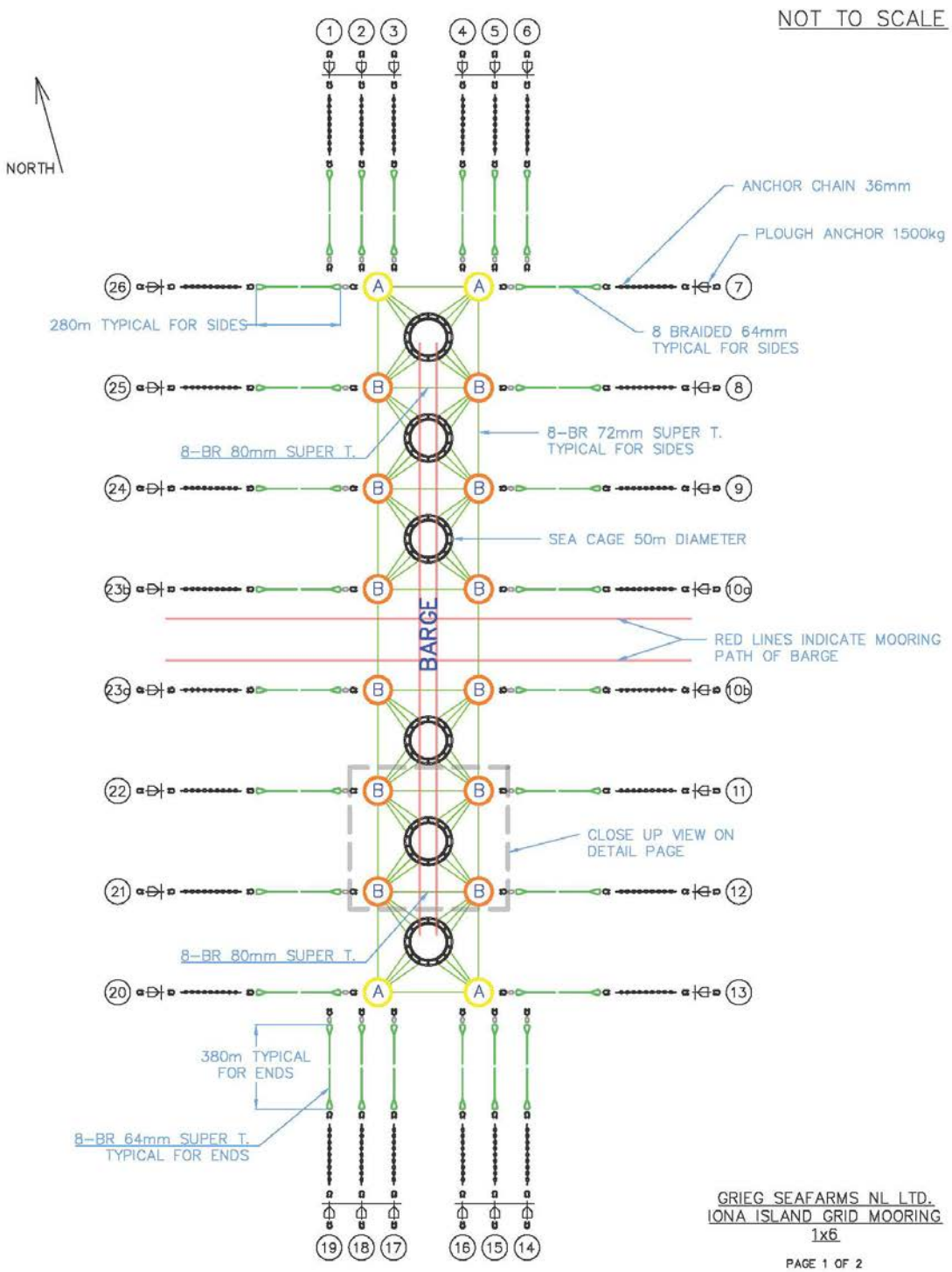



**Figure 2.37. Grid mooring system (A) and associated schematic legend (B) for sea cages and feed and/or accommodation barge at a seasonal sea cage site (e.g., Iona Island sea cage site in the Long Harbour BMA).**

**(B)**

| DETAILS FOR IONA ISLAND GRID MOORING – 1x6 | | |
|---|---|---|
| DETAIL NUMBER | DESCRIPTION | QUANTITY |
| 1 | GRID PLATE 16 HOLES 40mm | 14 |
| 2 | CHAIN FOR BUOYS 19mm 8 METER | 14 |
| 3 | BUOYS | |
| | A 4400 LITRE BUOYS | 4 |
| | B 2200 LITRE BUOYS | 10 |
| 4 | BRIDLE PARTS | |
| | 22mm CHAIN SLING WITH 34mm MASTERLINK | 72 |
| | 3 STRAND 64mm AQUALINE ROPE | |
| | LENGTH SIDE ROPES 44m | 48 |
| | LENGTH CENTRE ROPE 40m | 24 |
| 5 | MOORING SHACKLE MBL 90t | |
| 6 | MOORING SHACKLE MBL 60t | |
| 7 | MOORING SHACKLE MBL 40t | |
| 8 | MASTERLINK GALV. 34mm | |

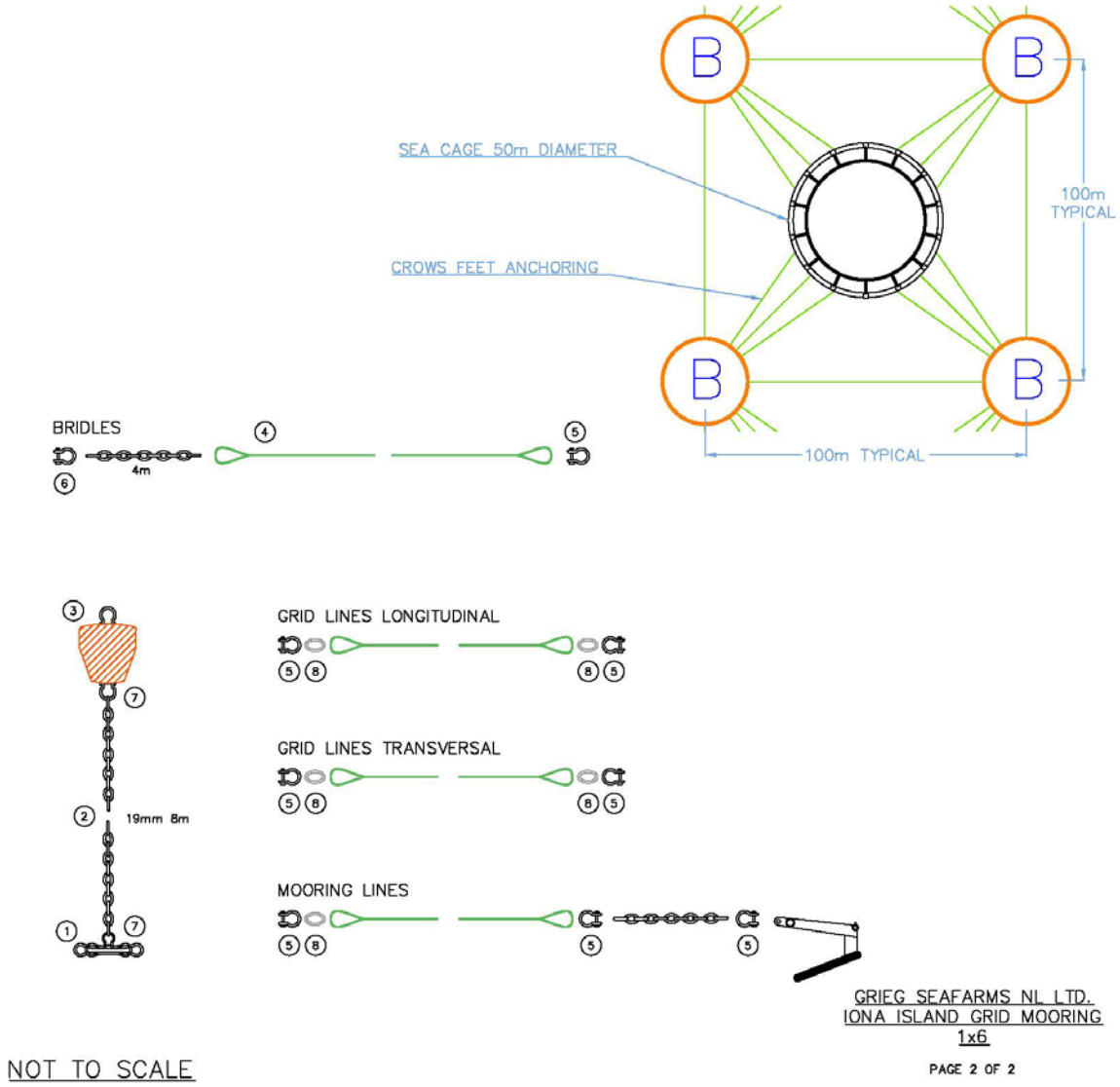



**Figure 2.37 (Continued). Grid mooring system (A) and associated schematic legend (B) for sea cages and feed and/or accommodation barge at a seasonal sea cage site (e.g., Iona Island sea cage site in the Long Harbour BMA).**




**Figure 2.38. Plough anchor used as moorings for sea cages and barges.**

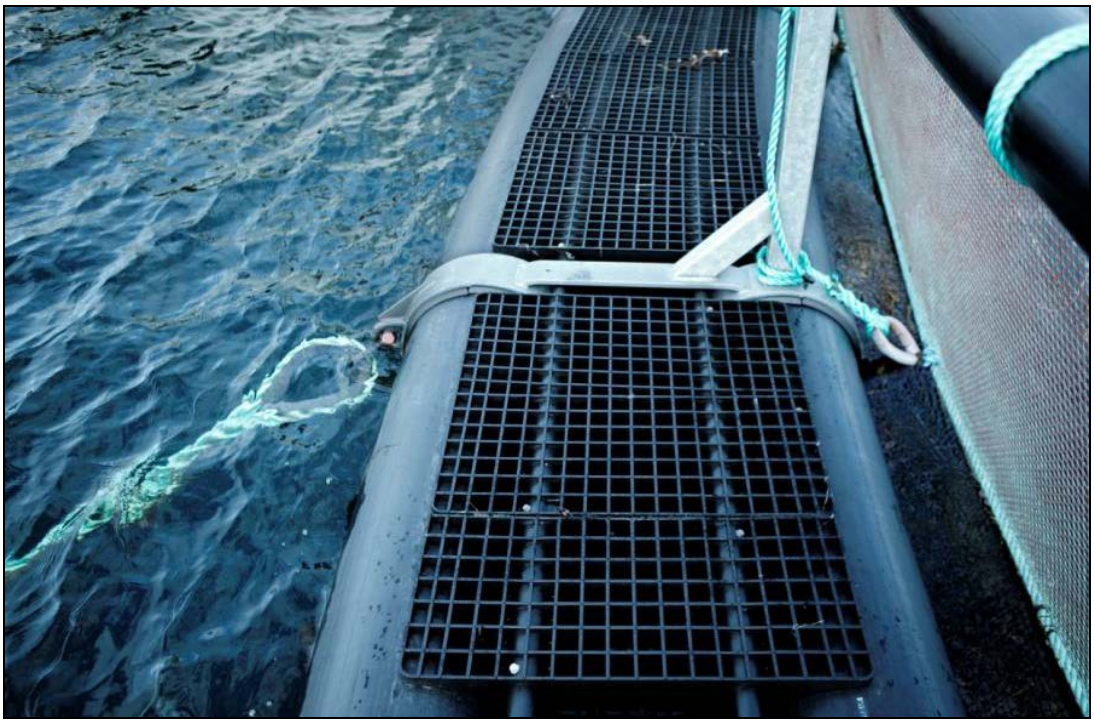


**Figure 2.39. An example of fastening of mooring in the standard mooring bracket.**

***Waste and Waste Management***

Of note, Grieg NL does not plan to dredge, dispose of dredged materials, or in-fill materials as sea. Additionally, there is no permanent infrastructure planned for the marine area; however, there will be moorings installed on the seafloor as discussed above. There will be very little waste generated during construction of the sea cages. Waste may include plastic piping (ranging from small particles, up to 1 m segments), rope segments, galvanized chain segments, steel wire, wooden pallets, wood pieces, and electrical cable pieces. Where possible, wastes will be reused and recycled. Grieg NL's Waste Management Plan (Appendix J) provides details on wastes generated during construction of the sea cages and how it will be handled.

### 2.4.4.2 Operations and Maintenance

As noted earlier, Grieg NL has identified 11 sea cage sites grouped into four BMAs within Placentia Bay for the marine portion of this undertaking. Three of the BMAs are planned for semi-annual production and one BMA is planned for seasonal production. Each semi-annual BMA will have three sea cage sites and the seasonal BMA has two sea cage sites. The semi-annual and seasonal sea cage sites will each have a maximum of 12 and 6 sea cages, respectively. Each of these sea cages can hold 160,000 fish.

***Planned Stocking Schedule and Fallowing Periods***

Grieg NL has developed a salmon stocking schedule that takes into consideration provincial requirements, water temperatures at the sea cage sites, and the benefits of limiting time at sea during the winter. These considerations are discussed below along with a summary of the stocking schedule.

*Rationale for Stocking Schedule*

The Province of Newfoundland and Labrador has requirements that Grieg NL must meet relative to the marine stocking schedule. For example, each of the 11 sea cage sites must rear a maximum of one million Atlantic salmon prior to increasing stocking densities at the sea cage site. Based on this requirement, in Year 3 (the first-year fish go to sea), salmon will be divided between the three sea cage sites in the Rushoon BMA. Although this results in increased start-up costs, the rationale is that in Year 6 when the RAS Hatchery has increased production to six million fish, all three of the Rushoon sea cage sites can be stocked with two million salmon. If only two sea cage sites are stocked in Year 3, Grieg NL will be required to reduce production to five million salmon. Fallowing requirements also affect the stocking schedule (Table 2.15), particularly for the seasonal BMA.

**Table 2.15. Fallowing schedule required by the Province and Grieg NL's planned fallowing schedule.**

| Marine Area | Provincial Regulation | Schedule for Semi-Annual Seafarms | Schedule for Seasonal Seafarms |
|---|---|---|---|
| | No. of Months for Fallowing | | |
| BMA | 4 | up to 16 | 4 |
| Proposed Sea Cage Sites | 7 | 18–20 | 16 |

Grieg NL has been monitoring water temperature in the four BMAs for over a year (see LGL 2018b in Volume 3). Based on these and other available data, water temperatures in the BMAs are not conducive

(i.e., typically <4°C) for transferring fish into the sea during the November–April period. For this reason, stocking schedules have been based on the last fish transfer to sea occurring in October (when smolt are >500 g) and earliest entry into the sea cages in the spring will occur in late-May when water temperatures are above 4°C. Atlantic salmon require this minimum temperature to ensure there is minimal mortality due to temperature shock.

Salmon will spend at most one winter at sea. Reducing time at sea is beneficial primarily because it minimizes mortalities. To allow for one winter at sea and to maximize harvest schedules, the RAS Hatchery schedule has been developed to receive eggs at a time that coordinates with both sea stocking and harvest schedules (one winter at sea), as well as the fallowing restrictions.

*Summary of Stocking Schedule*

A detailed stocking schedule for Years 3–9 of the Project by month for each of the 11 sea cage sites is provided in Appendix R. A summary of the planned stocking schedule and fallowing periods is provided below. As per the agreement with the Province (MOU; Appendix C), the sea cage sites will be stocked with a maximum of one million fish each for the initial stockings. Once each sea cage site has had one million fish reared on it, stocking densities per site can increase to a maximum of two million fish per sea cage site. Fallow periods of sea cage sites will be required and the three BMAs will rotate to ensure fallowing requirements are met or exceeded. At full production (i.e., maximum of seven million smolt), in any given year, there will be one BMA that is fallow, one BMA that is receiving fish from the RAS Hatchery during May–October, and one BMA that will have fish nearing or undergoing harvesting. Seasonal and semi-annual sea cage sites proposed by Grieg NL will exceed provincial regulation for fallowing time by more than double. In addition, the semi-annual BMAs will exceed these regulations for fallowing time by a factor of up to four (see Table 2.15). This is considered precautionary and will provide more time for sea cage sites to assimilate accumulated biological matter.

Although ramp-up schedules will vary, the semi-annual sea cage sites will receive fish from the RAS Hatchery between May and October. These semi-annual smolt will range in size from ~350–800 g and will remain in the sea cages for 14–18 months for continued grow-out and will be harvested at a size of ~5 kg. The seasonal sea cage sites (Long Harbour BMA) will receive fish from the RAS Hatchery in May of each year at a size of ~1,200–1,400 g and remain in the sea cages for eight to nine months for continued grow-out and harvest at a size of ~4.5 kg. When at full production, the semi-annual sea farms will produce six million salmon.

The seasonal sites will not be stocked until Year 5 of the Project (see Table 2.1 and Table 2.9 earlier), which complies with the requirements of the Province for ramp-up of two million fish in the first year at sea (i.e., Year 3), three million in the second year at sea (i.e., Year 4), and four million in the third year at sea (i.e., Year 5). Additionally, it complies with the Terms and Conditions outlined by the Province for Grieg NL to only stock a maximum of one million fish per sea cage site during each of the initial stockings. With 160,000 fish per sea cage, the number of cages each year will reflect this. The number of sea cages in use at each sea cage site will also be ramped up. For example, the first time salmon are transferred to sea from the RAS Hatchery (during Year 3), four sea cages at each of the sea cage sites in the Rushoon BMA will be used. Furthermore, in Year 4 when production increases to three million fish per year, seven sea cages will be used at each sea cage site (see Appendix R).

There are two seasonal sea cage sites (in the Long Harbour BMA) that will be alternated each year. Fish which are ~1,200–1,400 g will be stocked in a seasonal site in May and will be harvested by November–December of the same year at a size of ~4.5 kg. This seasonal site will allow larger fish from the RAS Hatchery to finish grow-out at sea but not have to spend a winter at sea. With a minimum

four-month fallowing period required at each BMA, harvesting by December will allow fish to be stocked again at the second seasonal site in May of the following year. When at full production, the seasonal sea farms will produce one million salmon per year.

### *Transfer of Smolt to Sea Cages*

As noted earlier, smolt will be transferred to a well boat from the RAS Hatchery and the well boat will travel directly (at a nominal speed of 8 knots,14.8 km/h) to the sea cage site. At the sea cage site, the well boat will transfer, by pump and flexible pipe, the smolt directly into the sea cage. Just as during transfer from RAS Hatchery to the well boat, the fish will be monitored (via video camera) and counted during transfer into the sea cages. If a transfer of fish between sea cage sites is required for any reason a response/corrective action will be developed as per the established SOP. This would likely involve the use of well boats.

### *Feed Type and Feed Schedule*

As discussed in Section 2.5.1.2, Grieg NL will use an established feed adjusted to meet the requirement of triploid sterile salmon. The break-down of feed size and contents for consumption by salmon at the sea cage sites is provided in Table 2.16.

**Table 2.16. Summary of feed contents and pellet size for salmon growth stages at the sea cage sites.**

| Pellet Size (mm) | Fish Size (grams) | Protein (min) | Oil (min) | Moisture (max) | Digestible Energy (MJ/kg) |
|---|---|---|---|---|---|
| 6.0 | 400–1,000 | 45% | 30% | 8.0% | 20.1 |
| 9.0 | 1,000–2,000 | 42% | 33% | 8.5% | 21.5 |
| 12.0 | 2,000–3,000 | 38% | 36% | 8.5% | 21.5 |
| 12.0 | 3,000+ | 36% | 38% | 8.5% | 22.0 |

Feed requirements of the sea cage sites will increase from ~9,000 MT for the first generation of salmon produced up to ~31,000 MT for each generation under the steady state (Table 2.17). Feed wastage will be minimized via the use of established feeding tables/software used (to determine feed type and amount) and an automatic feeding system which integrates video monitoring in the sea cages. Salmon will be monitored during feeding and once salmon have reached ~80% satiation, feed delivery will be ceased.

**Table 2.17. Summary of estimated feed usage relative to fish mass from the first year of harvesting (Year 4) to steady state of production (Year 8).**

| Year | Fish Mass (kg) | Estimated Feed Usage (kg) |
|---|---|---|
| 4 | 0.5–5.0 | 9,240,000 |
| 5 | 0.5–5.0 | 14,025,000 |
| 6 | 0.82–5.0 | 17,512,000 |
| 7 | 0.82–5.0 | 26,268,000 |
| 8 | 0.77–5.0 | 30,938,600 |

Upon entering into the sea cages, several factors influence the FCR (and eventually the EFCR) and the feed schedules including water temperature, daylight length, oxygen level, and weather conditions. Rapid changes in environmental conditions can also reduce the feeding rate. Grieg NL estimates an EFCR of

1.35 for the sterile triploid salmon at the sea cage sites in Placentia Bay. This is due to favorable environmental conditions in Placentia Bay and the large smolt (>350 g) size entering the cages from the RAS Hatchery.

***Feeding***

As described earlier (Section 2.4.4), feed barges will be used to provide feed to the fish in the sea cages. Feed will be delivered, by the feed company supplying feed to the barges, in bulk transport shipping containers and pumped into the cargo holds on the barge (Figure 2.40). If necessary, feed can be delivered to the barges in large bags by a service vessel through the use of its crane. Barges will be equipped with a centralized feed delivery system designed by AKVA and used at many sea farms in Norway. This system is state-of-the-art and consists of the components illustrated in Figure 2.41 including a feed blower, various sensors, camera system, feed lines (or pipes), and rotor spreaders. The feed is moved through the feed lines via forced air. The air used to transport the feed is supplied by blowers (compressors) installed in the engine room. This air is cooled down from 65–25°C while still on the barge, and the feed is placed on the transport line when the temperature reaches 25°C. The rotor spreader has a floating base and sits on the water surface inside the sea cage and feed is distributed through adjustable light-weight aluminum rotor pipes. It is possible that a sub-feeder will be used as part of the approach to control sea lice levels (see Section 2.5.2.2). A sub-feeding system (like the AKVA subsea feeder) works by transporting feed pneumatically from the feed barge to a floating subsea feeder. Sea water is then pumped up and added to the feed. This feed water is then passed through a main pipe down ~6–7 m below the sea surface where it is spread throughout the cage.




**Figure 2.40. Feed delivery vessel transferring feed to a feed barge.**

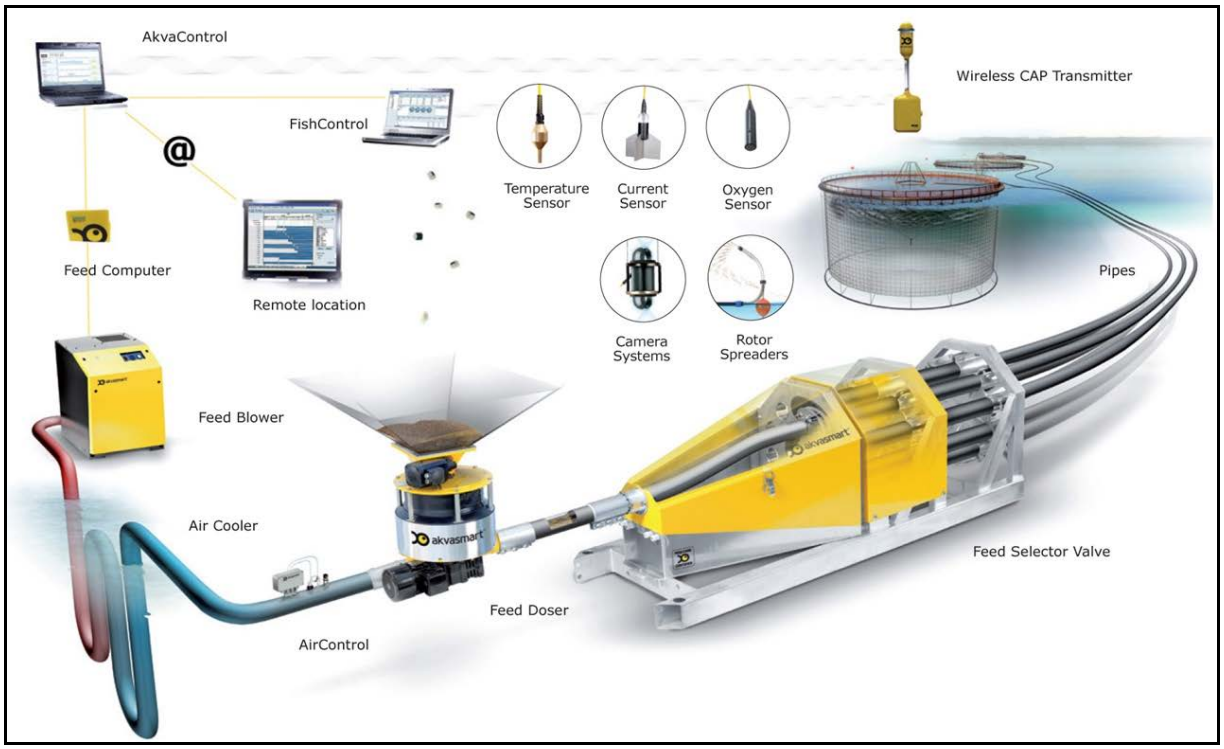



**Figure 2.41. Barge feed delivery system used to transfer feed to sea cages.**

Cameras mounted in the sea cages will provide staff with a view of the feeding behavior of fish and feed can be stopped as soon as reduced feeding behavior is noticed. This system optimizes feeding by providing only enough feed to satisfy the fish while reducing nutrient inputs into the environment. An example of a camera system that can be utilized on the sea cage and barge for monitoring feeding is the SmartEye Twin 360 (Figure 2.42). This advanced feeding and inspection color camera is produced by AKVA Group. The camera is stationary to each cage but has the capability to move within the cage using a winch system which allows easy and accurate vertical and horizontal positioning in the cages. It can be operated from the cage, a work boat, the feeding control room and via the internet. This system has two built-in high-resolution color cameras and an option to have a monochrome camera with very high light sensitivity to look down into deep and dark cages while also having the capability of 360 degree horizontal and vertical overview. A control room on the barge or located remotely provides the feed operator with a view of the feeding behaviour of the fish (Figure 2.43). Fish will be monitored during feeding and once fish have reached ~80% satiation (fish sink lower in the cage as they near satiation), feed delivery will be ceased. This approach optimizes feeding by providing only enough feed to satisfy the fish while reducing nutrient inputs into the environment. On average, feeding will take about 30–40 minutes per sea cage. This is repeated 2–4 times per day depending on water temperature and daylight length.



**Figure 2.42. AKVA Group SmartEye Twin 360 used to monitor feeding (and other operations such as net cleaning at the sea cage sites).**



**Figure 2.43. Monitoring station on a feed barge that can be used for monitoring feeding behaviour (and net cleaning inspections) via a camera system.**

### *Fish Health*

Procedures for verifying and maintaining fish health at the sea cage sites are detailed in Section 2.5.2.2. In summary, mitigation measures and regular monitoring will be in place to maintain fish health including biosecurity measures, routine husbandry practices, health checks and procedures, use of specialized feed and feeding procedures, sea lice control procedures, water quality monitoring, vaccinations, and removal and treatment of dead fish. Grieg NL has developed and will implement a Fish Health Management Plan (Appendix K) and all personnel will be trained in its proper procedures. Details on health checks and procedures are included here.

Fish health at the sea cage sites will be monitored and verified by Grieg NL personnel following the procedures as prescribed by the Aquatic Animal Health Division. Fish are routinely monitored by staff for not only physical changes such as signs of fin erosion, lesions, pigmentation problems, parasites and deformities but will also include monitoring of fish behaviour changes. As part of Grieg NL's Fish Health Management Plan (Appendix K), an active and passive surveillance program will be implemented in cooperation with a private veterinarian as well as the provincial veterinarian. Grieg NL personnel will be trained and aware of the importance of noticing and reporting to supervisors any noticeable changes (physical and behavioural). This health surveillance program will apply to both farmed Atlantic salmon and the cleaner lumpfish held in the sea cages. Three of the most common types of pathogens that can cause issues with fish at the sea cage sites are viruses, bacteria and parasites (i.e., sea lice). Many of these pathogens are considered to be opportunistic and can create a serious health challenge especially if the fish are exposed to stressful events or prolonged sub-optimal conditions. Care is taken throughout, to ensure the effects of necessary stressful events are kept to a minimum with sufficient recovery time allocated between stressors. Proper husbandry practices are put in place to ensure overall general hygiene is kept up to standard and proper disinfections procedures are put into place. Routine parasite screening (i.e., weekly for sea lice; see Section 2.5.2.2 for details) will be carried out as well as routine diagnostic testing. During sea lice and other health examinations, fish will be anaesthetized by being placed in an anesthetic bath. General anesthesia (e.g., TMS (MS – 222; 3-aminobenzoic acidethyl ester methanesulfonate) will be prescribed by a veterinarian and the typical recommended dosage is 100 ppm for 90 seconds in water that does not exceed 10°C. Any antibiotics used will be administered in the feed. All routine parasite screening and active surveillance will be conducted by Grieg NL personnel on a schedule determined in consultation with provincial authorities and a private veterinarian that also considers fish health and welfare. In addition to the active surveillance by Grieg NL, a passive surveillance program along with diagnostic testing will also be performed by provincial veterinarians.

### *Cleaner Fish*

The primary method of controlling sea lice (*Lepeophtheirus salmonis)* will be through the use of cleaner fish, more specifically North Atlantic lumpfish (*Cyclopterus lumpus)*.

Lumpfish naturally exhibit a "scan-and-pick" feeding behaviour and have been successfully used as cleaner fish in cold-water aquaculture projects. The use of cleaner fish in the salmon aquaculture industry, particularly in Norway, has seen a large increase since 2008 with almost 26 million cleaner fish used in 2015 in Norway alone and projections of up to 50 million required by 2020 (Powell et al. 2017).

At this time, there are no commercial suppliers of lumpfish in Canada. Within Newfoundland, Memorial University of Newfoundland's Ocean Sciences Centre (OSC) has been working with the aquaculture industry to domesticate and develop lumpfish broodstock. Grieg NL's R&D project entitled "*Rognkjeks/Lumpfish Broodstock Collection, Domestication and Spawning Techniques*" is currently entering its fifth year at OSC (Appendix S). As part of this R&D project, 24 wild lumpfish were collected

in 2015 and 48 wild lumpfish were collected in 2016 from local fishermen in Newfoundland. The OSC have successfully domesticated and maintained three successive year classes from these broodstock. In 2017, 81% of their egg production was from cultured broodstock.

Grieg NL will obtain juvenile lumpfish of optimal size for deployment in the sea cages in the spring/summer of each year. The lumpfish used as cleaner fish in the sea cages are not expected to reach sexual maturity prior to harvesting (see Section 2.5.2.2 for details). Grieg NL will stock the sea cages with lumpfish once they reach 20–50 g (~5–10 months old) and harvest them 12–16 months later at 17–26 months of age. Juvenile lumpfish (20–50 g) are preferred for controlling sea lice. Imsland et al. (2016) studied the effects of lumpfish size on foraging behaviour and co-existence with sea lice infected Atlantic salmon in sea cages. Lumpfish from smaller size class (20 g) showed a higher preference for naturally occurring food including sea lice versus salmon feed pellets. The final sea lice burden was 40% lower in salmon groups stocked with small lumpfish compared to the control group without lumpfish. The upper limit for the size of lumpfish, which can be stocked is assessed at ~400–500 g (Imsland et al. 2014). It takes ~14–16 months for a 10 g juvenile lumpfish to attain a body weight close to the 400–500 g potential upper size limit. This recommended stocking size for sea lice control (up to 500 g) coincides with the production cycle of Atlantic salmon in the sea cages as proposed by Grieg NL and indicates the lumpfish used will be effective for controlling sea lice.

Other industry partners have progressed to the point that a facility on the Connaigre Peninsula in Belleoram has been built to hold young (1 g) lumpfish transferred from the OSC for use by industry in this area. The capacity on the island is currently available with the OSC and the Belleoram facility to raise lumpfish to 20 g; however, a commercial third-party supplier is needed in Newfoundland to supply the industry with the quantity of lumpfish required to meet recommended stocking densities of ~10% of the total salmon per cage (Imsland et al. 2014). Grieg NL intends to work with a third-party supplier to develop a lumpfish hatchery on the Burin Peninsula. With a domesticated broodstock currently held at the OSC, Grieg NL will work with the OSC, much as other industries have, to obtain lumpfish during the initial years of production until the third-party lumpfish hatchery is constructed and operational. Based upon the recommended stocking density of ~10% of the total salmon per sea cage, 16,000 lumpfish will be required per sea cage. During the first year at sea, this results in 192,000 cleaner fish in total and at steady state production there would be 624,000 cleaner fish in total.

Lumpfish will be delivered to the sea cages via well boat by a third-party supplier. Lumpfish will be harvested at the same time as the salmon and will not be reused. There is interest from Asian markets for the lumpfish as a protein source and Ocean Choice International (OCI) is investigating options available for the lumpfish harvested in Placentia Bay to be sold to Asian markets.

Verification of fish health for cleaner fish will follow the same procedures as Atlantic salmon as prescribed by the Aquatic Animal Health Division (see Section 2.5.2.2 including details on vaccination). In addition, Grieg NL will implement best husbandry, handling, and transportation practices based on industry guidelines prepared by the Scottish Aquaculture Innovation Centre for the Norwegian Seafood Research Fund FHF Cleaner Fish Project (see http://scottishaquaculture.com/knowledge/knowledge-exchange/).

***Sea Cage Maintenance***

Grieg NL intends to utilize a third-party service provider for routine sea cage cleaning and maintenance. Marine fouling of sea cages will vary depending on a number of factors including season, water temperature and biotic processes such as shellfish settling. Of note, Grieg NL does not intend to use nets coated in anti-fouling material. Such coatings can leach toxins into the environment and Grieg NL

maintains that daily sea cage inspections and a systematic cleaning routine with specialized equipment can control biofouling. The cleaning schedule for cages and nets will be developed based on environmental conditions in Placentia Bay as well as routine monitoring. Nets will typically be cleaned weekly and cages will be cleaned once or twice during heavy fouling periods. Cages and nets will also be cleaned after harvesting is completed and prior to cages being transferred to other BMAs. Routine checks of equipment utilizing underwater cameras (e.g., SmartEye Twin 360), ROVs, and inspections by divers (as needed) will be used to confirm the cleaning schedule of the sea cages. Grieg NL will ensure equipment has minimal fouling.

There are several types of specialized equipment that can be utilized to maintain and clean the sea cages. An example of a product that is under consideration for this task is the Akvasmart cage cleaner (Figure 2.44)[6]. This product is used for the in-situ cleaning and disinfecting of the cage frame and is typically mounted on the stern of a service vessel. The cage cleaning system consists of a lifting unit, and a hydraulically driven wheel system that rotates the cage while it is being flushed and cleaned. The cleaning unit hydraulically lifts a section of the cage from the surface of the water. The flushing occurs when the cage is rotated around its own axis, while a windscreen washer mounted on rotating arms performs the cleaning using water under high pressure (Figure 2.45). Grieg NL will be utilizing a third-party service provider for this service.




**Figure 2.44. An Akvasmart cage cleaner mounted to the stern of a vessel.**

[6] The Akvasmart cage cleaner is a product from AKVA Group. See http://www.akvagroup.com/products/cage-farming-aquaculture/cleaning-systems/akvasmart-cage-cleaning-system.



**Figure 2.45. A sea cage undergoing cleaning with the Akvasmart cage cleaner**.

Grieg NL will use a ROV net cleaner like the FNC8 produced by AKVA Group (Figure 2.46). This net cleaner, which is equipped with an advanced camera system, can be operated remotely at the sea cage site and from the control room of the feed barge. The FNC8 uses thrusters for propulsion which allow it to "swim" just above the surface of the net while using high pressure seawater to clean. This touchless cleaning system has no sharp edges that could cause damage to the net. There are grates surrounding the thrusters, which minimize risk to fish. When cleaning operations have finished, the FNC8 will be recovered, cleaned and washed with fresh water and then stored.




**Figure 2.46. The FNC8 ROV net cleaner that is typical of the ROV that will be used to clean the sea cage nets.**

In addition to the ROV net cleaner, each BMA will have an ROV similar to the Sperre Sub-fighter 10k (Figure 2.47) to assist in tasks such as net inspections and in-situ net repair (if required). The ROV can be equipped with an attachment such as a Sperre fish net sewing machine (Figure 2.48). This sewing attachment allows for fast and efficient net repair in the water without the need for divers. In the event of a net tear, the ROV will be transported by boat to the sea cage and operated by trained personnel. To

repair a tear the fish net sewing machine arm pulls together the netting and places a band around the netting sealing it together in as many places as needed. The sewing attachment can repair a tear very quickly. For example, a five mesh tear can be repaired in several minutes.

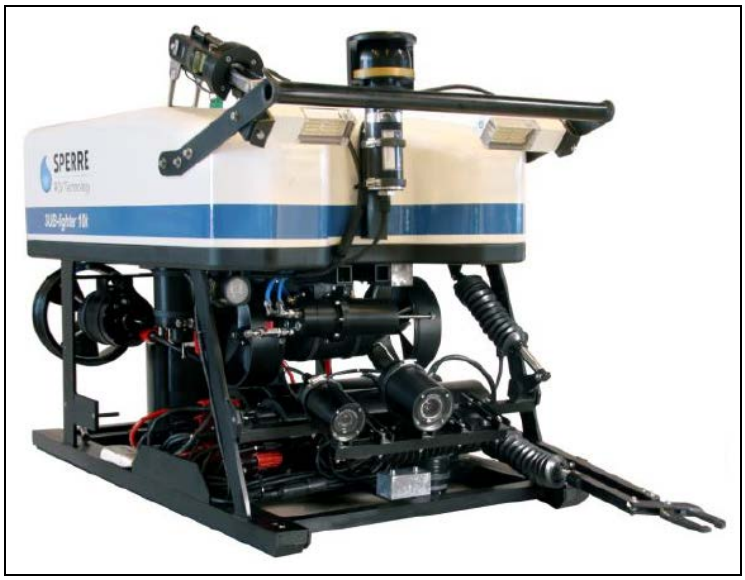



**Figure 2.47. Sperre Sub-Fighter 10k ROV that is typical of the ROV that will be used for net inspections and repair.**



**Figure 2.48. Sperre fish net sewing machine attachment.**

### *Water-quality Monitoring*

A routine program will be established for monitoring, measuring, and recording water quality at all active sea cage sites on a daily basis throughout the Project. In-situ data loggers will be installed on the barges at

each sea cage site as well as on each individual cage. In addition, sensors can be attached to cameras and buoys located at the perimeter of each sea cage site. These in-situ loggers will collect data on water temperature, oxygen levels, current speed and direction, as well as pH and salinity. Data will be wirelessly transmitted to centralized computer stations on the barges and at the control center in Marystown for real-time viewing or logged for historical collections. Plankton samples will be completed weekly, analyzed and levels recorded. This will be one of the information sources used to create net cleaning schedules. Data collection will be used to evaluate the severity of any environmental issues such as fouling or changes in physio chemical data, leading to a response. Environmental changes and plankton levels are rated and depending on the results various mitigation responses are initiated. During transport of smolt from the RAS Hatchery to the sea cage sites, water quality in the hold of the well boat will be monitored.

### *Mortalities*

Mortalities are estimated to be 20% over the maximum 18 months that fish will be at sea (Table 2.18). These mortality estimates are based on statistics collected in 2016 in Norway by Grieg Seafoods, Marine Harvest, and Norway Royal Salmon (GS 2017; MH 2017; NRS 2017). Within the first month that salmon are transferred to the sea cages a 5% mortality rate is predicted. Monthly mortality rates are anticipated to decrease thereafter to mostly 0.5–1.5%, with rates in the winter months of 2–2.5%. Theoretically, this will give a maximum number of 89 dead fish in each cage to be removed daily (based on 160,000 salmon per sea cage). There are established procedures in place to routinely collect and process the dead fish, which are described below. The number of fish mortalities will be recorded daily. In addition, procedures are in place to collect, record, and process fish in the event of a mass mortality (Appendix K).

**Table 2.18. Predicted mortality rates during production of Atlantic salmon at the sea cage sites.**

| Month at Sea | Example Month | Primary Activity Affecting Mortality Rate | Mortality Rate | Survival per Month | Total Survival Rate | Total Mortality Rate |
|---|---|---|---|---|---|---|
| 1 | May | Transfer | 5.0% | 95.0% | 95.0% | 5.0% |
| 2 | June | Grow | 1.5% | 98.5% | 93.6% | 6.4% |
| 3 | July | Grow | 0.5% | 99.5% | 93.1% | 6.9% |
| 4 | August | Grow | 0.5% | 99.5% | 92.6% | 7.4% |
| 5 | September | Grow | 0.5% | 99.5% | 92.2% | 7.8% |
| 6 | October | Grow | 0.5% | 99.5% | 91.7% | 8.3% |
| 7 | November | Grow | 0.5% | 99.5% | 91.3% | 8.7% |
| 8 | December | Grow | 1.0% | 99.0% | 90.3% | 9.7% |
| 9 | January | Grow | 1.0% | 99.0% | 89.4% | 10.6% |
| 10 | February | Winter | 2.0% | 98.0% | 87.7% | 12.3% |
| 11 | March | Winter | 2.5% | 97.5% | 85.5% | 14.5% |
| 12 | April | Winter | 2.5% | 97.5% | 83.3% | 16.7% |
| 13 | May | Grow | 1.5% | 98.5% | 82.1% | 17.9% |
| 14 | June | Grow | 0.5% | 99.5% | 81.7% | 18.3% |
| 15 | July | Grow | 0.5% | 99.5% | 81.3% | 18.7% |
| 16 | August | Harvest | 0.5% | 99.5% | 80.9% | 19.1% |
| 17 | September | Harvest | 0.5% | 99.5% | 80.4% | 19.6% |
| 18 | October | Harvest | 0.5% | 99.5% | 80.0% | 20.0% |

Dead fish typically accumulate at the bottom of the sea cages and at the surface. Fish will be monitored via surface and subsea cameras. As noted earlier, Grieg NL is proposing a centralized system (Mortex) which will allow for dead fish which accumulate at the bottom of the net to be removed daily. The Mortex system has dedicated video monitoring focused at the bottom of the net where dead fish typically accumulate. The dead fish are pumped from the bottom of the sea cages through a pipe, which at the surface connects into a fully enclosed pipe grid and ends at the main deck of the feed barge in an ensilage tank.

As part of the ensilage process, acid must be used. Typically, food grade formic acid (85%) is used for this and transported to the barges by supply vessels in IBCs (Figure 2.49). The IBCs can hold 1,000 L and will be transferred from a supply vessel to the barge with a crane. Once on the barge, the IBC is substituted for the empty acid IBC and reconnected. There is a designated storage tank for the acid and the IBC can easily be unloaded and loaded into this storage tank on the barge.



**Figure 2.49. Intermediate Bulk Containers (IBC) that will be used to transfer ensilage to shore and for transporting acid to the feed barges for use in ensilage.**

When the mortalities enter the ensilage tank, they enter through a container that has a secured locking cover. This cover is locked when mortalities are not being deposited. Once the dead fish are in the mill tank, they are ground into a slurry and acid is added to lower the pH, creating ensilage. The ensilage is then transferred to the integrated ensilage tanks located on the port and starboard sides of the barge (two 25 $m^3$ tanks on a feed/accommodation barge and two 11 $m^3$ on a satellite barge). The ensilage process occurs in a closed environment from the moment the fish enters the mill tank. The ensilage is stored in the integrated tanks (constructed of a minimum 7 mm steel and painted with an approved anti-acid paint) until it is removed through the ensilage discharge, which is secured with a cam-lock.

As an additional biosecurity measure, the ensilage and feed stored on the barges are physically separated in secure containment units. The integrated ensilage tanks on the feed barges are located in the vessel hull below the feed selector valves. Additionally, the feed is stored in secure feed silos, which are constructed of 5 mm Naval Grade A steel and located ~4 m above the main deck of the barge. The risk of contaminating the feed with ensilage is considered negligible.

Any visible moribund fish or surface mortalities will be retrieved and moribund fish will be euthanized if required. When handling mortalities from the sea cages, personnel will be required to wear rain gear, gloves, and boots which will be disinfected after each mortality disposal. Once at the surface, the dead fish are transferred to the designated and approved container on the feed barge for ensilaging (Figure 2.50); there will be limited personnel access to the ensilage container. Ensilage will be stored on the barges until sufficient quantities are acquired to justify transport via a service vessel to a designated resupply site. To remove the ensilage from the barge ensilage tanks, it will be pumped from the barge to IBCs on the service vessels. These IBCs are a secure and safe storage for ensilage which has a low pH. The IBCs also allow for easy transport from a service vessel to shore and to waste facilities. The containers will be transferred to service vessels via crane. The ensilage will be transported to either a local company in Newfoundland that will use the product as a commercial fertilizer and/or animal feed additive or a feed supply company located in Denmark (see Appendix J).

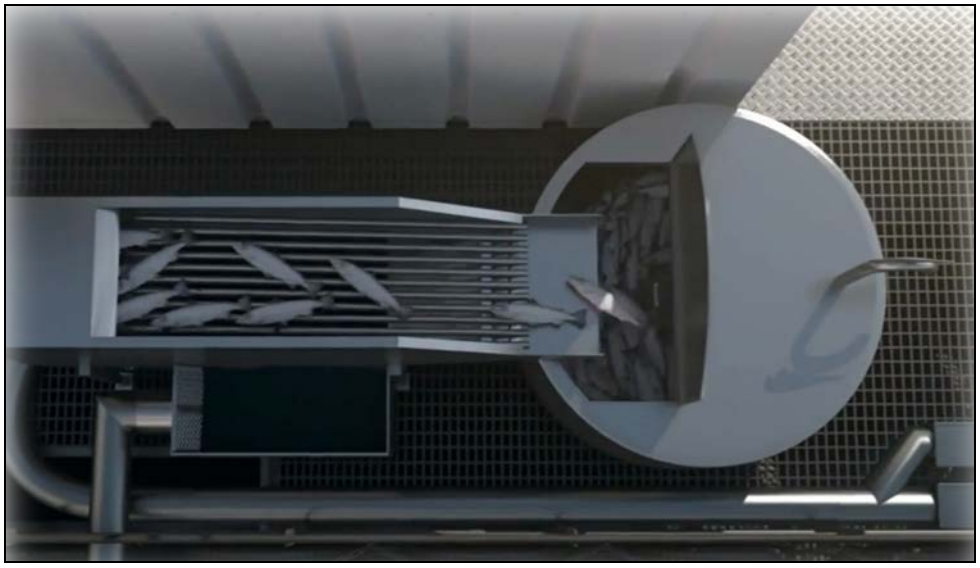


**Figure 2.50. Ensilage container for dead fish.**

If euthanasia of fish is required it will be done in a manner which minimizes pain and suffering of fish being used for sampling or culled due to health or production reasons. Euthanasia will be accomplished via an overdose of anesthetic, complete spinal severance, or a sharp blow on the top of the head ensuring a result of fish that are permanently unresponsive to stimuli. Records of all fish either culled or sampled are maintained.

***Transfer of Fish from Sea Cage to a Processing Plant***

Grieg NL is planning to use a dead hold vessel (operated by a third-party supplier) for the transfer of salmon and lumpfish to a processing facility. The dead hold vessel will move directly adjacent to the sea cage and using a flexible hose, fish will be pumped into the vessel. The dead hold vessel will be equipped with a compact containerized system for stunning and killing/bleeding the salmon (Figure 2.51). Live fish is pumped into the vessel where the water is separated from the fish by a dewaterer, with the sea water returning to the ocean. The fish are led into an orientation-unit. The orientation-unit is responsible for ensuring each fish moves to the next stage of the processing in a “head-first” orientation. The unit is a water-filled buffer tank and the water is refreshed each time new fish are pumped in. Once the fish leave

the orientation unit, they proceed to the “stunner”. The stunner is equipped with an electrical finger that touches the head of the salmon and delivers an electrical shock which “stun” the fish within 0.5 seconds. Electrical stunning of fish prior to processing is an industry best practice. It reduces stress for the fish, which in turn results in a high-quality product. Immediately after stunning, the fish enters a conveyor for gill cutting, which results in proper bleeding of the fish and results in a high-quality product. Process-water (blood-water and water for cleaning) is held in a container onboard the vessel that can be removed and treated/disinfected on shore at the processing plant. The dead hold vessel will undergo a disinfection procedure after each transfer of fish.

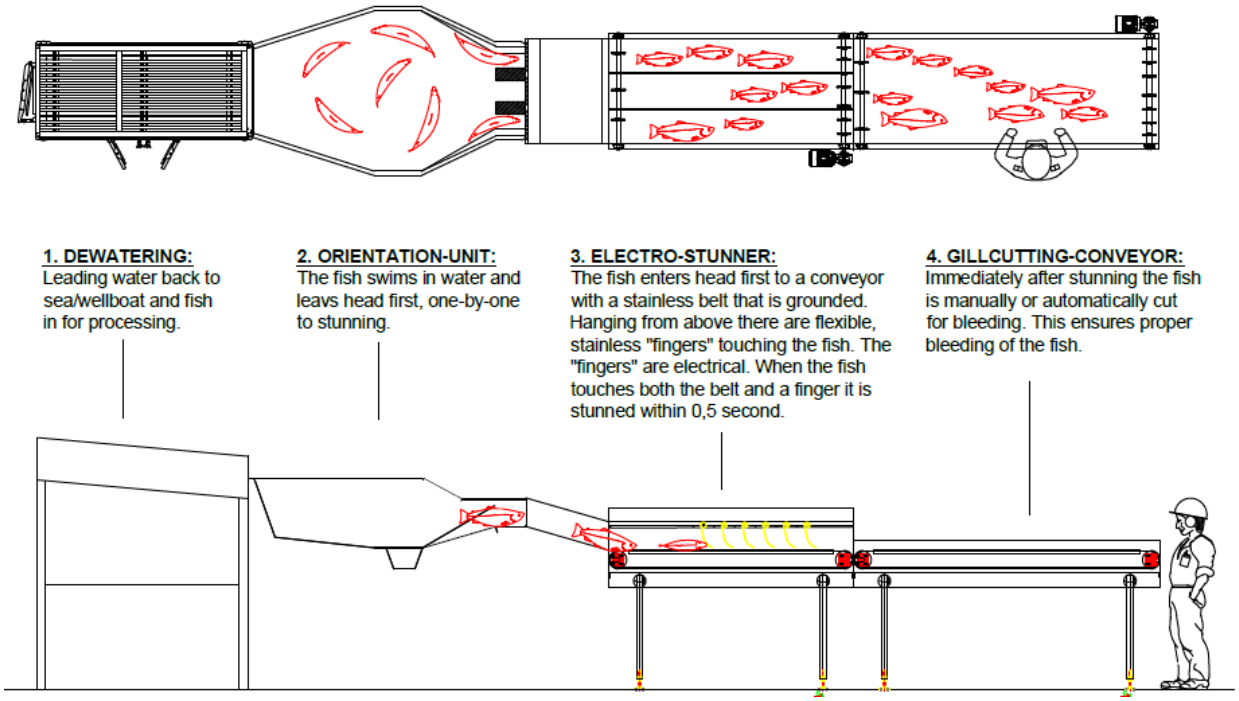



**Figure 2.51. Steps used to prepare fish prior to delivery at a processing plant.**

### *Personnel Transfer*

Personnel working at the sea cage sites will be transported via dedicated crew vessels (one per BMA). Grieg NL anticipates one-week shifts at sea where personnel will live aboard the feed/accommodation barge. The crew change sites will have specific areas for embarkation to and disembarkation from the sea cage sites, which is designed to avoid contamination. Petit Forte has been identified as a proposed crew change site for the Rushoon, Merasheen, and Red Island BMAs and Long Harbour has been identified as the proposed crew change site for the Long Harbour BMA. Long Harbour will not be used as the crew change site for the Red Island BMA to avoid crossing vessel traffic lanes. The proposed Petit Forte and Long Harbour sites will only be used for crew changes and not resupply and transfer of waste (see below). The routing between proposed crew change and sea cage sites will be the most direct route possible (Figure 2.52). Crew vessel speeds will be <10 knots (18.5 km/h) and when transiting through a BMA, sea cage sites will be avoided by at least 1 km (unless a given sea cage site is the destination of the crew vessel).

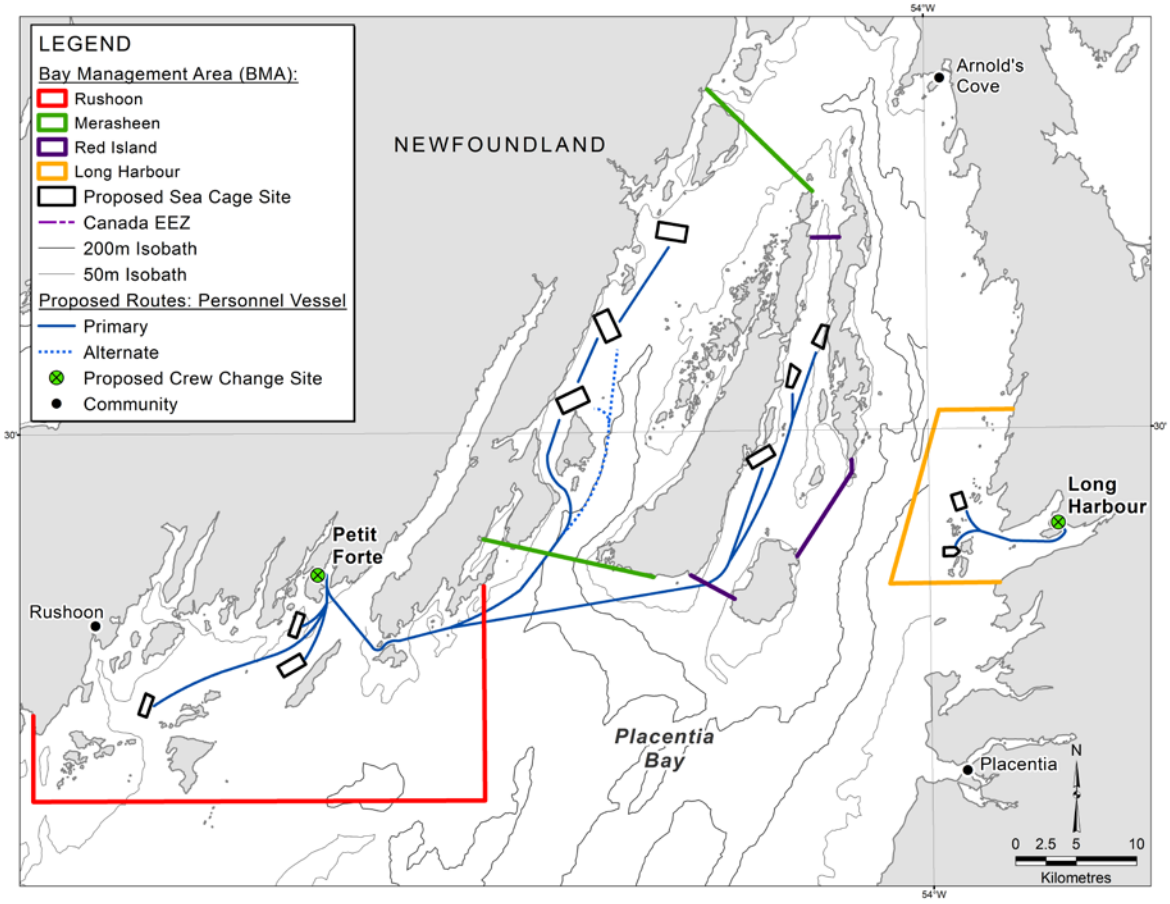



**Figure 2.52. Locations of proposed crew change sites and transfer routes to the sea cage sites.**

***Resupply***

Grieg NL will use resupply sites for transporting equipment and supplies (primarily via service vessels) to and from the sea cage sites. Resupply sites are proposed at two former OCI premises: one in Marystown and one in Burin. The premises in Marystown are equipped with three piers (each ~50–70 m in length) and the premise in Burin is equipped with a wrap-around pier (~300 m in length). One of the resupply sites will be designated "inflow" and the other "outflow" to prevent cross-contamination of clean/new equipment going to the sea cage sites and used equipment returning for cleaning and servicing. Additionally, the resupply site designated as outflow will receive waste (including ensilage) from the sea cage sites.

Service vessels (and the associated movement of equipment, supplies and waste) will not use the Petit Forte or Long Harbour stations. The use of separate resupply sites is designed to avoid contamination. The routing between proposed resupply and sea cage sites will be the most direct route possible (Figure 2.53). Service vessel speeds will be <10 knots (18.5 km/h) and when transiting through a BMA, sea cage sites will be avoided by at least 1 km (unless a given sea cage site is the destination of the service vessel).

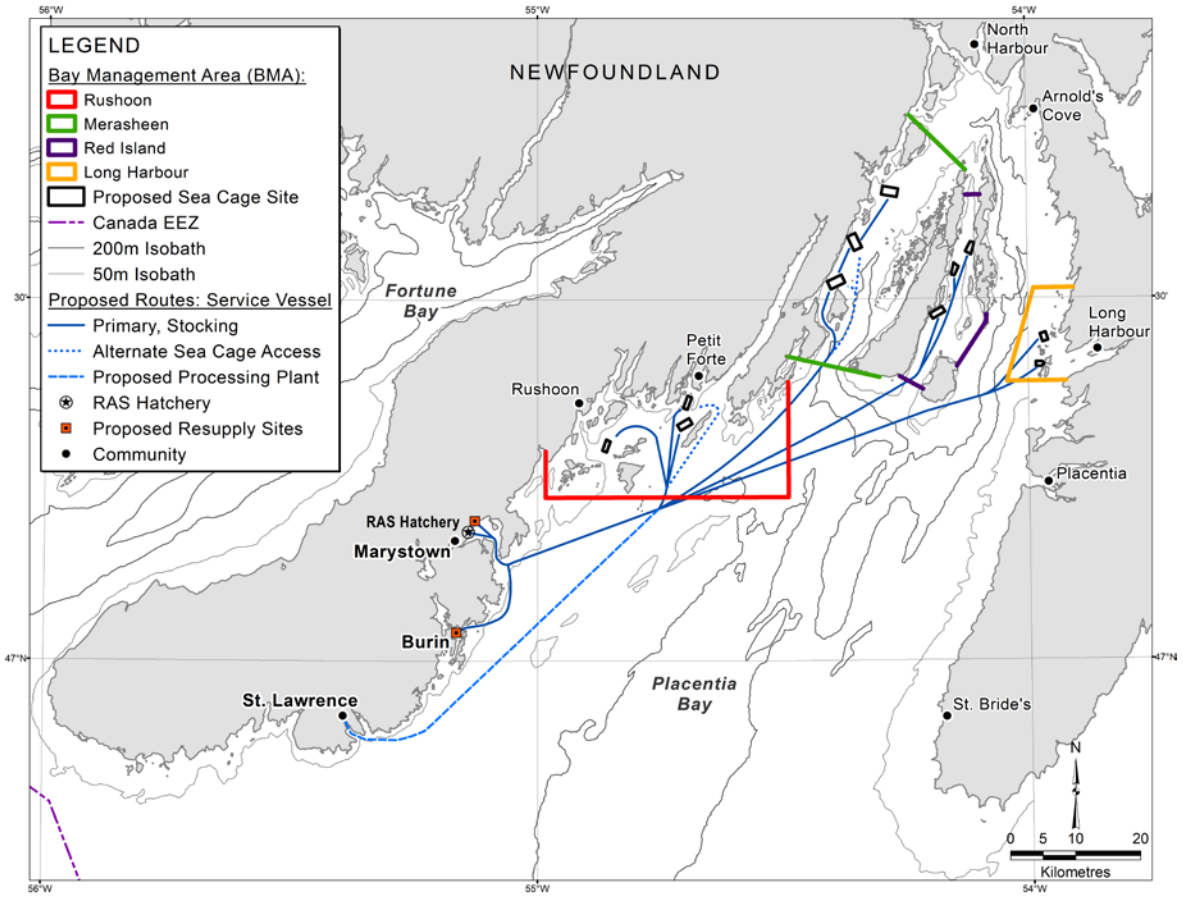



**Figure 2.53. Locations of proposed resupply sites and resupply routes to the sea cage sites. Also, shown is the routing to the tentative processing plant in St. Lawrence.**

Fuel for the barges will be delivered by a third-party service provider. Refueling will be conducted in accordance with the *Canada Shipping Act* and following Transport Canada's procedures for the refueling of small commercial vessels[7]. It is the responsibility of the ship's Master to ensure that all steps and procedures are conducted.

### *Waste and Waste Management*

The sea cage sites will produce a variety of wastes during operation including sanitary waste and wastewater, fish waste, fish mortalities, uneaten fish feed, petroleum products, operational debris and cleaning products. A general description of each waste type as well as waste management methods are summarized in Table 2.19. More detailed information on each waste including the handling, storage and disposal can be found in the Grieg NL's Waste Management Plan (Appendix J).

[7] https://www.tc.gc.ca/eng/marinesafety/debs-small-vessels-procedures-refuelling-2995.htm

**Table 2.19. Wastes generated at sea cage sites and management methods.**

| Waste | Description | Waste Management Methods |
|---|---|---|
| Sanitary waste and wastewater | All wastes and wastewater produced by humans or human activities including feces, urine, and washing water. | Vessels will have internal tanks for freshwater, grey water, and sewer/waste waters. Vessels will carry portable waste tanks interchangeable with the barge systems. Transport Canada standards will apply. |
| Fish waste | All waste produced by the fish including fish feces and ammonia. | Waste at the sea cage site will either be flushed by currents or settle to the sea floor. As per Provincial regulations, sites will have a fallow period (minimum 7 months on a site and 4 months per BMA). Grieg NL will allow 16–20 months fallow per site and up to 16 months per BMA. |
| Fish mortalities | All fish that have died in the sea cages. | A *Mortex* system will be utilized to collect fish mortalities daily from the bottom of the sea cage. The mortalities will be ensilaged on-site and ensilage will be collected by a service vessel for delivery to a third-party. |
| Uneaten fish feed | All feed that is fed to the fish but not eaten | Feed waste at the cage site will be minimal with the use of camera monitoring systems to ensure optimum feeding. However, any uneaten feed will be flushed by currents or settle to the sea floor. As per Provincial regulations, sites will have a fallow period (minimum 7 months on a site and 4 months per BMA). Grieg NL will allow 16–20 months fallow per site and up to 16 months per BMA. |
| Petroleum products | All petroleum-based products used on the vessels including oils, fuels, and greases | Management practices in place to reduce the amount, frequency and risk associated with the use of these products.<br>Reuse products when possible (e.g., waste oil can be collected and burned).<br>Choose environmentally friendly options when possible (e.g., food grade grease/oil). |
| Paints | All paints used on vessels and cages. | Reduce the use of these products. Ensure all painting is done before deployment or during fallowing of the site and only paint areas as needed. |
| Operational Debris | All operational debris produced at on the marine sites including general waste, electronic waste, waste from daily operations, and litter. | Reduce the amount of waste generated when possible (e.g., buy feed and products in bulk, buy products with less packaging, etc.)<br>Recycle when possible (e.g., cardboard, feed bags, aluminum cans, plastic bottles, e-waste, etc. and bring to shore on service vessel)<br>On site waste will be transferred to land and disposed in accordance with BPWMC. |
| Cleaning products | All products used to clean the vessels and barges including soaps, disinfectants, and detergents. | Management practices in place to reduce the amount and frequency of these products. Use only products that can enter the vessels grey water and are easily broken down. |

### *Chemical Use*

As a condition of the initial EIS release, Grieg NL provided Health Canada with a list of substances, agents or chemicals (Appendix N) that may be used during the Project. This included information on the names and types of possible substances to be used (both approved and a number which are still under development), their purpose, and the specific aspect of the operation in which they will be utilized (including those which will be used regularly and routinely, and others that may be required in certain circumstances, such as in the event of fish health issues). The list of proposed substances also provided an estimate of the likely quantities / rates at which each product may be used. Health Canada notified Grieg NL that it was satisfied with the proposed list of substances (A. Denning, Health Canada, via email on 14 October 2016). Health Canada will be made aware of any additional substances identified in future and their approval will be acquired. The disposal of chemicals will be handled in accordance with appropriate regulations and procedures as outlined in the Waste Management Plan (Appendix J).

### *Biosecurity*

Biosecurity measures at the sea cage sites are detailed in Section 2.5.2.2 as these measures are designed to mitigate pathogen presence and spread. In summary, key biosecurity measures include:

- Use of four BMAs (three semi-annual and one seasonal).
- Fallowing of the sea cage sites (and BMAs) for periods that meet or exceed provincial requirements.
- Selection of sea cage sites based on suitable currents, water temperature, bottom types, and distance from municipal sewage outflows.
- Minimizing the exchange of equipment between sea cage sites.
- Careful cleaning and disinfecting of equipment and vessels.
- Daily removal of fish mortalities and secure storage on the barges.
- Feed and ensilage stored on the barges at the sea cage sites are physically separated in secure containment units.
- Crew change sites will have separate and biosecure inflow and outflow areas.
- A separate resupply site for receiving waste (e.g., ensilage).
- The fish will not be permitted to leave the RAS Hatchery until an approved transfer permit is received, which indicates fish have been vaccinated and are considered disease free.
- Well boats will be cleaned and disinfected prior to each transfer of fish.
- Well boat and service vessels are not permitted to travel directly from one BMA to another BMA unless they been cleaned/disinfected after exiting a BMA.
- All the hatches of the well boat will have to be closed when travelling through a BMA to get to another to ensure recirculation in the boat and no outflow.
- When harvesting, take the most direct route possible without passing through another BMA after fish have been harvested.

### *Other Mitigation Measures and Monitoring*

In addition to biosecurity measures designed to minimize the transfer of pathogens, Grieg NL will employ numerous other mitigation measures and monitoring tools to minimize the effects of the Project on the environment. Details are provided in Section 2.5.2.2.

***Personnel Safety, Emergency Response, and Site Security***

Details on personnel health and safety as well as emergency response procedures are included in Grieg NL's Emergency Response Plan (Appendix T). Site security procedures at the sea cage sites are included in Section 2.5.2.2.

### 2.4.4.3 Decommissioning and Rehabilitation

A decommissioning plan will be developed with input from appropriate regulatory agencies that outlines procedures for shutting down Grieg NL operations at the sea cage sites. It is premature at this stage to provide specific details on decommissioning processes; however, the decommissioning plan will clearly lay out the approach and details regarding removal of all fish and fish products, waste, chemicals, equipment and infrastructure and restoration of the aquatic environment.

Decommissioning of the sea farms will be completed in several stages. A staged approach will allow for organized rehabilitation of the project site and appropriate environmental control. Key steps in the decommissioning process for the sea farms will include:

- Removal of all remaining fish and fish products;
- Drainage, cleaning, disinfecting and removal of all vessels, pipes and equipment;
- Removal of all sea cage components;
- Removal of moorings for the sea cages and barges;
- Removal and appropriate disposal of all hazardous chemicals, reagents and materials;
- Removal of all salvageable equipment, materials and supplies;
- Removal and appropriate disposal of all non-salvageable equipment, materials and supplies;
- Assessment of the seafloor beneath the sea cage sites and implementation of appropriate remediation measures as appropriate; and
- Implementation of a monitoring program to determine the efficacy of the remediation measures. The length of the monitoring period will be determined in consultation with the appropriate regulatory authorities.

The development of the decommissioning plan will be revised and updated regularly on an as-needed basis as the Project moves through the Operations phase. All legislation and guidelines set by the Federal and Provincial Governments that may apply to the sea cage sites at the decommissioning and rehabilitation stage will be reviewed and followed.

## 2.5 Monitoring and Mitigation Measures

As reviewed in Section 2.3, municipal, provincial and federal regulations must be followed by Grieg NL during construction, operations, and decommissioning of the RAS Hatchery and sea cage sites. Grieg NL will meet or exceed these requirements.

Grieg NL is in the process of finalizing SOPs for both the RAS Hatchery and sea cage operations (see Appendix K for a list). These SOPs will lay out step-by-step procedures for Grieg NL personnel (and third-party providers) who are responsible for implementing mitigation measures and monitoring. Mitigation measures and monitoring procedures for the Project are described below.

### 2.5.1 RAS Hatchery

Mitigation measures and monitoring procedures are in place for the construction, operation and maintenance, and decommissioning/rehabilitation of the RAS Hatchery. The RAS Hatchery will be constructed in the existing Marystown Marine Industrial Park, which provides Grieg NL access to Placentia Bay.

#### 2.5.1.1 Construction

Most of the site clearing work for the RAS Hatchery has already been conducted with the exception of grading the site. Clearing of the RAS Hatchery site required that erosion and sediment controls were in place, and because some clearing activities were planned during the breeding bird season, bird surveys were implemented. Blasting activities for leveling the hatchery site will be mitigated and any hazardous materials used during construction will utilize appropriate mitigation procedures (see below). The RAS Hatchery is located within an approved Marine Industrial Park. The Marystown Marine Industrial Park underwent an environmental assessment in 2008 and was released from the assessment process on 14 August 2008.[8]

***Erosion and Sedimentation Control***

During clearing and grubbing of the RAS Hatchery site, contractors have, and will adhere to current Industry Best Practices for managing erosion and sedimentation in accordance with municipal, provincial and federal regulations (see Section 2.3). These measures include:

- Grubbing will be contained to areas necessary for project development.
- Grubbed material will not be pushed into areas that are to be left undisturbed.
- Grubbed material will be stockpiled in a designated area.
- A minimum 15 m buffer zone will be maintained between grubbed areas and any adjacent watercourse, including Jones Brook and Placentia Bay.
- Rock berms, silt fencing, and hay bales will be used to control run-off and potential sedimentation of waterways (Figure 2.54), particularly in susceptible areas (i.e., steep slopes; Figure 2.55).
- Sediment control structures will be monitored, maintained, and repaired on a scheduled basis (minimum weekly) and before/after rainfall events >10 mm.
- Additional silt fencing and hay bales will be stored on site and available if needed.

Additional measures will be undertaken to rehabilitate and stabilize construction sites. As previously stated, grubbing will be contained to areas necessary for project development. The footprint of the buildings will cover ~36% of the site area with the remaining area including roadways, parking lots, walkways, and green space. Sloped areas will be covered with rip rap (clean blasted rock) or hydro seed as appropriate. The remaining green space will be covered with topsoil and sods or hydro seed. There will be no disruption of shoreline areas and no construction of access roads.

[8] See www.mae.gov.nl.ca/env_assessment/Projects/y2008/1387/index.html

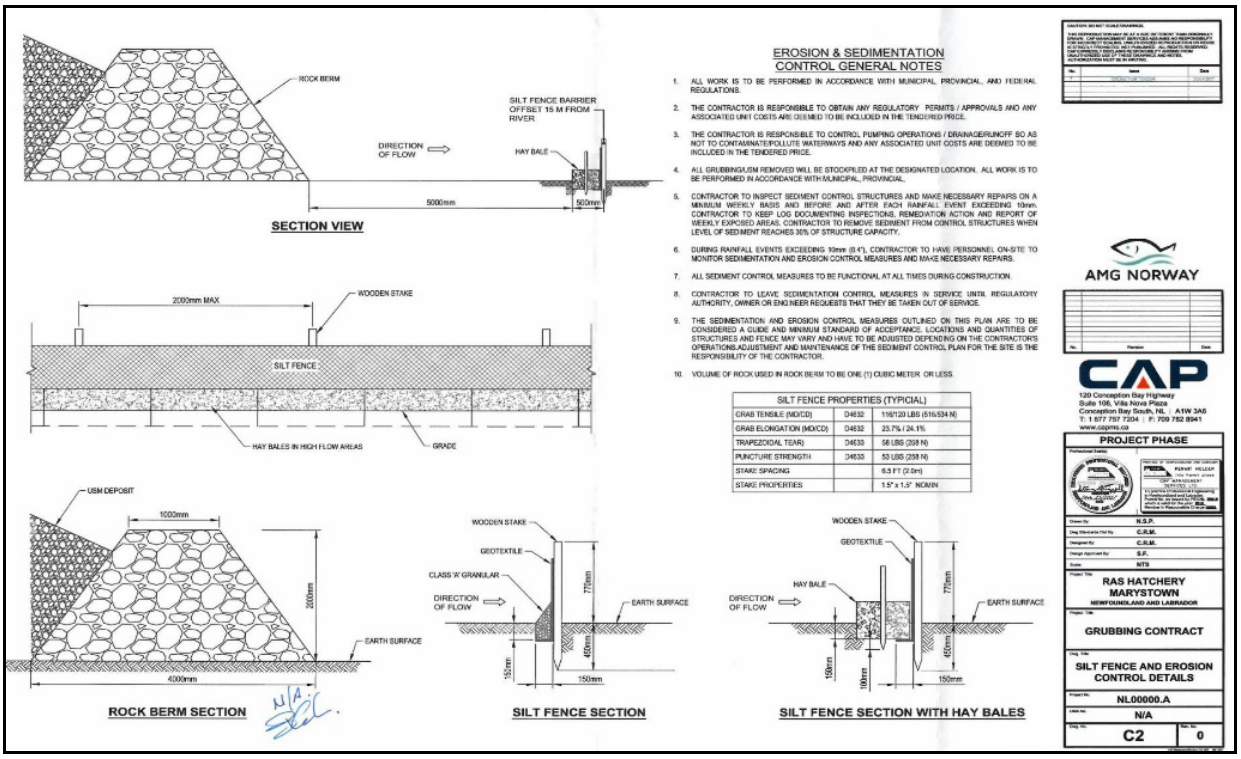



**Figure 2.54. Erosion and sedimentation control mechanisms in place for site preparation at the RAS Hatchery.**



**Figure 2.55. Berm at the edge of slope leading to hay bales, silt fencing, and a natural vegetation buffer at the RAS Hatchery site.**

### *Breeding Bird Surveys*

As required under provincial and federal regulations, breeding bird surveys were conducted in early-July 2017 in advance of grubbing activities. Two experienced bird biologists systematically walked through the survey sites searching for birds and looking for evidence of nesting (see Appendix U). There was only one occasion that required mitigation action. Savannah Sparrows (*Passerculus sandwichensis)* had nested in an area not yet cleared as evidenced by the presence of a fledgling. The surrounding area had been deforested in the previous year (after the bird breeding season). The biologists determined that the fledgling Savannah Sparrow(s) required more time to reach an adequate size to fly away and cross the previously cleared area to reach suitable habitat before construction in the area commenced. The area where the fledgling was observed was marked with a flag and the site was not cleared until two weeks later. If future site clearance activities are required during the breeding bird period, the area will be monitored for nesting activity and appropriate mitigation actions will be taken. Areas will be visually inspected by construction personnel. If any evidence of nesting is detected, then a bird biologist will be consulted and delay of clearing activities will occur.

### *Blasting Mitigation Measures*

Drilling and blasting are required to bring the site for the RAS Hatchery to specific grades (i.e., levels). A licensed, qualified and experienced contractor will be hired to conduct all drilling and blasting operations and to ensure that permitting requirements are met (see Section 2.3). As per the operations permit and relevant legislation, explosives will not be stored or remain on-site overnight.

Blasting patterns and procedures will be developed to minimize seismic impact within the pre-blast survey zone and proper techniques to reduce flyrock potential will be utilized. A blast site safety manual will be required from the licensed contractor. Key aspects of this manual, including a blasting warning protocol (i.e., horns and/or sirens) and a site employee muster station area will be reviewed with site personnel prior to blasting operations. The site will be surveyed prior to any blasting to identify the presence of any animals such as moose or black bear. In the unlikely event an animal is detected in the cleared area, the blast will be delayed until such time that the animals have left the site.

### *Hazardous Materials, Mitigation and Management Measures*

A variety of fuels and potentially hazardous materials will be used during construction activities which could include petroleum, oil, lubricants, cleaners and solvents, flammable gases (i.e., acetylene), antifreeze, paints, epoxies, and explosives. Grieg NL is aware of the concerns regarding the use of hazardous materials and their potential uncontrolled release into the environment through leakage or accidental spillage and the subsequent adverse effects. Grieg NL will insist that contractors follow all required regulatory policies and procedures and industry best practices including the following:

- Procedures for the handling of fuels and other hazardous materials as well as contingency plans for spills will be present in hard copy at receiving, storage, transfer and disposal areas.
- Transportation, storage and use of fuels and all other hazardous materials at the construction site will be conducted in compliance with all relevant laws and regulations.
- A complete inventory of the hazardous materials on the job site shall be maintained according to the WHMIS Regulations. This inventory shall be made available to regulatory agencies upon request, and shall be kept readily available in case of any emergency.

- All contractors will be required to observe strict compliance with the requirements of WHMIS regarding employee training, use, handling, storage, and disposal of hazardous materials and regarding labeling and provision of Material Safety Data Sheets as required by WHMIS legislation.
- All contractors will be required to observe strict compliance with the requirements of the most recent version of the *Transportation of Dangerous Goods Act*.
- Contractors will be required to submit a detailed EPP prior to the start of construction.

***Waste and Waste Management***

Both solid and liquid wastes will be generated during construction of the RAS Hatchery (see Section 2.4.3.1). The amount of waste generated will be minimized to the extent possible, primarily by recycling and reusing materials. All wastes will be handled according to procedures in Grieg NL's Waste Management Plan (Appendix J).

### 2.5.1.2 Operations and Maintenance

The Project will employ best available technology in terms of the proposed hatchery design. At each stage of salmon development, mitigation measures and monitoring will be in place to maintain fish health in the RAS Hatchery. During transfer of the smolt from the RAS Hatchery to the well boat, measures such as counting devices and double walled pipes will be in place to minimize the risk of accidental escapes.

***RAS Hatchery Design***

There are several design features of the RAS Hatchery that minimize the effects of operations on the environment and minimize the health risks to salmon. Firstly, the RAS operates by filtering water from the fish tanks so it can be reused. The system uses 300 L/min versus the 500,000 L/min, which is typical in a flow-through system that is not reusing any water to accomplish an equivalent production (i.e., seven million smolt). The RAS is designed to allow year-round control of fish growing conditions with equipment and procedures that are flexible and energy efficient.

The RAS Hatchery will be designed to obtain certification under the globally-recognized Leadership in Energy and Environmental Design rating system (LEED; see https://new.usgbc.org/leed). For example, pre-fab building materials will be used to construct the facilities with emphasis placed on the manufacturer's commitment to reducing their impact on the environment (e.g., using 80% recycled steel). Also, the facilities requiring the largest volume of water will be located on the down slope portion of the building site so that water can be gravity fed thereby reducing the pumping energy requirements. Water required for aquaculture operations will be supplied by a nearby well, which was drilled specifically for the Project thereby reducing the effects on Marystown's municipal water supply. The RAS can control water quality while also minimizing the entry of pathogens; this is discussed further below. The design of the RAS Hatchery is such that there will be minimum greenhouse gas emissions. Air emissions will be produced by a back-up generator (Standby 2,000 ekW 2,500 kVA; 60 Hz, 1,800 rpm, 480 volts; CAT® 3516B TA Diesel Engine), which will be operated during emergency situations and tested every two weeks for ~0.5 hours.

Biosecurity was also a key factor in building design. There will be separate, bio-secure rooms/buildings for each stage of salmon development. In addition, the Post-Smolt Facility is divided into three modules due to biosecurity considerations. Modules A, B, and C, each have a separate building with independent

services such as dressing rooms, control room, feed storage, disinfection room, electrical room, and sumps.

***Fish Health***

At each stage of salmon development mitigation measures and monitoring will be in place to maintain fish health including (1) routine husbandry practices, (2) biosecurity measures, (3) use of specialized feed, (4) feed storage and delivery, (5) water quality maintenance, (6) removal and treatment of fish mortalities, and (7) health checks and procedures (as outlined in Grieg NL's Fish Health Management Plan; Appendix K).

(1) *Husbandry Practices*: Grieg NL will employ standard cleaning and disinfecting procedures in the RAS Hatchery. Proper cleaning and disinfection is crucial to eliminating cross-contamination between tanks and between buildings within a hatchery setting. Cleaning and disinfection will take place between events such as fish grading, transfer of fish between buildings, culturing of batches (e.g., fish grown from a shipment of eggs), or a fish health event. Tanks will be cleaned and inspected on a routine schedule. Smaller equipment that is used daily will be cleaned and disinfected at the end of each personnel shift. All tools and equipment will be designated for each facility and not shared or transferred between buildings or sites. Depending on the size of equipment to be disinfected, a power washer may be used to assist with cleaning. All surfaces will be scrubbed or sprayed with a disinfectant. Electrical equipment will be wiped down with disinfectant wipes and heat applied.

(2) *Biosecurity Measures*: As noted above, the RAS Hatchery has been designed to enhance biosecurity. In addition to daily husbandry practices such as cleaning and disinfecting equipment, protocols will be in place to enhance biosecurity as personnel, equipment, and fish move between rooms and/or buildings. Air movement in and out of the facility as well as pressure is controlled and filtered. Doors are controlled by a central access system where each worker must have the required credentials (embedded into an ID tag) to enter their work area, and may not enter other areas to prevent cross-contamination. Entrance to production halls (i.e., where grow-out tanks are located) require strict biosecurity measures, and are designed accordingly. Each facility is independent and has separate biosecurity measures including those for dressing rooms, control room, feed storage, disinfection room, electrical room, and sumps. Personnel will have separate work clothes for each facility and will be required to change upon entering a new building. Disinfection procedures for personnel and their clothing will also be in place. These measures are in place to maintain biosecurity.

(3) *Specialized Feed*: The feed that will be used in the RAS Hatchery has been formulated to meet the nutritional requirements of triploid sterile salmon. More specifically, the feed has been developed to minimize the occurrence of mandible and spinal deformities as well as the development of cataracts, which has previously been an issue with triploid sterile salmon (IMR 2015). Grieg NL will utilize a major supplier for all its triploid sterile salmon feed in the RAS Hatchery (and at the sea cages). All the feed will be CFIA approved as well as EU approved. Many genetically modified (GM) plant varieties are produced in large quantities globally and are approved for use in fish feeds both in Norway and the European Union. European consumers, however, are skeptical about fish produced by means of GM feed ingredients. Concerns have been raised regarding the safety of GM plants, including potential toxicity and/or allergenicity of the novel protein,

potential unintended effects, and risk of horizontal gene transfer to other species. Therefore, none of the feed companies producing salmon feed for EU/Scandinavian salmon producers are using GMO ingredients in their mix. In the US market, GM organisms are accepted by the consumer and used in most of the salmon feed produced in Canada and the US.

(4) *Feed Storage and Delivery*: All feed will be stored in enclosed structures (e.g., silos) and/or facilities to eliminate the attraction of wild animals including pests/predators and the potential transfer of disease from wild animals. This also reduces the need to control pests/predators. Within the RAS Hatchery, the feed delivery conveyor systems are designed to minimize dust and breakage of the feed. An automatic feeding system based on standardized feeding tables/software and video monitoring is designed to prevent feed spills and wastage.

(5) *Water Quality*: Water quality will be monitored and maintained at optimal conditions for growth during first-feeding, smoltification, and post-smolt production. A routine program (detailed in a SOP) will be established for monitoring, measuring, and recording water quality in all buildings of the RAS Hatchery. Each tank is equipped with an in-situ dissolved oxygen probe, each module (i.e., group of tanks) has in-situ temperature and pH monitoring. In the event of issues providing oxygen to the tanks, each tank is equipped with emergency oxygen diffusers. Waste and other debris in the tanks will undergo a series of treatments before being partially or totally reused (see Appendix J). Incoming water will be filtered with a fine filtration system (2 micron). The incoming filtered water will then be mixed with flow water returning to the DNS. All outgoing water from the DNS will pass through an UV unit before returning to the tanks.

(6) *Mortality Removal*: Fish mortalities as well as moribund fish will be visually assessed and collected at a minimum, daily, via a port on each tank. Fish mortalities will be transported immediately upon collection from each of the RAS Hatchery buildings to a centralized ensilage tank. Once sufficient quantities of ensilage have been reached, it will be transported offsite. Appendix J (Waste Management Plan) provides additional details.

(7) *Health Checks and Procedures*: Salmon at each stage of development will undergo health checks and procedures to minimize health risks such as disease. Prior to being shipped to Newfoundland, eyed eggs will be tested and certified as disease-free (sterile and all female; see Appendix I). Prior to entering the First-Feeding Facility, the eggs will be brought to a disinfection room (located in the RAS Hatchery but separated from the hatching units and first-feeding tanks) where they will be rinsed, then disinfected (with an iodine solution) as per Article 4.4.2 of the Aquatic Animal Health Code (Disinfection protocol for salmonid eggs) (OIE 2015) and de-boxed. All equipment encountering the eggs or egg containers will also be disinfected. Records of time, source, and location of eggs will be maintained. During incubation, eggs will be monitored and any nonviable eggs promptly removed to eliminate fungal growth.

Both active (in response to health issues) and passive (routine checks) health surveillance of fish will be ongoing. Grieg NL will use a private veterinarian to respond to signs of health issues and to conduct routine monitoring prior to each transfer of fish to a new facility. Grieg NL staff and management will work closely with this private veterinarian to communicate any indications of behavioural or physical changes that may indicate a

health or disease concern in the fish. Grieg NL staff will be trained to be familiar with normal fish appearance and behaviour and will be aware of the importance of relaying any changes observed (physical or behaviour) to supervisors or management. Grieg NL has developed and will implement a Fish Health Management Plan that will outline SOPs to ensure fish health is optimized within all Grieg NL facilities (Appendix K). Personnel will monitor fish health including indicators of disease (i.e., infectious salmon anemia [ISA], furunculosis, Vibrio, infectious pancreatic necrosis [IPN], *Yersinia ruckeri*, and bacterial kidney disease [BKD]), parasites, fungus, wounds or ulcers as well as deformities, behavioural changes, and indicators of readiness for saltwater (e.g., Na+, K+, ATPase). These examinations are often a combination of visual inspections as well as blood samples. Each transfer between hatchery facilities (First-Feeding, Smoltification, and Post-Smoltification) will be done with minimal stress on the fish. Records will be maintained for each transfer including date, time, number, and weight of fish. Where appropriate (e.g., during vaccinations), fish will be anesthetized to minimize stress and trauma during handling. All handled fish will be closely monitored for a period post-handling. In addition to the network of Grieg NL staff, management and a private veterinarian, Grieg NL will also participate in routine checks by a provincial veterinarian as part of the Province's passive surveillance program. A provincial veterinarian will monitor fish health at the RAS Hatchery. This audit schedule will be determined by DFLR.

After the smolt have been transferred to the Post-Smolt Facility and prior to transfer to sea, they will be vaccinated as per the specific recommendations of provincial veterinarians. Typical vaccinations approved for use in Canada, include multivalent vaccines for standard bacterin with *Aeromonas salmonicida* (Furunculosis), *Listonella anguillarum* and *anguillarum* type II, and *Vibrio salmonocida* (Vibriosis). Vaccines for IPN and wound disease can also be included in these multivarents. These vaccinations are available from companies such as PharmaQ or Merck Animal Health. Grieg NL will also include the BKD and ISA vaccine, if recommended, based on consultations with the private veterinarian and DFLR. Once it has been determined that sufficient smoltification has transpired, a health check by a provincial veterinarian will be conducted within 45 days before transfer to sea. This check will sample a number of fish from each tank that is being transferred to sea. Fish will not be transported if there are any health concerns and until the transfer permit approved by DFO, DFLR and CFIA is received. As noted earlier, Grieg NL is planning to utilize an automated fish vaccination system which minimizes fish mortality (<0.02%; Skala, n.d.).

### *Fish Escapes*

There is very little risk of salmon escaping into the environment during the majority of RAS Hatchery operations given that it is a contained system and the hatchery is not immediately adjacent to a natural waterbody. In addition, during fish transfers between tanks and facilities, fish will be carefully monitored and counted (at both the outflow and inflow end). There is potential for fish escape during transfer of smolt from the RAS Hatchery to the well boat; however, the potential is greatly reduced via mitigation measures and monitoring. Smolt will be transferred to a well boat via a double pipe (~150 m in length) leading from the Post-Smolt Facility to Mortier Bay. The pipeline will be constructed such that a protective sacrificial pipe surrounds the transfer pipe. This protects the transfer pipe from wear and abrasions. A reinforced, continuous hose extending ~50 m from the shoreline to the well boat will be used to transfer the fish. The hose will sit at the water's surface and will be continuously monitored by personnel. Fish will be counted via video monitoring (and a counter) as they exit the hatchery and as they

enter the well boat. The day prior to transport, all equipment which will be used (i.e., pipes, hoses, pumps, counters) will be checked and prepared including checking the pipe and hose for breaches. A check list will be followed on the day of transfer for personnel at the hatchery (and the sea cage sites). Transfer of fish to the well boat will only occur during calm conditions.

***Waste and Waste Management***

The RAS Hatchery will produce a variety of wastes during operation including sanitary waste and wastewater, fish waste, fish mortalities, uneaten fish feed, petroleum products, operational debris and cleaning products (see Table 2.13 for a summary). More detailed information on the handling, storage, transport, and disposal of wastes from the RAS Hatchery is included in the Waste Management Plan (Appendix J).

***Site Security***

Security procedures and infrastructure will be in place at the RAS Hatchery. Fencing will be constructed around the land-based facilities and all staff, contractors, sub-contractors, vendors, and visitors who enter the area will have to pass through a security gate. A closed-circuit television (CCTV) system will be installed around (and inside) the RAS Hatchery covering many of the vulnerable areas, public access points and adjacent streets. The CCTV system will be monitored by Grieg NL security from a Security Control Room. In addition, perimeter breach, intruder and panic alarms will be installed and continuously monitored from the Security Control Room. Security will respond immediately to the activation of these alarms. Members of the Security Team will carry out routine patrols of the buildings to provide a visible deterrence to criminal activity.

***Emergency Response/Contingency Plan***

Grieg NL will have in place an Emergency Response Plan detailing procedures to respond to accidents, malfunctions, and emergencies at the RAS Hatchery including a security breach, mass fish mortality, escape of fish during transfer to the well boat, spills of hazardous substances, and response to a serious fish health incident (Appendix T).

#### 2.5.1.3 Decommissioning and Rehabilitation

A decommissioning plan will be developed with input from appropriate regulatory agencies that outlines procedures for shutting down Grieg NL operations at the RAS Hatchery. The decommissioning plan will clearly lay out the approach and mitigation and monitoring details regarding removal of all fish and fish products, waste, chemicals, equipment and infrastructure (as per appropriate regulatory provisions).

### 2.5.2 Sea Cage Sites

Mitigation measures and monitoring procedures are in place for the construction, operation and maintenance, and decommissioning/rehabilitation of the sea cage sites. There are 11 proposed sea cage sites located in four BMAs in Placentia Bay. Mitigation measures are also in place for the proposed transport corridors to the sea cage sites.

#### 2.5.2.1 Construction

It is anticipated that the sea cages will be assembled in the Marystown Marine Industrial Park and towed to the sea cage sites by a multi-purpose vessel. A tow route established in consultation with local fishers

will be used and the tow speed will be <3 knots (5.6 km/h). Towing activities will be clearly communicated to stakeholders in the area and through Notice to Mariners and other communication tools (see Section 2.5.2.2 below). Anchors will be installed for moorings at each of the sea cage sites. Prior to installing sea cages, all anchors and moorings will be inspected.

### 2.5.2.2 Operations and Maintenance

There are several primary types of effects that may result from sea farms including effects on the genetic integrity and biological fitness of wild Atlantic salmon in Placentia Bay, spread of disease and parasites to the surrounding environment, effects on the marine habitat from sea cage deposits, and entanglement of marine fauna. Mitigation measures and monitoring procedures for these effects are described below.

***Fish Escape***

In Canada, there are several primary reasons for the escape of finfish from sea farms including personnel errors made during routine fish handling procedures and net damage caused by weather, ice, and predators[9]. From 2010–2016 in Newfoundland there have been five reported incidents of salmon escapes from sea farms and at least nine breaches in nets with no official report of escapes. Of the five reported incidents two were attributed to personnel errors made during harvesting, two were attributable to extreme weather, and one was attributed to a predator strike (possibly sharks; DFA 2015). The nine net breaches, which were reported in 2012, were attributed to sharks and tunas. The reported salmon escapes in Newfoundland occurred during operation of a different type of sea cage system than the Aqualine Midgard cage system Grieg NL is proposing for use.

Federal and provincial regulators as well as the aquaculture industry recognize the importance of preventing escapes of fish from sea cages and as such, have developed regulations to minimize the chances of such escapes. Since 1999, DFLR (formerly DFA), DFO and the salmonid industry have implemented a management strategy called the *Code of Containment for the Cage Culture of Salmonids in Newfoundland and Labrador* (COC; DFA 2014; Appendix V in Sullivan et al. 2018). Additionally, mitigation measures and monitoring for minimizing the effects of predators and ice on the sea cages are designed to minimize the potential escape of fish.

*Code of Containment*

The COC is based on internationally recognized principles that focus on procedures which minimize the potential for equipment failures and improve upon handling practices. There are five primary elements to the COC: (1) Equipment; (2) Handling Practices; (3) Inspections; (4) Documentation and Reporting; and (5) Mitigations. These elements and how they will be specifically applied to the Project are described below. Grieg NL is using industry best practice where possible.

(1) *Equipment*: As per the COC, all finfish containment systems (cage structures and nets) must be designed, constructed and installed to withstand local weather and ocean conditions including storms, water currents, and waves. Sea cage systems must also be maintained to control biofouling and ice accretion, which can compromise the system. Predator control measures are also important to minimize the risk of escapes (see below for more details). In addition to following the COC requirements with regard to the cage structure, nets and moorings, Grieg NL will utilize a Norwegian company, Aqualine, for its cage systems.

[9] See http://www.dfo-mpo.gc.ca/aquaculture/protect-protege/escape-prevention-evasions-eng.html

The Aqualine sea cage system, including its dimensions, design, and construction, is based on the Norwegian Standards (NS9415:2009) currently in use in Norway and which are considered industry best practice (Appendix II in Sullivan et al. 2018; see Volume 3). The Aqualine sea cage proposed by Grieg NL, weighs 35 tonnes and is constructed of robust materials (netting material is Aqualine Ultima/Ultra SG netting which is made with HDPE material), is certified by SINTEF to withstand 9 m significant wave heights. The Norwegian Standards require cage system and mooring design to minimize the risk of fish escapes due to technical failure. This dimensioning allows for deformations, environmental loads such as wind, waves, currents and ice as well as damage such as puncture. If during extreme situations a rupture or damage occurs to parts of the floating collar, the cage construction will keep its shape and prevent total collapse. The clamps which are connected to a dimensioning main supporting system in the horizontal plane will hold the construction together while the floating collar's remaining capacity will prevent the cage net from collapsing. Aqualine's floating collars are equipped with floater tubes filled with rods made out of expanded polystyrene. Should damage or a puncture occur to the collar, these rods maintain the buoyancy of the cage until repairs can be completed. Tidal variations and storm surges are not critical for the floating collar; however, ice accretion may cause loads on the construction. The load effect from icing is primarily connected to loss of buoyancy. Build-up of ice can readily be removed (see *Ice Monitoring and Mitigation*). Grieg NL will also use a ROV to assist in tasks such as net inspections and in-situ net repair, if required.

(2) *Handling Practices*: The COC details Handling Practices and includes appropriate precautions to prevent escapes during all stages of fish handling including transfers, counting, grading, sea lice counts, treatments, harvesting, net changing or cleaning. Additionally, Grieg NL will avoid handling and feeding fish during super chill conditions. As a minimum, Grieg NL will adhere to the best practices included in Appendix 6 of the COC including for grading, weight sampling, sea lice counts, transportation, well boat treatments, and harvesting. A common mitigation measure that reduces the likelihood of escapes during handling is the use of a drop net. Drop nets are placed under the work area and above the sea surface in the event a fish is 'dropped' during routine procedures that require handling of fish. Prior to each use drop nets are inspected for holes, wear and any other damage. Drop nets will be of sufficient size to cover the entire work area and the mesh size will be small enough to contain the smallest fish being handled. In addition to following the COC recommendations to ensure that escapes are minimized, Grieg NL will also utilize technology including automatic counters and video monitoring as an added security during handling. Fish counters and video cameras will be utilized during handling procedures including grading, transfers and harvesting to allow careful monitoring of fish numbers and enable a quick response to potential issues. All personnel will receive appropriate training in handling procedures.

(3) *Inspections*: As part of the COC, nets that are over three years old and still in use will be tested every 18 months by a third party (i.e., Aqualine). Nets are tested for strength (e.g., stress test with a tension scale instrument) and integrity. In addition, as a minimum, nets will be visually inspected every 90 days by an ROV. Cages and surface mooring components will also be inspected as per the COC. Surface components of mooring systems, cages, nets and ropes on each site will be inspected once per week and recorded on Form A.4 of COC. Underwater components of the mooring system, including the anchors, will be inspected based on a schedule developed in consultation with Aqualine and approved by DFO or DFLR. Each year, Grieg NL will be required to submit a

"Mooring Maintenance/Replacement Plan" Form A2 for each site occupied with fish. In addition, periodically audits of the cage system as specified in COC Procedures for Compliance will be conducted and DFLR will arrange for audits of net testing procedures. Audits by DFLR will be conducted at a minimum of twice yearly (one in the spring, after fish entry; one audit in fall/early winter). Any identified damaged equipment will be repaired or replaced immediately.

Grieg NL will also comply with the Norwegian Standards (NS9415:2009) for its sea cage system as supplied by Aqualine. The Aqualine sea cage nets which will be used for this Project are issued a service card that is valid for not more than 24 months. These service cards provide information on the condition of the net as well as a period of validity. Nets without a valid service card cannot be used in the cage system. New service cards are issued after an inspection which follows established Aqualine and Norwegian Standards (NS9415:2009) procedures.

(4) *Documentation and Reporting*: Submission of the net testing results every 18 months (for nets over three years old) and annual submission of inventory reconciliation including number of fish stocked, mortalities, removals and explanation of discrepancies is required. The COC includes forms for these reports and all documentation will be maintained by Grieg NL for inspection by DFLR during their routine audits.

(5) *Other Mitigation Measures*: To prepare for a fish escape event, escape response drills will be performed on site annually. All new employees will also perform an escape response drill as part of their site orientation. Escape response drills will include deploying weighted netting over a "mock" hole in the sea cage, reviewing kit contents and reviewing SOPs. Should any escape be suspected or known to occur, the COC requires immediate reporting of escape incidents to both DFO and to the DFLR (C. Hendry, Acting Manager of Aquaculture Management, Ecosystems Management Branch, pers. comm., 5 April 2018). Grieg NL will be required to begin discussions with DFO within 24 hours of the incident to determine if recapture efforts should be initiated. Authorization of recapture is at the discretion or direction of DFO in consultation with Grieg NL and stakeholders as needed. Although all escapes are reported, not all escapes incidents may trigger recapture efforts. Factors such as the life history stage of the escaped fish, the time of year, incident-specific factors and conservation objectives for wild fish populations will be considered. DFO may also deem it necessary to issue a license for recapture. DFO, in consultation with Grieg NL, may determine that captured salmon should be sampled to verify that they are indeed from Grieg NL's sea cages. Through genetic analysis of blood samples, it is possible to identify the broodstock (eggs supplied by Stofnfiskur; see Appendix I) of the escaped salmon and whether or not they are sterile. Each BMA will have an escape response kit and all marine personnel will be trained in its use. Once notification has been provided to DFO, and if a recapture response is authorized along with any necessary licenses, Grieg NL will enact their recapture plan (see Emergency Response Plan in Appendix T). If conditions permit, it will involve deployment of gill nets and/or dip nets near the sea cage sites where the escape has occurred. Procedures including methods to count, document and report on escaped fish are provided in Appendix T. If a recapture response is triggered and there is a serious breach in the net, fish will be transferred to a well boat where they will be counted and later returned to a replacement net. This will allow for an accurate assessment of the number of escaped fish.

*Ice Monitoring and Mitigation*

The sea cage may accumulate ice during freezing rain events or from sea spray that freezes. All sea cages will be routinely monitored for ice accretion either directly by personnel on site and/or remotely via video camera. Ice accretion will be minimized by personnel removing ice as it accumulates, which is typically done with rubber mallets, as is the practice for vessels.

Based on a review of Canadian Ice Service data (see Appendix V) and discussions with the Placentia Marine Communications and Traffic Services (MCTS; see Appendix D) and local stakeholders (Appendix W), sea ice and icebergs are not predicted to pose a threat to the sea cage sites. However, it is recognized that there is a very low probability that sea ice may occur in and near the sea cage site. Grieg NL will routinely (i.e., minimum daily) receive and monitor broadcasts on ice conditions (and/or weather) from the MCTS and receive guidance on the predicted timing and extent of any pack ice (or iceberg) incursions. The Canadian Coast Guard (CCG) holds pre-season meetings with its clients to discuss traffic expectations and service requirements. Grieg NL has submitted an application to "request standing" with the CCG on a committee should the need arise for assistance with ice. A three-tiered approach will be used to manage ice based on the type and size of the ice:

1. Slush, small patches of drift ice, and ice in general less than 5 cm thick will be mitigated through the robust design of the Aqualine sea cage as well the deployment of an ice boom and use of Grieg NL operated service vessels.
2. A multi-purpose vessel (operated by a third-party provider; Appendix W-5) with ice class capacity will be on standby to mitigate and potentially break-up and/or move 5–15 cm thick ice; more specifically pancake ice, ice cakes, brash ice (<20 m across); small ice floes (20–100 m across); and medium ice floes (100–500 m across).
3. A CCG ice breaker may assist with large ice floes (>500 m across), solid pack ice, and iceberg(s) in the unlikely event these ice conditions are encountered at or near the sea cage sites.

In the rare circumstance of a major ice incursion which cannot be mitigated through the measures outlined above, Grieg NL's Emergency Response Plan will detail procedures to either harvest the fish or tow the sea cage(s) to a safe location (see Appendix T). The sea cage(s) can only be towed when water temperatures are suitable for the health and welfare of the fish (between 4–18˚C).

*Predator Protection and Control*

A Predator Control Plan will be required as part of Grieg NL's aquaculture license application. Methods to monitor, deter, and exclude marine predators from the sea cages sites are required because predators such as sharks and tuna can create holes in nets which may contribute to escapement. For example, in fall 2015, DFO reported farm-origin salmon at the mouth of a river in Fortune Bay. It was speculated that sharks, which had been observed in the area, may have created a hole in the bottom of the net (DFA 2015). In addition, birds may attempt to take fish from the sea cages possibly facilitating the spread of pathogens. Several mitigation measures and monitoring tools will be in place to minimize interactions with predators.

Each sea cage will have bird nets which cover the entire top of the cage and prevent birds from taking fish. The bird net and bird poles are part of the Aqualine Midgard sea cage system and are designed to provide sufficient tension to eliminate net sagging. The sides of the bird net can be raised and lowered like a window blind to quickly and easily access the cage. Bird nets will be deployed ensuring mesh size will be sufficient to deter predators but minimize the risk of entanglement. If a bird does become

entangled Grieg NL will follow established procedures to release the bird (which will be developed in consultation with ECCC-CWS). Grieg NL will have a Migratory Bird Handling Permit (issued by CWS) in place and will follow reporting requirements.

For waterborne predators several techniques will be used. The bottom of each sea cage will have reinforced netting which minimizes the risk of tears. Also, the daily removal of dead fish from the bottom of sea cages via the automated Mortex system (see Section 2.4.4) is intended to reduce the attraction of sharks and possibly seals. Each sea cage will have one or two cameras that offer 360 degree viewing and can be raised and lowered within the water column. These cameras, in addition to an ROV inspection camera, will allow for monitoring of the net integrity and fish behaviour. If a hole is detected in the net, it will be repaired as quickly as possible (estimated to range from <1 hour to several hours) by an ROV or a diver if the hole is at the surface. The fish behaviour in sea cages will be monitored by personnel on the feed/accommodation barge and/or at the monitoring control center located at the RAS Hatchery for indications (i.e., crowding in bottom of net, skittish behaviour, change in feeding) that a predator may be nearby. If fish behaviour indicates the presence of a predator and/or a predator is directly observed (via the video or by personnel at the sea cage), the net will be inspected immediately for holes. This may involve a thorough review of video footage and/or dedicated inspection via an ROV. If predator incursions are determined to be an issue, Grieg NL in consultation with DFLR and DFO, will determine whether an anti-predator net (i.e., a double net that completely surrounds the sea cage under water) is warranted. There are trade-offs with using an anti-predator net—the primary drawback is that it makes cleaning the primary net much more difficult, which can result in water flow issues and subsequent health risks to the fish.

It is possible that seals and river otters may be attracted to the sea cages but it is unlikely they would gain access to fish from the top of the sea cage. The fencing (and bird netting) on the inside of the gangway would make it difficult for these animals to gain access to the fish. Like sharks, it is possible that seals and perhaps river otters may tear holes in the sea cage netting but to the best of our knowledge this has not happened previously in Newfoundland. However, monitoring should minimize this risk as described above. Of note, Grieg NL will not use acoustic deterrent devices in an attempt to keep marine animals away.

In all circumstances, predator management will be conducted in such a manner as to ensure human safety. Any accidental entanglement of marine mammals, otters, wild fish, and sea turtles will be reported to DFO and action will be taken, in consultation with DFO, to free or remove the animal (see Entanglement below). In extreme circumstances, if all methods have failed and a marine animal is posing a serious threat to the integrity of the nets (or to personnel safety), lethal measures may be considered. Before such actions are taken (by a third-party; firearms will not be stored at the sea cage sites), DFO will be consulted.

*Other Mitigation Measures*

In addition to the measures in the COC, predator protection and control, and ice monitoring and mitigation, there are other mitigation measures in place to further minimize the likelihood of fish escapes. For example, sea cage sites are selected in areas that provide shelter, have suitable current conditions, and are predominantly ice free. Sea cages are then oriented to minimize exposure to the prevailing winds and waves. Additionally, husbandry practices such as maintaining clean nets and continuous monitoring of fish and nets also serve to minimize the risk of fish escapes. These and other measures are discussed below under *Fish Health* and *Effects on Marine Habitat*.

***Genetic Integrity and Biological Fitness of Wild Salmon***

Although mitigation measures and monitoring procedures are in place to prevent fish escapes, it is still possible that some salmon may escape from the sea cages. The concern is that released salmon may affect the genetic integrity and biological fitness (via reproductive interference) of wild Atlantic salmon in Placentia Bay. To minimize this risk, Grieg NL will be using fertilized triploid (sterile and all female) Atlantic salmon eggs (European strain) supplied from an accredited and approved company named Stofnfiskur (based in Iceland). Triploid organisms have three sets of chromosomes instead of the standard two (diploid). This will be the first time that triploid all-female Atlantic salmon eggs will be used in Canada but triploid Atlantic salmon have been used successfully in cold water aquaculture operations in Norway and Scotland as described in Section 2.4.1.1. As noted earlier, eggs will be imported from Stofnfiskur as per the schedule shown in Table 2.10. The gradual ramp up of egg importation and subsequent salmon stocking numbers should allow potential issues with initiating operations to be rectified prior to reaching maximum production. Any technological or procedural improvements arising from ongoing research and development in finfish aquaculture will be considered by Grieg NL during the production ramp up and indeed throughout the Project.

Any finfish egg imports in Canada must be sourced from and received by facilities where robust quarantine measures are followed and which have been approved by regulatory agencies including CFIA, DFO and DFLR. Imports must be approved under the *Health and Animals Act*, and a permit issued, which is the responsibility of the CFIA. The issue of this permit is based on advice received from other regulatory agencies including DFO and DFLR. In 2012, experts from DFO and DFA (now DFLR) visited Stofnfiskur's facility in Iceland as part of the approval process to import sterile/triploid eggs from Stofnfiskur into Canada. This approval process required, in part, extensive review of all Stofnfiskur's permits, procedures and certifications. [See Appendix I for a review of Stofnfiskur's history and accreditations.] Based on this assessment, DFO through the Canadian Science CSAS process granted the approval for the importation and use of the European strain triploid Atlantic salmon being produced at Stofnfiskur facilities (DFO 2016). Based on these reviews and assessments, CFIA issued Grieg NL an import permit, recognizing Stofnfiskur as an approved exporter to Canada, in March 2016 (Permit No. Q-2016-00213-4; Appendix H) and Grieg NL has continued to renew this permit every three months as per the regulations.

Induced triploidy of Atlantic salmon has been ongoing for over 30 years and is currently the only commercially viable method to sterilize large numbers of fish species for an aquaculture scale operation (DFO 2013; Benfey 2015). It is commonly conducted by treating newly fertilized eggs with hydrostatic pressure which disrupts the movement of chromosomes during meiosis (Benfey 1998). More specifically, it is based on normal gametogenesis with an extra set of maternal chromosomes (polar body) being retained early in development when the egg is subjected to hydrostatic pressure. Prior to revised techniques currently used by Stofnfiskur, the use of pressure methods to induce triploidy resulted in >98% triploidy induction success (O'Flynn et al. 1997; Anon. 2012; Devlin et al. 2010 *in* Benfey et al. 2015). One of the concerns highlighted in the CSAS report (DFO 2016) as well as during consultations for the Project, is that the failure rate of inducing triploidy in Atlantic salmon eggs has been 1–2%.

In 2017, Stofnfiskur implemented new improved technology and increased the success rate of inducing triploidy from approximately 98% to 100%. Stofnfiskur also utilizes smaller chambers for the egg pressurization technique (i.e., 2 L in volume) when they are subjected to hydrostatic pressurization. By using smaller chambers, all eggs are subjected to the same pressure whereas the use of larger chambers in the past resulted in some eggs not receiving the necessary pressure required to induce sterile triploidy (resulting in only >98% success). The result of this modification as well as the new improved technology

is a process that now will produce 100% triploidy results. Stofnfiskur has also adopted a two-tier testing procedure. A small subset from each batch of eggs is cultured at a slightly higher temperature thereby speeding up the development process. The result is a sample of the batch that can be sent for verification testing at least one week prior. Both the subset and the primary batch must have 100% sterile triploid verification in order to be shipped to a customer. If verification tests indicate less than 100% sterile triploidy, the entire batch of eggs is discarded. This two-tier testing approach increases the probability of detecting failure rates. The smaller pressure chambers discussed above also allow Stofnfiskur to separate the eggs from each female. This enhances biosecurity and permits the eggs from each female to be readily tracked and sampled for all verification testing. Additional details on the Stofnfiskur triploidy (and all female) induction procedures and verification procedures are provided in Appendix I.

In addition to using triploid all-female eggs there are several additional measures which minimize the risk of affecting the genetic integrity and biological fitness of wild Atlantic salmon. DFO (2016) has proposed that the sea cages be at least 20–30 km from the mouths of salmon rivers in order to reduce the possibility of farmed escapees interacting with wild salmon stocks. The majority of scheduled rivers are located more than 50 km away from the proposed sea cage sites. Only the sea cage sites in the Rushoon BMA are located <20 km from a scheduled salmon river. In this case, the mouths of four scheduled rivers (i.e., Nonsuch Brook, Cape Rodger River, Bay de l'Eau River, and Red Harbour River) are located <20 km (i.e., 8.7–19.8 km) from the Rushoon BMA proposed sea cage sites.

***Genetic Integrity and Biological Fitness of Wild Lumpfish***

Although mitigation measures and monitoring procedures are in place to prevent fish escapes, it is possible that some lumpfish may escape from the sea cages. However, the risk of farmed lumpfish affecting the genetic integrity of wild lumpfish is minimal since these fish, although cultured, originated from broodstock collected in Newfoundland. Grieg NL has worked with Memorial University of Newfoundland's OSC to develop a broodstock of lumpfish whose eggs originated from Newfoundland. Twenty-four wild lumpfish were collected in 2015 and 48 wild lumpfish were collected in 2016 from local fishermen. The OSC have successfully domesticated and maintained three successive year classes from these broodstocks and in 2017, 81% of their egg production was from cultured broodstock (Appendix S provides the latest progress report from the OSC). Lumpfish from this native broodstock will be used to produce farmed lumpfish that will be used as cleaner fish in all of Grieg NL's sea cages. No wild lumpfish, beyond the 72 fish collected in 2015–2016, will need to be collected to produce lumpfish used by Grieg NL.

The lumpfish used as cleaner fish in the sea cages are not expected to reach sexual maturity prior to harvesting, thereby further minimizing the potential for farmed lumpfish to affect the genetic integrity of wild lumpfish. The age at which lumpfish reach maturity can vary depending on location and occur as early as two to three years of age for males in Norway and as late as five years of age for wild females in Newfoundland (Simpson et al. 2016). Based on observations of lumpfish held in captivity in Newfoundland, sexual maturity typically occurs at about three years of age (D. Boyce, OSC, pers. comm., 20 March 2018). Grieg NL will stock the sea cages with lumpfish once they reach 20–50 g (approximately 5–10 months old) and harvest them 12–16 months later at 17–26 months of age. By harvesting the lumpfish at approximately two years of age, it is unlikely lumpfish will have reached sexual maturity; thereby, further minimizing the likelihood that farmed lumpfish would affect the genetic integrity of the wild lumpfish.

### *Fish Health*

A number of aquatic disease-causing agents (pathogens) such as viruses and bacteria as well as parasites (i.e., sea lice), which occur naturally in the environment, can affect farmed fish. These pathogens can be spread from equipment used to transfer fish as well as through the water by animals releasing the pathogen or from sick or moribund fish. Some known sources of aquatic infections include contaminated equipment or feed and untreated wastewater. A number of tools will be implemented by Grieg NL to eliminate or minimize the spread of disease and sea lice at the sea cage sites and the surrounding aquatic environment. Mitigation measures and regular monitoring will be in place to maintain fish health including (1) biosecurity measures, (2) routine husbandry practices, (3) health checks and procedures, (4) use of specialized feed and feeding procedures, (5) sea lice control procedures, (6) water quality monitoring, (7) vaccinations, and (8) removal and treatment of dead fish. Grieg NL has developed and will implement a Fish Health Management Plan for its sea farms and all personnel will be trained in its proper procedures (Appendix K).

(1) *Biosecurity Measures*: BMAs are a strategy that Grieg NL has adopted to enhance biosecurity and mitigate pathogen presence and spread at its proposed sea cage sites. As described in Section 2.4.2.2, Grieg NL has proposed four separate BMAs within Placentia Bay (see Figure 2.3). BMAs enhance biosecurity by establishing discreet regions for individual companies and are recognized as an effective approach to disease management, to mitigate pathogen presence and spread (Chang et al. 2007). With the proper use of BMAs, including Grieg NL SOPs that regulate personnel and equipment transfer between and within BMAs, the risk of disease introduction and spread is reduced.

In addition to the use of BMAs, there are federal and provincial regulations, including inspections and permits, that ensure all aquaculture facilities operate in a manner that prevents disease spread while still facilitating market access for Canada's aquatic resources, both wild and cultured. The CFIA addresses aquatic animal diseases of finfish through the National Aquatic Animal Health Program (NAAHP). The NAAHP is co-delivered by CFIA and DFO. CFIA is the lead agency for program development and implementation while DFO provides the science support for the program (diagnostics, research and advice), and also coordinates and assists with sampling for surveillance purposes. The main objective of NAAHP is to prevent the introduction and spread within Canada of reportable and emerging aquatic animal diseases. The program is consistent with international standards set by the World Organization for Animal Health (OIE). As part of this program, CFIA has a number of regulatory disease response tools including movement controls or "quarantine", a License to Transport of Animals or Things, and an Order to Dispose.

Domestic movements of aquatic animals or equipment (including nets and cages) may require a Domestic Movement Permit Application to move Finfish and/or Things within Canada (CFIA/ACIA 5743) from CFIA. Whether a permit is required depends on the declarations of the reportable disease status of the areas being transferred from and to. The use of permits for these movements implements a control to contain certain diseases within areas of Canada where they are known to occur. For this reason, CFIA would be contacted by Grieg NL prior to any domestic movements of fish or equipment. In addition to contacting CFIA for domestic movements, Grieg NL would also be required, following the National Code on Introductions and Transfers of Aquatic Organisms, to submit an application to DFLR and DFO, which will address three main risks: genetics,

ecosystem and disease prior to any transfer of the fish from the RAS Hatchery to the sea cages for grow-out. The request is submitted to DFLR under a "one stop shop" process. DFLR and DFO review the request under their respective mandates, and if the request is acceptable to both regulators, DFLR forwards both approvals to the applicant. The fish will not be permitted to leave the RAS Hatchery until these approvals are received.

The proposed sea cage sites have been selected based on suitable currents, water temperature, bottom types, and distance from municipal sewage outflows (see below for more details). Consideration of these factors, as well the requirement to fallow sites, all contributes to fish health and mitigating effects on the marine environment.

Other biosecurity measures include ensuring that feed and ensilage stored on the barges at the sea cage sites are physically separated in secure containment units and that procedures for handling these materials minimize the risk of contamination.

(2) *Husbandry Practices*: As in the RAS Hatchery, Grieg NL will employ standard husbandry practices designed to minimize the spread of disease at the sea cage sites. These practices include cleaning/disinfecting of equipment, vessels, and ROVs, and managing personnel and tasks to minimize health risks to fish. The cleaning schedule for cages and nets will be developed based on environmental conditions in Placentia Bay as well as routine monitoring. Nets will typically be cleaned weekly and cages will be cleaned once or twice during heavy fouling periods. Cages and nets will also be cleaned after harvesting is completed and prior to cages being transferred to other BMAs. Routine checks of equipment utilizing underwater cameras, ROVs, and inspections by divers (as needed) will be used to confirm the cleaning schedule of the sea cages. Personnel will be required to change into designated work clothing and boots upon arrival at the sea cage site. Personnel gear will be cleaned and disinfected on a routine schedule. Personnel will be transported from designated crew change sites (i.e., proposed at Petit Forte and Long Harbour). These crew change sites will have designated areas for embarkation and disembarkation to the sea cage sites, which are designed to avoid contamination. The proposed Petit Forte and Long Harbour sites will only be used for crew changes (via dedicated crew vessels). Resupply sites are proposed at two former OCI premises; one in Marystown and one in Burin (see Section 2.4.2.2). Grieg NL will use these sites for transporting equipment and supplies (primarily via service vessels) to (inflow) and from (outflow) the sea cage sites. Additional, one of the resupply sites designated outflow will receive waste from the sea cage sites. Service vessels (and the associated movement of equipment, supplies and waste) will not use the Petit Forte or Long Harbour stations. The use of separate resupply sites is designed to avoid contamination.

As discussed below, fish mortalities will be removed from each sea cage on a daily basis. When handling mortalities from the sea cages, personnel will be required to wear rain gear, gloves, and boots which will be disinfected after each mortality disposal. Once at the surface, the dead fish are transferred to a designated and approved container on the feed barge for ensilaging; there will be limited personnel access to the ensilage container.

(3) *Health Checks and Procedures*: Fish health (salmon and lumpfish) at the sea cage sites will be monitored by Grieg NL personnel following the procedures as prescribed by the Aquatic Animal Health Division. Fish are routinely monitored by staff for not only physical changes such as signs of fin erosion, lesions, pigmentation problems, parasites and deformities but will also include monitoring of fish behaviour changes. As part of

Grieg NL's Fish Health Management Plan (Appendix K), an active and passive surveillance program will be implemented in cooperation with a private veterinarian as well as the provincial veterinarian. Grieg NL personnel will be trained and aware of the importance of noticing and reporting to supervisors any noticeable changes (physical and behavioural). This health surveillance program will apply to both farmed Atlantic salmon and the cleaner lumpfish held in the sea cages. Three of the most common types of pathogens that can cause issues with fish at the sea cage sites are viruses, bacteria and parasites (i.e., sea lice). Many of these pathogens are considered to be opportunistic and can create a serious health challenge especially if the fish are exposed to stressful events or prolonged sub-optimal conditions. Care is taken throughout, to ensure the effects of necessary stressful events are kept to a minimum with sufficient recovery time allocated between stressors. Proper husbandry practices are put in place to ensure overall general hygiene is kept up to standard and proper disinfections procedures are put into place. Routine parasite screening will be carried out as well as routine diagnostic testing. All routine parasite screening and active surveillance will be conducted by Grieg NL personnel on a schedule determined in consultation with provincial authorities and a private veterinarian that also considers fish health and welfare. In addition to the active surveillance by Grieg NL, a passive surveillance program along with diagnostic testing will be performed by provincial veterinarians.

Grieg NL will aim to avoid the use of antibiotics. There are some potential pathogens that may require treatment and each case will be assessed in consultation with Grieg NL's private veterinarian and the provincial veterinarian. Any antibiotic use will be with approved products, judicious use and under prescription. An example would be Enteric Red Mouth disease (ERM) that is caused by a bacterium that has a wide host range and a broad geographical distribution but can be treated before it becomes a chronic issue. Grieg NL will only utilize antibiotics as a last resort based on recommendations of health authorities such as the private and provincial veterinarians in consideration of the health and welfare of the fish.

Grieg NL will be using a sea cage net which extends 45 m below the water surface. This relatively deep net has sufficient volume to allow fish to swim to depths that will allow it to avoid unsuitable surface conditions (e.g., water temperature, sea lice, and waves) and thereby decrease stress on the fish. In addition, the grow-out plan is that fish will only spend one winter at sea; this minimizes the risk of fish mortality.

(4) *Specialized Feed and Feeding Procedures*: Grieg NL will use an established feed adjusted to meet the requirement of sterile triploid all-female salmon. More specifically, the feed has been developed to minimize mandible and spinal deformities as well as the development of cataracts in triploid salmon. Grieg NL will utilize a major supplier for its sterile triploid all-female salmon feed at the sea cages. All the feed will be CFIA and EU approved. Feed wastage will be minimized via the use of established feeding tables/software used to determine feed type and amount and an automatic feeding system which integrates video monitoring in the sea cages. Salmon will be monitored during feeding and once salmon have reached ~80% satiation, feed delivery will be ceased. Cameras mounted in the sea cages will provide staff with a view of the feeding behaviour of fish and feed can be stopped as soon as reduced feeding behaviour is noticed. This system optimizes feeding by providing only enough feed to satisfy the fish while reducing nutrient inputs into the environment.

(5) *Sea Lice Control*: Sea lice levels on salmon will be monitored weekly (anaesthetizing a sub-sample of fish and counting the sea lice at various life stages) when water temperatures are above 4˚C and weather conditions allow. In consideration of fish health and welfare, when water temperatures are below 4˚C, physical monitoring as noted above will be less frequent and will be based on advice of a veterinarian; however, weekly monitoring by underwater cameras will be conducted. Grieg NL will use an adaptive management approach involving several methods to control sea lice in a given sea cage site and across BMAs. Lumpfish will be used as a cleaner fish to minimize sea lice occurrence on salmon in all sea cages. Lumpfish naturally exhibit a "scan-and-pick" feeding behaviour and have been successfully used as cleaner fish in other cold-water aquaculture projects (see Section 2.4.4.2). If monitoring indicates an increase in sea lice levels, guidance will be acquired from private and provincial veterinarians. If sea lice levels require implementation of additional mitigation measures beyond the use of cleaner fish at a given sea cage site, Grieg NL will implement further preventative mitigation measures at other active sea cage sites in all BMAs. These measures would include the use of sea lice skirts and delivering feed through a dispenser located ~6–7 m below the surface (i.e., via a sub-feeder). These measures will be done in combination with the use of functional feed (Jensen et al. 2015). Functional feed has been developed to inhibit sea lice by increasing mucous production on the salmon skin, thereby making it more difficult for sea lice to attach to the salmon. The use of a sub-feeder will be considered for use when feeding with functional feed. This will motivate the fish to stay under the main sea lice area by receiving the feed at ~6–7 m below the surface. The use of a sea lice skirt will add one more extra barrier for the sea lice, which in combination with the above would reduce the sea lice pressure even further. If the use of all these measures is not successful at controlling sea lice, Grieg NL will once again consult with private and provincial veterinarians. At this stage, three options will be considered: the use of a "Thermolicer", therapeutants, or harvesting the fish. If required, therapeutants (e.g., SLICE) would be administered in the feed of the fish. The use of SLICE will be considered based on the advice from the private and provincial veterinarian and what stage of the production cycles the affected fish has reached. The Thermolicer® works by exposing fish and sea lice to 30–34°C water for ~25–30 seconds. The sea lice have a much lower tolerance to this warm water than the fish do and fall off and die when exposed to these conditions. A dedicated vessel is used for treatment. The sea lice are removed when exposed to warm water and the fish are then sent back to the sea cage[10]. Depending on the size of the fish, it is also possible that the fish will be harvested early to minimize sea lice. Delousing efforts will be balanced against fish welfare, avoiding resistance and with regard to the effects on the environment. Continuous monitoring and response is important to ensure sea lice levels remain low and the use of therapeutants can be minimized or eliminated.

(6) *Water Quality Monitoring*: A routine program will be established for monitoring, measuring, and recording water quality at all active sea cage sites on a daily basis throughout the Project. In-situ data loggers will be installed on the barges at each sea

[10] The Steinsvik Thermolicer was tested by the Norwegian Veterinary Institute and they determined that "thermal de-licing results in a significant reduction in the number of mobile and adult lice" (Viljugrein et al. 2015). They also stated that "Thermal delicing is a new method without chemicals which can be used as an alternative to pharmaceuticals, and should be used together with other measures as an overall strategy against lice" (Viljugrein et al. 2015). Steinsvik has reached an agreement with a third-party supplier in Newfoundland to offer this system. Grieg NL will sign an agreement with Steinsvik to use this system in the future as necessary.

cage site as well as on each individual cage. In addition, sensors can be attached to cameras and buoys located at the perimeter of each sea cage site. These in-situ loggers will collect data on water temperature, oxygen levels, current speed and direction, as well as pH and salinity. Data will be wirelessly transmitted to centralized computer stations on the barges and at the control center in Marystown for real-time viewing or logged for historical collections. Plankton samples will be completed weekly, analyzed and levels recorded. This will be one of the information sources used to create net cleaning schedules. Data collection will be used to evaluate the severity of any environmental issues such as fouling or changes in physio chemical data, leading to a response. Environmental changes and plankton levels are rated and depending on the results various mitigation responses are initiated. During transport of smolt from the RAS Hatchery to the sea cage sites, water quality in the hold of the well boat will be monitored.

(7) *Vaccinations*: As discussed above, prior to transfer to sea, salmon will be vaccinated as per the specific recommendations of provincial veterinarians. Vaccines in NL must be approved by the Chief Aquaculture veterinarian (DFLR). Typical vaccinations include the standard bacterin with *Aeromonas salmonicida*, *Listonella anguillarum* and *anguillarum* type II, and *Vibrio salmonocida*. Grieg NL will also include the BKD and the ISA vaccine based on consultations and recommendations with health authorities (DFLR and a private veterinarian). The lumpfish will also receive vaccinations as recommended by provincial veterinarians prior to transfer to sea. Currently lumpfish vaccinations can be administered as a dip-vaccine or injected. Lumpfish dip-vaccines are commonly administered to protect against one or more variants of *Vibrio* bacteria. Injection vaccinations for lumpfish target *Aeromonas salmonicida* type V and type VI as well as some *Vibrio* bacteria. Grieg NL will communicate with suppliers of the lumpfish to ensure the appropriate vaccination regime for the lumpfish has been administered prior to accepting delivery of lumpfish to its sea cages.

(8) *Mortality Removal and Treatment*: Grieg NL will use an automatic system (i.e., Mortex system; see Section 2.4.4 for details) that removes dead fish from the bottom of the sea cage each day or more frequently as required. Any visible moribund fish or surface mortalities will be retrieved and moribund fish will be euthanized if required. By collecting mortalities daily this will decrease predator attraction to the cages and minimize disease risk. The number of fish mortalities will be recorded daily. When handling moribund fish from the sea cages, personnel will be required to wear rain gear, gloves, and boots which will be disinfected after each mortality disposal. Once at the surface, the dead fish are transferred to a designated and approved container on the feed barge for ensilaging; there will be limited personnel access to the ensilage container. The dead fish are ground into a slurry and acid is added to lower the pH. The ensilage will be transferred to shore once sufficient quantities are amassed. If a mass mortality occurs, an Emergency Response Plan will detail procedures (Appendix T).

***Pathogen/Parasite Transfer between Farmed and Wild Atlantic Salmon***

There is risk that disease and parasites may be transferred between farmed and wild Atlantic salmon (as well as other wild fish). Similarly, there is risk that disease and parasites may be transferred between farmed and wild lumpfish (as well as other wild fish). There are two primary way of minimizing this risk: decrease the potential for interactions between farmed and wild fish, and maintain healthy farmed fish. Procedures for fish health maintenance, including vaccination, were detailed above. The proposed sea

cage sites were selected in part because they are relatively distant from the mouths of rivers where salmon may return to spawn. The majority of scheduled rivers are located more than 50 km away from the proposed sea cage sites. Only the sea cage sites in the Rushoon BMA are located <20 km from a scheduled salmon river. Interactions with wild Atlantic salmon can also be minimized by reducing attraction of these fish to the sea cage sites. Wild Atlantic salmon may be attracted to feed and potential increased prey at the sea cage sites. As noted above, feed wastage will be minimized via the use of established feeding tables/software used to determine feed type and amount and an automatic feeding system which integrates video monitoring in the sea cages. Salmon will be monitored during feeding and once salmon have reached ~80% satiation, feed delivery will be ceased. The daily removal of fish mortalities (weather dependent) is also intended to indirectly decrease the attraction of wild Atlantic salmon. Fallowing of the sea cage sites will also decrease the accumulation of organic materials and hence, potential attraction of wild Atlantic salmon to the sea cage sites and decrease the potential for parasite transfer.

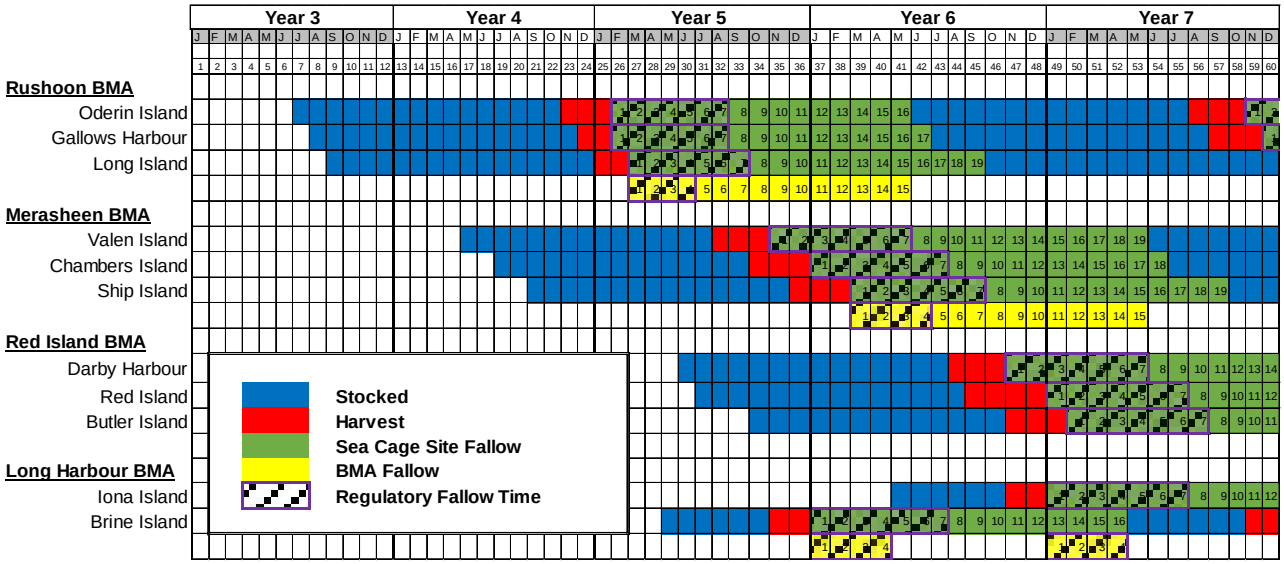
***Effects on Marine Habitat***

Several mitigation measures and monitoring procedures will be implemented to minimize the effects of sea cage operations on the marine environment—namely to protect fish and fish habitat beneath and surrounding the sea cages from the nutrification effects of deposition of biochemical oxygen demand (BOD) matter (fish feces, uneaten fish feed, and naturally occurring biofouling material). Some of these mitigation measures also serve to minimize deposits in waters frequented by marine mammals, sea turtles, and seabirds.

One of the first steps is selecting proposed sea cage sites that meet the requirements of the AAR and DFLR's Aquaculture Licence Application process. Relative to effects on fish and fish habitat, proposed sea cage sites were selected based on sufficient current velocity and direction necessary to minimize depositional build-up, adequate water depth for sea cages, and suitable bottom type (i.e., >50% hard bottom) [Other factors included protection from predominant direction of sea states and swell, distance from scheduled salmon rivers, location relative to other human activities, distance from municipal sewage outfalls, and location relative sensitive habitat and areas.] Further details on site selection are provided in LGL (2018b in Volume 3).

Fallowing (leave the site without fish) is another key mitigation measure designed to minimize the effects of aquaculture on marine habitat. Atlantic salmon aquaculture sites in Newfoundland and Labrador are located predominantly over hard bottom substrates where it is difficult to consistently obtain sediment samples. The primary mitigation measure to manage potential effects from uneaten feed and feces is to fallow at the end of each production cycle. In Newfoundland and Labrador, the mandatory fallowing time after harvesting is seven months for a sea cage site and four months for a BMA. Grieg NL will increase this fallowing time for sea cages to a minimum of 16 months and a maximum of 19 months after harvesting and BMA fallowing time will range from four to seven months. This results in increased time for the benthic community to recover. A detailed fallowing schedule for each of the proposed sea cage sites is provided in Table 2.20. Follow-up monitoring to evaluate nitrification effects from deposition of BOD will be conducted at each of the sea cage sites. The *Monitoring Protocol for Hard Bottom Benthic Substrates under Marine Finfish Farms in Newfoundland and Labrador* (AAR, Annex 9; GC 2015) will be followed. Additional details are provided in in LGL (2018b in Volume 3).

**Table 2.20. Grieg NL fallowing schedule for each proposed sea cage site relative to the minimum regulatory fallowing schedule.**




Grieg NL will not use pesticides and disinfectants at its sea cage sites. Therapeutants and antibiotics will only be used based on advice of health care professionals (private and provincial veterinarians) and in consideration of the health and welfare of the fish. Biodegradable detergents will be used during routine cleaning of the net collar and after harvesting and during fallowing. Feed wastage will be minimized via the use of established feeding tables/software used to determine feed type and amount and an automatic feeding system which integrates video monitoring in the sea cages. Salmon will be monitored during feeding and once salmon have reached ~80% satiation, feed delivery will be ceased. Cameras mounted in the sea cages will provide staff (located in the control room on the feed barge and/or located remotely) with a view of the feeding behaviour of fish and feed can be stopped as soon as reduced feeding behaviour is noticed. This system reduces nutrient inputs into the environment by optimizing feeding.

Husbandry practices designed to minimize biofouling will also serve to mitigate effects on the marine environment. As overviewed above, Grieg NL will adhere to a schedule to clean its sea cages to minimize biofouling (which can affect the integrity of the cage). The cleaning schedule for cages and nets will be developed based on environmental conditions in Placentia Bay as well as routine monitoring. Nets will typically be cleaned weekly (via a ROV net cleaner equipped with an advanced camera system) and cages will be cleaned once or twice during heavy fouling periods. Cages and nets will also be cleaned after harvesting is completed and prior to cages being transferred to other BMAs. Routine checks of equipment utilizing underwater cameras (e.g., SmartEye Twin 360), ROVs, and inspections by divers (as needed) will be used to confirm the cleaning schedule of the sea cages. Grieg NL will ensure equipment has minimal fouling.

Grieg NL will assist DFO's monitoring program for Non-Native/Aquatic Invasive Species and regularly examine cages and mooring equipment for Aquatic Invasive Species occurrence. This includes reporting any incidence of green crab.

***Entanglement***

It is possible that marine mammals, sea turtles, river otters, wild fish, and birds may become entangled in the sea cage nets and in the case of some animals in the associated mooring and buoy lines. Sea cage mooring and buoy lines will be kept tensioned and there will be no loose ropes in the water. If a bird becomes entangled Grieg NL will follow established procedures to release the bird (which will be developed in consultation with ECCC-CWS). Grieg NL will have a Migratory Bird Handling Permit (issued by CWS) in place and will follow reporting requirements. Each sea cage is equipped with one or two video cameras with 360 degree viewing and which can be raised and lowered within the water column; this will allow for regular monitoring of entanglements. Any entanglement of marine mammals, otters, wild fish, and sea turtles will be reported to DFO and action will be taken, in consultation with DFO (and the Whale Release and Strandings Group), to free or remove the animal. In extreme circumstances, if all methods have failed to release an animal and it is posing a serious threat to the integrity of the nets (or the safety of personnel), lethal measures may be considered. Before such actions are taken, DFO will be consulted.

***Waste and Waste Management***

As noted earlier, sea cage sites will produce a variety of wastes during operation. Table 2.19 provides an overview of the types of waste and how wastes will be managed. Additional details are provided in the Waste Management Plan (Appendix J).

***Greenhouse Gas Emissions***

The atmospheric emissions from Project activities at the sea cage sites will be those from the Project vessels' engines and generators and will be within the range of emissions from typical marine vessels on the east coast, such as fishing, research, or offshore supply vessels. The feed/accommodation barges which will continuously attend the sea cage sites will be anchored and therefore, will only operate generators. The newly constructed service vessels will have engines which are designed to minimize emissions and will comply with the new Tier Three Regulations of Transport Canada (and with Annex VI of MARPOL 73/78).

***Interactions with Other Users***

Grieg NL will use several techniques to ensure other users of Placentia Bay are aware of the sea cage operations and to minimize the potential for interactions with users of the area. Firstly, Grieg NL has undertaken consultations with local users of the BMAs to discuss proposed locations of the sea cages sites. Discussions focused on whether commercial fisheries and associated transit routes to fisheries areas overlapped with the sea cage sites. Additionally, routing to cabins on islands near the proposed sea cage sites were discussed during consultations (Appendix D). Final placement of sea cage sites will be determined through the provincial lease process and in consultation with local fishers and other stakeholders.

Each sea cage site will be clearly marked according to regulatory requirements. Sea cage sites will be delineated with a series of highly visible marker buoys, radar reflectors, and strobe lights. To maintain site biosecurity, only Grieg NL personnel, vessels, and third-party providers are recommended to occur within the delineated marker buoys of the sea cage site. In addition to increasing biosecurity, these marker buoys will also provide guidance for any other users (i.e., crab or cod fishermen) to avoid entanglement. The marker buoys for the cage sites will be beyond the mooring lines of the cages. Therefore, any activities conducted outside the delineation marker buoys will avoid interaction with any of the cage site

equipment and moorings. Grieg NL will have established transit routes with vessel speed limits (10 knots or 18.5 km/h) from crew change sites (proposed for Petit Forte and Long Harbour), resupply sites (proposed for Marystown and Burin), and the RAS Hatchery to each of the sea cage sites. Several communication tools will be used to make information on sea cage site, Project vessels, transit route locations, and/or major project activities (e.g., towing sea cages to the BMAs) available to the public including:

- Location and navigation markings for sea cage sites and descriptions of Project vessels will be provided to official marine information systems (i.e., Notice to Mariners and Notice to Shipping) and the Placentia Bay Traffic Committee;
- Announcements on the Fisheries Broadcast;
- Posters with key information about the sea cage sites will be placed at marinas in Placentia Bay communities;
- Meeting with the Placentia Bay vessel pilots to familiarize them with location and structure of the sea cages and sea cage operations;
- Grieg NL will work with Harbour Authorities and post notices about the sea cage locations and navigational aids to recreational fishers at the key wharves for recreational boaters in Garden Cove, Swift Current, Arnold's Cove and Southern Harbour and others as requested;
- Sea cage locations and markings information will be provided to the Placentia Bay Integrated Management Planning Committee (PBIMPC) as well as updates regarding the activities planned for the BMAs (e.g., when there will be harvesting, when cages will be removed for fallowing);
- The Marystown Harbour management will be informed about activities at the RAS Hatchery, in particular when fish are being transferred to sea or a large vessel is due in port;
- On-going meetings with local stakeholders; and
- Notifications on Grieg NL and local town websites.

A Placentia Bay Traffic Committee, chaired by the CCG, has been in place for many years as a forum for all marine users of the Bay to address traffic issues and concerns in the area (NLRC 2007). As a member of the marine community of Placentia Bay, Grieg NL will participate on this Committee in order to remain informed about concerns and changes to vessel traffic in the bay.

With the exception of the two proposed seasonal sea cage sites near the islands (Iona and Brine Islands) outside the entrance to Long Harbour, the proposed sea cage sites in Rushoon, Merasheen, and Red Island BMAs are clear of the areas usually used by commercial large vessel traffic.

Large vessels associated with the Project will be equipped with Automatic Identification System (AIS), and any Project vessel crossing the Vessel Traffic Separation Scheme lanes in Placentia Bay will call into the CCG Placentia MCTS.

***Vessel Operations***

Good husbandry and a strong pollution prevention focus in operating procedures are essential. Grieg NL will include this message in its training and orientation information and presentations and maintain an ongoing environmental awareness program for marine operations. Environmental protection measures related to vessel operations will include:

- All Project-related vessels must be in good working order, and all efforts must be made to avoid the discharge of oils, fuels or other such compounds into the marine environment. Bilge dumping will be strictly prohibited. Project vessel crews must remain mindful of wind and sea conditions and forecasts. Project vessels' maximum speed is 10 knots (18.5 km/h).
- Waste management will be consistent with industry best practices. No waste of any kind is permitted to be thrown overboard. Any garbage generated is to be collected and separated in accordance with MARPOL 73/78 Annex IV: Pollution by Sewage from Ships, and Annex V: Pollution by Garbage from Ships. Air emissions will be those associated with standard operations for marine vessels, in accordance with MARPOL 73/78 Annex VI: Regulations for the Prevention of Air Pollution from Ships.
- Fuel for the barges will be delivered by a third-party service provider. Refueling will be conducted in accordance with the *Canada Shipping Act* and follow Transport Canada's procedures for the refueling of small commercial vessels. Grieg NL will have spill kits and procedures in place on the feed/accommodation barge(s) in each of the BMAs. Details will be in the Emergency Response Plan.
- Grieg NL's Environmental Protection Plan will identify sensitive areas and times of year for each of the BMAs, and specify any additional precautions that are to be taken by Project vessels.
- Should vessels associated with the Project require transit in the vicinity of any of the designated areas containing breeding seabird colonies, they are to abide by safe distance regulations in accordance with the area in question, and avoid disturbing the birds to the extent possible, particularly during breeding seasons.
- All vessels will exercise caution with respect to whales and sea turtles and, if sighted, slow, then maintain speed and direction.

***Species at Risk***

Grieg NL will record sightings of any species considered at risk observed at the sea cage sites and during transit to the sea cage sites. Personnel will receive training from experienced biologist(s) on the identification of the various bird, marine mammal, shark/tuna, and sea turtles and the associated data recording procedures. Data will be submitted to DFO and ECCC-CWS as appropriate.

***Sensitive Areas***

The whole of Placentia Bay is considered an Ecologically and Biologically Significant Area, the Placentia Bay Extension EBSA. As described later, there are many unique attributes and sensitive areas within the Placentia Bay EBSA. The primary mitigation measure for many of the sensitive areas in the Study Area is avoidance. Grieg NL's proposed sea cage sites are located well away from Important Bird Areas (IBAs) and Provincial Protected Areas (see Figure 4.12 later). The proposed sea cage sites are also located outside of proposed leatherback sea turtle critical habitat.

***Site Security***

Security procedures and infrastructure will be in place at the sea cage sites. Each active sea cage site will have Grieg NL personnel on site at all times (i.e., "24/7") with the exception of during extreme weather events. As discussed above, it is recommended that only Grieg NL personnel, vessels, and third-party providers travel within the sea cage sites. Personnel will visually scan for security breaches such as unauthorized persons on sea cage collars. In addition, a CCTV system will be installed around the sea cages and will be monitored primarily by personnel on the feed/accommodation barge and in the Security

Control Room at the RAS Hatchery. In the unlikely event of serious security breaches (such as vandalism or persons refusing to leave the site), Fisheries Officers from DFO will be contacted and respond to the scene.

***Emergency Response/Contingency Plan***

Grieg NL will have in place an Emergency Response Plan detailing procedures to respond to accidents, malfunctions, and emergencies at the sea cage sites and transport corridors to the sea cage sites (Appendix T). Procedures will be in place for a security breach, mass fish mortality, escape of fish, spills of hazardous substances, and response to a serious fish health incident. Grieg NL will also have appropriate Safety Plans in place for personnel and vessel operations.

#### 2.5.2.3 Decommissioning and Rehabilitation

As with the RAS Hatchery, a decommissioning plan will be developed with input from appropriate regulatory agencies that outlines procedures for shutting down Grieg NL operations at the sea cage sites. The decommissioning plan will clearly lay out the approach and mitigation and monitoring details regarding removal of all fish and fish products, waste, chemicals, equipment and infrastructure and restoration of the aquatic environment (as per the AAR).

## 2.6 Personnel Requirements

As noted earlier, Grieg NL recognizes that aquaculture represents a significant industrial opportunity for Canada and in particular, the province of Newfoundland and Labrador. Grieg NL is committed to providing full and fair opportunity to Canadians and in particular, residents of Newfoundland and Labrador to gain meaningful employment from the Project. Furthermore, Grieg NL is committed to diversity in the workplace and believes strongly in non-discrimination with a focus on personnel that are committed, dedicated and knowledgeable in their area of expertise or have a strong willingness to learn and grow. It is these qualities that Grieg NL intends to pursue to build a team that will continue to support the Grieg Group of companies' values and principles. Grieg NL recognizes that diversity in the workplace promotes not only different perspectives but also opinions that can in turn provide varying approaches and solutions and therefore, will be embracing such diversity in its workforce.

Details of Grieg NL's personnel requirements including projected workforce by month and hiring practices including those related to employment equity are provided in the Workforce and Timeline document (Appendix X) and the Women's Employment Plan (Appendix Y). Personnel requirements for the RAS Hatchery and sea cage sites are summarized below.

### 2.6.1 RAS Hatchery

During the construction and operational phases of the RAS Hatchery, it is anticipated that there will be a maximum of 200 and 36 jobs, respectively (Table 2.21).

### 2.6.2 Sea Cage Sites

During the construction and operational phases of the sea cage sites, it is anticipated that there will be a maximum of 12 and 137 jobs, respectively (Table 2.22).

**Table 2.21. Numbers and types of occupations estimated for the RAS Hatchery during construction and operation.**

| Occupation | NOC Code (2011) | Full Time/Part Time | Max. No. of Positions | Grieg NL or Contractor (CT) | Years Required |
|---|---|---|---|---|---|
| **RAS HATCHERY (Construction Phase)** | | | | | |
| Engineering Manager | 0211 | FT | 3 | CT | Year 1–5 |
| Civil Engineers | 2131 | FT | 2 | CT | Year 1–5 |
| Civil Engineering Technologists | 2231 | FT | 2 | CT | Year 1–5 |
| Drafting Technologists/Technicians | 2253 | FT | 1 | CT | Year 1–5 |
| Land Survey Technologists/Technicians | 2254 | FT | 1 | CT | Year 1–5 |
| Construction Inspector | 2264 | FT | 4 | CT | Year 1–5 |
| Electrical Power Line and Cable Workers | 7244 | FT | 5 | CT | Year 1–5 |
| Telecommunication Line and Cable Workers | 7245 | FT | 5 | CT | Year 1–5 |
| Steamfitters, Pipefitters and Sprinkler System Installers | 7252 | FT | 20 | CT | Year 1–5 |
| Welder | 7237 | FT | 10 | CT | Year 1–5 |
| Carpenters | 7271 | FT | 20 | CT | Year 1–5 |
| Concrete Finisher | 7282 | FT | 20 | CT | Year 1–5 |
| Heavy Equipment Mechanics | 7312 | FT | 4 | CT | Year 1–5 |
| Crane Operators | 7371 | FT | 2 | CT | Year 1–5 |
| Truck Drivers | 7511 | FT | 5 | CT | Year 1–5 |
| Heavy Equipment Operators | 7521 | FT | 4 | CT | Year 1–5 |
| Construction Labourers | 7611 | FT | 92 | CT | Year 1–5 |
| **TOTAL** | | | **200** | | |
| **RAS HATCHERY (Operation and Maintenance Phase)** | | | | | |
| Senior Management | 0016 | FT | 1 | Grieg NL | 2016- |
| Maintenance Manager | 0714 | FT | 1 | Grieg NL | Year 1 onward |
| Production Manager | 0911 | FT | 1 | Grieg NL | 2016- |
| Aquaculture Managers | 0823 | FT | 7 | Grieg NL | 2016- |
| Aquaculture Technicians | 2221 | FT | 19 | Grieg NL | Year 1 onward |
| Aquaculture Technicians | 2221 | PT | 6 | Grieg NL | Year 2 onward |
| Power Systems Electrician | 7202 | FT | 1 | Grieg NL | Year 2 onward |
| **TOTAL** | | | **36** | | |

Note: Relative to the occupations listed in the Workforce and Timeline document (Appendix X), during Operations and Maintenance, welder, heavy equipment operator and air conditioning mechanic titles were removed and these three FTE are now listed as Aquaculture Technicians (which increased from 16–19).

**Table 2.22. Numbers and types of occupations estimated for the sea cage sites during construction and operation.**

| Occupation | NOC Code (2011) | Full Time/Part Time | Max. No. of Positions | Grieg NL or Contractor (CT) | Years Required |
|---|---|---|---|---|---|
| **SEA CAGE SITES (Construction Phase)** | | | | | |
| Captains | 8261 | FT | 1 | CT | Year 1 |
| Engineering | 0211 | FT | 1 | CT | Year 1 |
| Deck Hands | 8441 | FT | 6 | CT | Year 1 |
| Electrical Industrial | 7242 | FT | 1 | CT | Year 1 |
| Welder Operator | 7237 | FT | 1 | CT | Year 1 |
| Heavy Equipment Mechanic | 7312 | FT | 1 | CT | Year 1 |
| Crane Operator | 7371 | FT | 1 | CT | Year 1 |
| **TOTAL** | | | **12** | | |
| **SEA CAGE SITES (Operation and Maintenance Phase)** | | | | | |
| Senior Managers | 0016 | FT | 2 | Grieg NL | 2016- |
| Supervisor General Officer | 1211 | FT | 1 | Grieg NL | Year 2 onward |
| Supervisor Financial | 1212 | FT | 1 | Grieg NL | 2016- |
| Human Resources Officer | 1223 | FT | 1 | Grieg NL | 2016- |

| Occupation | NOC Code (2011) | Full Time/Part Time | Max. No. of Positions | Grieg NL or Contractor (CT) | Years Required |
|---|---|---|---|---|---|
| Administrative Assistant | 1241 | FT | 1 | Grieg NL | Year 1 onward |
| Maintenance Manager | 0714 | FT | 1 | Grieg NL | Year 1 onward |
| Production Manager | 0911 | FT | 1 | Grieg NL | Year 1 onward |
| Aquaculture Managers | 0823 | FT | 7 | Grieg NL | 2016- |
| Aquaculture Technicians | 2221 | FT | 39 | Grieg NL | Year 2 onward |
| Captains | 8261 | FT | 16 | Grieg NL & CT | Year 2 onward |
| Deck Hands | 8441 | FT & PT | 38 | Grieg NL & CT | Year 2 onward |
| Aquaculture Labourers | 8613 | FT & PT | 29 | Grieg NL | Year 2 onward |
| **TOTAL** | | | **137** | | |

Note: Relative to the occupations listed in the Workforce and Timeline document (Appendix X), during Operations and Maintenance, crane operator, welder, heavy equipment mechanics and power systems electrician were removed and these 12 FTE are now listed as technicians (increase from 33–39), deck hands (increase from 36–38), and labourers (increase from 25–29).

## 2.7 Alternatives

This section presents a summary of the process used to select the proposed undertaking, with a focus on the advantages and disadvantages to the environment of the undertaking as proposed. A comparative overview analysis is presented of factors relevant to the decision-making process. In doing so, insight is provided into the functionally different methods available to meet the project need and to achieve the project purpose. As well, reference is made to the influence that market conditions and regulatory circumstances have had on selection of the preferred and proposed undertaking. Following a brief discussion of alternatives to the Project, attention is then focused on alternatives within the project (i.e., alternative means to carry out the proposed undertaking).

In considering potential alternatives both to and within the Project, Grieg NL has assessed a number of evaluation criteria described below.

### 2.7.1 Evaluation Criteria

The criteria listed in the EIS Guidelines that were used to support the comparative evaluation of alternatives include:

- Environmental effects – anticipated biophysical effects associated with construction, operation, closure, and decommissioning.
- Technical feasibility – limits of technology and availability or proposed utilization of “best available proven technology”.
- Economic feasibility – net financial benefits of the undertaking to the proponent, to the Province and to its residents.
- Market access – ability to access markets using available routes in a manner and timeframe that can meet market requirements.
- Regulatory regime – influence of the regulatory regime on the effectiveness of operations and attractiveness of an alternative.

Each evaluation criterion was assigned a rating across a range of -3 to +3. The proposed Project, the base case, was assigned a value of zero for each criterion. The other alternatives were considered in comparison to the proposed Project and assigned a relative value. A negative value for a criterion indicates that the Alternative under evaluation is less favourable compared to the proposed Project, while

a positive value indicates that the Alternative under evaluation is more favourable compared to the proposed Project. Where no distinction between the two scenarios can be made, a zero value is assigned.

### 2.7.2 Alternatives to the Project

Realistically, the only alternative to the Project is 'No Project'. Therefore, the two scenarios identified for evaluation and comparison include:

- *Proposed Project*: represents the undertaking as proposed and described in this EIS; and
- *Alternative, No Project*: represents the situation where the Project does not commence. Such an outcome would have obvious consequences (i.e., neither benefits nor environmental effects).

For the proposed Project, a much more detailed consideration of factors is presented elsewhere in the EIS. For the "No Project" alternative, the consideration takes into account the forecasted situation within the Province over the time frame of the proposed undertaking.

#### 2.7.2.1 Assessment

Table 2.23 provides an overview of the analysis conducted to compare 'Proposed Project' with the Alternative, 'No Project'.

**Table 2.23. Summary Analysis of Alternative to the Proposed Project.**

| Scenarios | Evaluation Criteria | | | | |
|---|---|---|---|---|---|
| | Environment | Technical | Economic | Market | Regulatory |
| Proposed Project | 0 | 0 | 0 | 0 | 0 |
| Alternative, No Project | +3 | -2 | -3 | -2 | na* |
| * denotes not applicable | | | | | |

As indicated in Table 2.23, the Alternative, No Project, has a rating for 'Environmental Effects' that is more favourable than that for the Proposed Project. There would be fewer biophysical environment issues associated with the Alternative, No Project than with the Proposed Project. The other four criteria have lower ratings for the Alternative, No Project than for the Proposed Project. There would be a high loss in economics with the absence of the Project, combined with reduced market access for the local industry and reduced exposure to and utilization of the technical innovations associated with the proposed undertaking. The economic effect extends beyond the lost opportunity for Grieg NL. The Placentia Bay region would lose employment opportunities related to the RAS Hatchery, as well as jobs on the marine side. A series of contracted services would be lost, as would spin-off opportunities in the processing sector. Overall, the Alternative, No Project is considered less favourable than the Proposed Project.

### 2.7.3 Alternatives within the Project

A set of credible alternatives within the Project have also been identified. The selected alternatives reflect choices about geographic location as well as applicable technology. The latter varies between employing existing technologies as currently practiced in Newfoundland and Labrador, through to the application of new yet unproven technologies that are under development.

The three scenarios identified as alternatives within the Project include:

- *Alternative 1, West Coast Project*: represents a re-location of the proposed Project to an alternate location in the Province. Based on a preliminary evaluation, the most likely alternate location would be on the West Coast of the Island in the Bay St. George and Codroy Valley area, rather than in Marystown and Placentia Bay.

- *Alternative 2, Total 'On Land" Project*: represents an absence of any use of the marine environment for rearing. All growth of fish up to market size would be in tanks on land and utilizing new and emerging technologies.

- *Alternative 3, Conventional Technology Project*: represents the proposed undertaking employing conventional technologies currently employed in Newfoundland and Labrador (i.e., diploid (non-sterile) eggs; conventional sea cages; two year at-sea rearing cycle).

Atlantic salmon aquaculture is a growing industry, with associated technology advancements that serve to improve productivity, while reducing environmental effects and production costs. Thus, there is a selection of available technologies and methods available for consideration. Prior to the comparative analysis involving the proposed Project and the three alternatives within the Project described above, this section describes some key production methods and strategies associated with salmon aquaculture. The relevant methodological and strategic choices made by Grieg NL for its proposed Project are also discussed.

### 2.7.3.1 Background: Combination of Land-based and Marine-based Farming

Salmon farming (from egg to harvest) requires a combination of land-based and marine-based farming. Historically, salmon farmers would base their production schedule on culturing diploid smolt from egg to ~50–100 g in a land-based facility (flow-through, recirculating or partial recirculating) before transfer to sea for continued grow-out in the marine environment. Traditionally, land-based systems for the culturing egg to smolt (~50–100 g) have been flow-through systems. Water was pumped into a facility for the developing salmon and after passing through culture tanks was discharged into the environment. Little to no filtration or reuse of the discharge water occurred. A recent advancement that has received attention for salmon farming is the use of closed-containment systems that isolate the culture environment from the surrounding ecosystems and focuses on production from egg to harvest size in a controlled environment. An example of such a closed-containment system is a land-based RAS. The current preferred alternative to culture Atlantic salmon is a combination of longer land-based production in a closed-containment RAS to a size of 200 g or larger, followed by continued grow-out to harvest size in the marine environment. This approach takes advantage of the closed-containment system to reduce (but not eliminate) a growth period at sea. The method of using a combination of land-based RAS and sea-based cages, which is predominately used today by industry, is very similar to the proposed method by Grieg NL. There are, however, some notable features of the Grieg NL proposal that represent improvements over the existing, approved approaches.

All methods of growing salmon from egg to 50 g use a land-based RAS similar to that which is currently proposed by Grieg NL for the production of this size fish. Typically, most combination land and sea operations, including those currently in operation in Newfoundland, do not have a Post-Smolt Facility. As such, two years of growth at sea are required before fish reach harvest size.

Grieg NL is planning to farm Atlantic salmon at sea for only one winter. This can be accomplished with the use of an on-land Post-Smolt Facility. The Smoltification Facility will grow fish to a size of 50 g, after which they will be placed in the Post-Smolt Facility and held until they reach a weight of 350–1,400 g before transfer to sea. This increased size greatly reduces the production time in the sea. The approach reduces the time required for fish to reach a harvestable size, while reducing stress and exposure to pathogens such as disease or sea lice. A shorter production time at sea can also decrease the organic deposits that are associated with sea-based culture of fish.

An alternative for the recirculating land-based system would be the use of a flow-through system that pumps water directly from the source into the system with minimal treatment and no reuse. This process would require a water flow of 500,000 L per minute to sustain the quantity of fish that Grieg NL is proposing. The available freshwater source at the proposed RAS Hatchery site would not be able to meet this demand. It is also not possible to produce large smolt without heat control as there would be limited to no growth in the cold winter months, thus a flow-through system would be highly energy inefficient due to heat loss.

In comparison, a RAS Hatchery can be supplied by available groundwater sources, filtered to eliminate any entry of diseases or parasites, heated/chilled if needed, and only use 300 L of water per minute. Importantly, very little waste will be produced. Given these advantages, a flow-through system was rejected by Grieg NL.

The marine environment is an ideal culture environment for Atlantic salmon as this is their natural habitat. Any culture system outside of this will have to attempt to replicate this environment. Choosing areas with ample supply of high quality sea water and located over substrates characterized by otherwise low benthic productivity, can provide salmon farmers a culture environment that does not rely on expensive (economically and environmentally) production methods while meeting the biological needs (water quality) of the salmon. Sea cages utilize ocean currents to move water and provide fresh oxygen to fish (Summerfelt 2012) without any energy cost to the operation, therefore, reducing the carbon footprint of production.

Another advantage of sea cages is their capacity to hold salmon at a density of about 25 kg of fish per cubic metre of water at peak size. For a land-based farm to be profitable, salmon would have to be stocked at a density of 80 kg/$m^3$ or higher (Summerfelt 2012). In the marine environment, fish can be stocked at densities that use less than 4% of the cage space. This allows for natural schooling activity to occur and, in turn this activity produces less stress and consequently a healthier fish.

Marine-based sea cages do have disadvantages. Culturing salmon in a marine sea cage environment results in direct emissions to the surrounding water, including nitrogen and phosphorous. Although farmed salmon will have been vaccinated as well as disease and parasite-free when they enter the marine environment, the fish can contract disease and parasites that are naturally occurring in the ocean (Krkošek 2017). Another disadvantage of marine sea cages is the potential for losses in production due to escapes from the cages. Potentially these escaped fish could interact with wild salmon and compromise the genetic integrity of wild salmon populations. Technological improvements in sea cage systems such as the proposed Aqualine Midgard system by Grieg NL have greatly reduced the potential for escapes to occur. In addition, development and implementation globally of standards such as Norwegian Standards (NS9415) (Jensen 2010) or the Newfoundland Code of Containment play a role in reducing farmed salmon escapes. The utilization of sterile triploid all-female Atlantic salmon for production can eliminate the potential for genetic mixing (Glover 2016).

Grieg NL has concluded that the use of Aqualine Midgard sea cages for completion of the growth cycle, in combination with longer land-based production in a closed-containment RAS, is preferred over available alternative systems.

### 2.7.3.2 Background: Egg Supply

In addition to alternatives to production methods, there are also alternatives to production strategies. Atlantic salmon farming has focused in the past on the culture of mixed-sex diploid Atlantic salmon. However, a majority of fish farmers of Atlantic salmon world-wide have encountered opposition and concerns have been expressed about the potential for genetic compromise of wild salmon progeny in the event of escapes of farmed fish. A strategy alternative that has been used to eliminate potential genetic interaction as well as disturbance of the spawning area in the rivers for the wild salmon is the use of triploid sterile all-female salmon.

Atlantic salmon aquaculture is a growing industry, with associated technology advancements that serve to improve productivity, while reducing environmental effects and production costs. Thus, there is a selection of available technologies and methods available for consideration. The text below provides an overview of the new technologies associated with egg supply.

Farmed Atlantic salmon can be cultured (or purchased) as diploid, triploid, mixed sex of either diploid or triploid and all-female (diploid or triploid). During normal reproductive development, organisms have three sets of chromosomes after fertilization and will typically shed one set of chromosomes. The result is an organism that is referred to as diploid (two sets of chromosomes). However, if this process is interrupted, it is possible for an organism to retain this extra set of chromosomes and become triploid (three sets of chromosomes). This is a naturally occurring phenomenon but can also be induced. The process of triploidy in Atlantic salmon is easy and inexpensive to induce and can be achieved by subjecting a fertilized egg to pressure during specific stages of development. The result is a fish that is sterile and unable to reproduce.

In the early years, the Newfoundland aquaculture industry attempted to develop native Newfoundland and Labrador wild Atlantic salmon broodstock, but these stocks were determined to be unsuitable for aquaculture production. The industry then began the importation of mixed sex, diploid, non-native Saint John River strain Atlantic salmon (DFO 2013). The non-native Saint John River strain of Atlantic salmon is currently the only strain used in commercial production of Atlantic salmon in Newfoundland and Labrador. Commercial suppliers of this Saint John River broodstock (or eggs) for the Newfoundland salmonid aquaculture industry are limited or are partly-privately owned by aquaculture companies. This ownership might result in limits on the availability of eggs and hence, present a commercial risk to the purchaser.

With a single broodstock source (Saint John River) supplying not only Newfoundland but the entire aquaculture industry in Atlantic Canada, should a major disease outbreak occur, it would result in a substantial decrease in the supply of eggs to the industry. Non-native European strain diploid however, is restricted by the Protocol for the Introduction and Transfer of Salmonids NAC (92)24 (Porter 1992). In March 2016, Grieg NL submitted a request to the CFIA and DFO to import non-native European strain triploid Atlantic salmon eggs from Stofnfiskur in Iceland. The importation has been approved by the CFIA and an import permit has been issued to Grieg NL.

Grieg NL has chosen not to use diploids or mixed sex triploids for its proposed undertaking. One of the main issues with land-based production of mixed sex fish is precocious maturation in males. It has been found that up to 30% of males mature early in RAS when the fish are ~1.5–2 kg in weight. They stop

growing, loose coloration and their flesh quality deteriorates making them unsuitable for market. A reason for early maturation is possibly due to an accumulation of female sex pheromones in the RAS (Cowan 2016). Another disadvantage to using diploid salmon occurs during the maturation process when salmon have reduced muscle growth, leading to a smaller fish. Early sexual maturation in farmed salmon inhibits growth, reduces product quality and can lead to more disease and higher mortality.

Another concern is that diploid salmon are fully capable of reproducing and may retain an inclination to return to freshwater to spawn. This increases the risk of compromise to the genetic integrity of wild salmon, i.e., escaped aquaculture fish having the impetus to return to rivers to spawn.

Mixed-sex triploids have also been deemed unsuitable by Grieg NL based on the small percentage of males that, even though functionally sterile, may mature and develop sexual characteristics including reproductive behaviours. This has several implications, including problems within the RAS with hormone accumulation (Warren-Hansen 2015) and effects on the other fish within the RAS from the release of pheromones. Another issue is the effects should a male exhibiting reproductive behaviour escape and compromise the spawning of wild females (Fjelldal et al. 2014).

The report "Potential Effects Surrounding the Importation of European-Origin Cultured Atlantic salmon to Atlantic salmon Populations and Habitats in Newfoundland" from the Canadian Science Advisory Secretariat in 2013 stated that the only method currently available for effective reproductive containment of farmed fish on a commercial scale is the production of all-female triploids. The use of sterile female triploids in Atlantic salmon aquaculture would eliminate the possibility of escaped farm adults returning to rivers and interbreeding with wild stocks (DFO 2013).

Stofnfiskur, the preferred supplier of triploid all-female Atlantic salmon eggs has been producing high-quality Atlantic salmon eggs, from a unique selective breeding program for more than 25 years. They supply all-female, sterile, triploid, Atlantic salmon (European broodstock) which are hormonally and functionally sterile, eliminating any egg production or behaviour changes. A female sterile salmon does not have any desire to return to rivers or to display spawning behavior, eliminating threats to wild populations (Cotter 2000). With no maturation, these salmon put more energy into growth resulting in a larger fish in the same amount of time as diploid fish.

Grieg NL has concluded that the proposed undertaking will rely for its egg supply on the all-female, sterile, triploid Atlantic salmon from Stofnfiskur in Iceland. The three main reasons for this choice include:

- the intention to be the first fish farm to significantly lower the probability of genetic pollution to wild salmon;
- to have access to a well-developed pool of salmon broodstock offering a variety of traits; and
- to reduce commercial risk of depending on just one non-native stock (Saint John River).

#### 2.7.3.3 Summary of Methods and Strategies Proposed by Grieg NL

Grieg NL has chosen to use a combination of closed-containment land-based RAS and marine-based Aqualine Midgard cage system method for the proposed undertaking to be located in Placentia Bay. In conjunction with this method, the strategy of utilizing sterile triploid all-female Atlantic salmon, as well as extended land-based production (and decreased sea-based rearing), results in a unique project for the Province of Newfoundland and Labrador.

As described in the previous sections, the selection of this Alternative was based on careful evaluation of the choices available. The factors considered included environmental interactions, economics, market and regulatory circumstances, and technical performance.

When selecting the location for the Project, initial consideration was given to the Southwest Coast, however most candidate locations were ruled out due to site holds that were already in place from existing operators. Encouraged and advised by DFO, Grieg NL moved their focus to Placentia Bay which was found to be the most viable option, providing sufficient biosecurity spacing for four separate BMAs. Grieg NL therefore accepted an offer for exclusive rights to use Placentia Bay from the Provincial Government of Newfoundland and Labrador to create more jobs and sustainable economic growth in the Bruin Peninsula region (Appendix C).

The Burin Peninsula has experienced a decline in employment over the past few years with the closure (or reduction) of some major employers including a shipyard, mining industry and oil and gas fabrication centers (Sheppard 2016). This area of the province in years past has been considered a hub and as a result there is near universal access to standard community infrastructure for health, education, communication and transportation on the Burin Peninsula. The Burin Peninsula also offers optimal logistic and supply routes for equipment, raw materials, and communication systems. These factors among others make the Burin Peninsula an ideal location for developing industries such as aquaculture.

Most of the surrounding communities on the Burin Peninsula have Harbor Authorities and existing wharf facilities. These communities are also home to many fishers with sea-going skills highly qualified for working on the marine sites. The traditional fishery in the area is at very low resource levels and currently does not support livelihoods to the extent they would desire; the fishermen in these areas have addressed and embraced the project at an early stage (see Appendix D).

Grieg NL has selected eggs that will produce sterile triploid all-female Atlantic salmon. The preferred supplier will be Stofnfiskur in Iceland. The fish reared from these eggs will greatly minimize the potential for any escaped farmed Atlantic salmon to affect the genetic integrity of wild Atlantic salmon stocks (Glover et al. 2016).

The proposed production schedule of raising smolt to a larger size on land provides decreased feed (nutrient) inputs as well as increased fallowing periods at sea for any organic material that accumulates under the sea cages. Fallowing periods are necessary for the organic matter to assimilate and the benthic environment to recover. By increasing the period a site is fallow, increases the time for these organics to assimilate and the sea floor to recover.

Technological improvements in sea cage systems such as the proposed Aqualine Midgard system will minimize the potential for fish escapes to occur. In addition, development and implementation globally of standards such as Norwegian Standards (NS9415) (Jensen 2010) or the Newfoundland Code of Containment play a role in reducing farmed salmon escapes.

Based on its examination of alternatives to and within the Project, Grieg NL has selected a combination of land with RAS technology and marine-based grow-out for its Atlantic salmon aquaculture Project. The utilization of these two production methods, combined with the selection of sterile triploid all-female Atlantic salmon eggs, and the use of innovative sea cage technology provides both economic and environmental advantages that ultimately make this the ideal solution for culturing Atlantic salmon in an ideal location - Placentia Bay.

### 2.7.3.4 Assessment

Table 2.24 provides an overview of the analysis conducted to compare 'Proposed Project' with the three identified alternatives within the Project.

**Table 2.24. Summary Analysis of Alternatives within the Proposed Project.**

| Scenario | Evaluation Criteria | | | | |
|---|---|---|---|---|---|
| | Environment | Technical | Economic | Market | Regulatory |
| Proposed Project | 0 | 0 | 0 | 0 | 0 |
| Alternative 1, West Coast Project | 0 | -1 | -1 | -1 | 0 |
| Alternative 2, On-Land Project | +1 | -2 | -3 | -1 | -1 |
| Alternative 3, Conventional Technology | -2 | -2 | -1 | 0 | 0 |

***Within Project, Alternative 1***

Alternative 1, West Coast Project has acceptable conditions and is generally equivalent to the proposed Project with respect to the Environment and Regulatory criteria. However, the alternate location is less favourable for market delivery than is the location currently being proposed. Air shipping will rely on the international airports in St. John's and Gander, both of which are closer to Placentia Bay than Bay St. George. In addition, a preliminary comparison indicates that Placentia Bay is a technically superior location for sea cage rearing of salmon. There appear to be few locations in Bay St. George where the shoreline features are conducive to fish transfer from a RAS Hatchery site. The economic criterion also favours the proposed Project.

Compared with Bay St. George, community infrastructure with relevant service and supply support is well developed in Placentia Bay, and a large population base of ~20,000 residents suggest an adequate supply of workers available for operations. There is also a large training capacity available on the Burin and Avalon peninsulas. Third-party services with both equipment and personnel for maintenance, transportation, and other services are locally in place in Placentia Bay and more readily accessible than is the case for Bay St. George.

The marine sites available in Placentia Bay offer ideal production environments with more suitable water depths, more favourable currents, and more protected areas for the sea cages. The vast area of Placentia Bay compared to Bay St. George offers superior spacing between each site and each BMA resulting in improved biosecurity for the operation.

Overall, Alternative 1, West Coast Project is less favourable than the proposed Project.

***Within Project, Alternative 2***

Alternative 2, On-Land Project has been advocated as an attractive and viable replacement for the proposed Project. The on-land concept has a number of potential advantages (Ayer and Tyedmers 2009) that include:

- minimized fish escapes;
- minimized predator interactions;
- reduced disease transmission;
- lower feed inputs;
- higher stocking densities; and
- improved waste management capabilities.

There are, however, several critical issues associated with the on-land concept. Most importantly, attempting to grow market size 5 kg Atlantic salmon exclusively on land has yet to be proven economically viable and has important technical challenges.

While Alternative 2 reduces or eliminates potential environmental interactions in the marine environment, this would be offset by increased interactions on land. A total land-based facility would require an extensive amount of land, electricity, and water (Ayers and Tyedmers 2009; Boulet et al. 2010; Warren-Hansen 2015). The carbon footprint of salmon produced at land-based aquaculture facilities is twice that of salmon produced in traditional open net pen systems (Liu 2016). On balance, and taking a conservative approach, Alternative 2 is regarded as having a slight advantage with respect to the environmental effects criterion.

Alternative 2 also involves important technical challenges. From the NASCO report "*Addressing impacts of salmon farming on wild Atlantic salmon: Challenges to, and developments supporting, achievement of NASCO's international goals*", a number of pilot and commercial scale RAS facilities for land-based salmon production have been built in recent years. These operations found that RAS technology for land-based production is available, but there still remain many technical and biological obstacles based on the experience to date (Cowan 2016).

The provision of marine water that replicates the natural environment of the ocean is essential for the adult stage of Atlantic salmon. Fluctuations in water quality can have detrimental effects on fish and create challenges for farmers, making it critical that these fluctuations are well managed. Sea cages utilize ocean currents to move water and provide fresh oxygen to fish (Summerfelt 2012). By comparison, land-based farms compensate for that natural environment by pumping water, heating and cooling water, and injecting oxygen. All of these essential activities would require careful and continuous monitoring and adjustment. This challenge increases over time, especially when fish grow beyond 1 kg in size. It has been found that up to 30% of male salmon mature early in RAS when the fish are approximately 1.5–2 kg in weight. They stop growing, lose coloration and their flesh quality deteriorates making them unsuitable for market. A reason for early maturation is possibly due to an accumulation of female sex pheromones in the RAS (Cowan 2016). The negative technical challenges posed by Alternative 2 are high in comparison to the proposed Project, and hence a negative value was assigned this criterion.

The economics of Alternative 2 are not favourable, especially for an operation located some distance from market. The demands for electric energy, water and land serve to increase capital cost over traditional open net pen salmon farming. Cost analysis comparisons conducted on land based production versus marine-based production; with an annual production of 5,000–6,000 tonnes has determined that a land-based system is 2.5 times as costly as that of a marine-based net cage system (Warren-Hansen 2015; Cowan 2016). Grieg NL is planning to produce 33,000 mt of Atlantic salmon per year. This is 5.5 times higher than that which was analyzed, indicating that a commercial operation of this scale has yet to be tested for economic viability. In addition, a totally on-land facility would logically be located close to market, making a Newfoundland location unattractive. The main advantage with a land-based operation is the potential to set up production close to the main market for the product. The majority of salmon produced in Newfoundland is currently shipped to the US. Given its relatively high production costs and lack of reliance on the marine environment, closed-containment RAS production of Atlantic salmon would likely choose locations proximate to major markets such as the northeastern United States.

While Grieg NL recognizes the benefits of a closed-containment RAS, this alternative is just not feasible for the Placentia Bay project for production of 33,000 mt of Atlantic salmon grown to a 5 kg fish size. Currently, the costs associated with such a system render this alternative economically unviable. In the event that a totally land-based production system does become economically viable, such a facility would

not likely be located in Placentia Bay. An important advantage of the Placentia Bay region is the availability of extensive, suitable marine water. For these reasons, Alternative 2 was rated as most unattractive with respect to the economic feasibility and market access criteria.

Finally, it may well be that regulators would be challenged to deal with compliance issues for such a facility; hence this criterion is also rated lower than that for the proposed Project.

Overall, Alternative 2, On-Land Project is less favourable than the proposed Project.

***Within Project, Alternative 3***

Alternative 3, Conventional Technology would see an operation using technology and methods already in use within the Province. Therefore, this alternative is less favourable than the proposed Project in terms of potential environmental effects. Many of the features of the proposed Project are intended to avoid or greatly reduce the potential negative environmental effects that have been caused by current aquaculture operations and practices. Obviously, this alternative is rated lower as well with respect to technical features and economics since one important outcome of using newer but proven technologies intended for the proposed Project is a more efficient and cost-effective operation.

Overall, Alternative 3, Conventional Technology is less favourable than the proposed Project.

***Summary of Comparison of Within Project Alternatives with Proposed Project***

Alternative 1, West Coast Project would have a similar set of environmental interactions and in general would result in similar environmental effects compared to the proposed Project. While Alternative 2, On-Land Project would avoid interactions with the marine environment, it would also introduce a set of terrestrial and aquatic (freshwater) environment issues, including a greatly expanded carbon footprint. As is described in this document, the environmental issues related to marine operations for the proposed Project have been greatly reduced, and in some cases avoided entirely. The On-Land Project alternative was, however, rated slightly higher than the proposed Project for this criterion. Alternative 3, Conventional Technology is rated the lowest with respect to environmental effects criterion, mainly because such an undertaking would fail to apply the lessons learned from past aquaculture operations.

Based on this comparative evaluation, the proposed Project is clearly preferred over the three alternatives within the Project with respect to technical, economic and market feasibility, and compares well with respect to environmental considerations.

## 2.8 Accidents and Malfunctions

This section presents a set of potential accident and malfunction scenarios for the Project, including credible “worst case scenarios” and “emergency scenarios”. In developing these scenarios, the assumption has been made that preventative actions have either not been taken or have been unsuccessful, resulting in an accident or malfunction that has caused potentially negative environmental effects. During Project operations, every effort would be made to implement appropriate preventative measures.

It has also been assumed that, for the purposes of scenario development, effective emergency response measures will be applied. The potential effects of these scenarios are assessed in Section 7.7.

The scenarios described below are considered to best represent potential accidents and malfunctions associated with the Project. Grieg NL will regularly review its operations and procedures and revise its Emergency Response Plan as necessary.

### 2.8.1 Fish Escapes at Sea Cage Sites

There are several primary reasons for the escape of finfish from sea farms, including personnel errors made during routine fish handling procedures, and net damage caused by weather, ice, and predators. In Newfoundland during 2010–2016, there have been five reported incidents of salmon escapes from sea farms and at least nine breaches in nets with no official report of escapes. Of the five reported escape incidents, two were attributed to personnel errors made during harvesting, two were attributed to extreme weather, and one was attributed to a predator strike, possibly sharks (DFA 2015). The nine net breaches, which were reported in 2012, were attributed to strikes by sharks and tunas. The reported salmon escapes in Newfoundland occurred during operation of a different type of sea cage system than the Aqualine Midgard cage system proposed by Grieg NL. Of the ~1,000 Midgard sea cage systems in use around the world, including areas with environmental conditions similar to Placentia Bay, no fish escapes have been reported (see Sullivan et al. 2018 *in* Volume 3).

The emergency scenario of an escape of salmon and lumpfish into the surrounding environment at the sea cage sites includes one sea cage at a site in the Rushoon BMA being compromised and partially collapsing. This could be caused by extremely unfavourable conditions such as during a severe weather event in combination with failure of operational procedures to properly secure the sea cage. The result of such an event could be the escape of all 160,000 salmon and 16,000 lumpfish. It is assumed that this event occurs in spring/early summer.

The worst-case scenario of an escape of salmon and lumpfish into the surrounding environment at the sea cage sites includes all 12 sea cages at a site in the Rushoon BMA being compromised and partially collapsing. This could be caused by inaccurately forecasted and extremely unfavourable weather conditions. This also assumes that personnel did not implement operational measures for securing the site. While some of the contained 2,000,000 salmon would escape, others would be entangled in the net and possibly die. Regardless, the worst-case scenario assumes the release of 2,000,000 salmon and 200,000 lumpfish into the wild. It is assumed that this event occurs in spring/early summer.

### 2.8.2 Mass Mortality

Mass mortality events in salmon aquaculture are typically associated with a disease event and occasionally equipment failures at hatcheries. In Newfoundland, cases of ISA were reported in Atlantic salmon during 2012–2018, the most recent case occurring in February 2018 (CFIA website 2018). There have been a total of seven reported cases of ISA in Newfoundland during 2012–2018[11]. In 2013, two sea cages in Hermitage Bay were required to be depopulated (CBC 2013), and it was reported in 2017 that at least one of six sea cages near Gaultois required depopulation of ~50,000 Atlantic salmon (Roberts 2017).

A credible emergency scenario of a mortality event would be a sudden increase in the daily mortality rate (i.e., loss of 1,000 fish in one tank within one facility such as Post-Smolt Facility (building A) or loss of 1,000 fish in one sea cage in the Rushoon BMA. It is assumed that such a loss could occur as the result of environmental conditions unfavourable for salmon culture (e.g., low oxygen).

[11] During 2012–2018, there were 15 reported cases of an ISA virus strain not known to cause the disease (CFIA website 2018).

If a sudden increase in daily mortalities were to occur at either of the described sites (i.e., Post-Smolt Facility, building A or a site in the Rushoon BMA), the mortalities would be collected as per the daily procedures at each facility. Grieg NL's private veterinarian and the provincial veterinarian would be notified to perform a post-mortem examination to confirm that the cause was related to unfavourable culturing conditions. Culturing conditions would be assessed and oxygen levels would be adjusted using air stones and backup oxygen generators as needed. The mortalities would be ensilaged at the RAS Hatchery and sea cage sites.

The specifics of the worst-case scenarios of mass mortality at the RAS Hatchery and the sea cage sites considered include:

- All fish (maximum of 6 million mortalities ranging in size from 5–50 g) in the Smoltification Facility during February, or
- All fish (maximum of 6 million mortalities) at the Rushoon BMA (e.g., 36 sea cages) in August.

This loss could be the result of a disease event occurring at the same time as unfavourable environmental conditions for salmon culturing (e.g., low oxygen levels or high water temperatures). The fish would be in a weakened condition due to stress caused by the unfavourable environmental conditions. In the event of such a loss, Grieg NL would implement its mass mortality response plan which includes the notification of regulatory agencies and activation of depopulation, if required. All mortalities would be collected at the sea cage sites using equipment and procedures similar to those used during harvesting. All mortalities at the RAS Hatchery will be removed using equipment and procedures similar to those used during fish transfers to sea cage sites. In this instance, either a well boat or an OCI vessel equipped with industry standard containers will be used to transport the mortalities to a designated outflow wharf in a biosecure manner. Biosecure handling and transport is designed to avoid any spillage. In the case of a confirmed presence of a reportable fish disease, Grieg NL will contact Barry Group Inc. The Barry Group Inc., which owns a rendering plant in Burgeo, NL would receive the collected mortalities as well as the fish that are live harvested and weigh less than 1 kg. Fish that weigh more than 1 kg would be harvested and processed according to CFIA recommendations. Grieg NL will adhere to governmental guidelines and regulations for the disposal of organic material and fish mortalities (see Appendix J for details).

### 2.8.3 Spills

Spills of harmful substances can occur as a consequence of storage, transfer and transport of fuel, hazardous materials, chemicals, and potentially other materials such as therapeutants. Spills of fish feed can also occur.

#### 2.8.3.1 Hatchery Spills

At the RAS Hatchery, the types of spills that may occur are limited to fuel, ensilage, formic acid, and feed. Pesticides and therapeutants will not be stored at this site. For all spill scenarios outlined below, with the exception of a feed spill, Grieg NL's spill management plan for the RAS Hatchery would be enacted and the Pollution Line contacted immediately. If necessary, a Response Organization might also be contacted to assist with environmental clean-up (Appendix M).

Fuel (diesel) for the back-up generators will be stored, as per NL Regulation for "Storage and Handling of Gasoline and Associated Products Regulations, 2003" under the *Environmental Protection Act*, in two 90,000 L tanks located >75 m from the hatchery buildings. A fuel spill occurrence is most probable

during the delivery of fuel due to either a break in the filling line from the fuel truck or to lack of attention during the transfer activity. Refuelling will be carried out by a certified third-party supplier (Transportation of Dangerous Goods certificate and proper class of driver's license) and their procedures will include constant monitoring to assure that the fuel transfer would be stopped as soon as an issue was detected.

The emergency scenario associated with a hatchery spill considers the loss of 100 L of diesel fuel during refuelling. It assumes a fuel transfer rate of 220 L/minute and a 20–30 second response time by the fuel truck driver.

The worst-case scenario considers the loss of fuel from one of the 90,000 L tanks due to a rupture or leak. The storage tanks will be located on a concrete pad and surrounded by a dike[12]. A breach in the storage tank should result in the spilled fuel being contained within the diked area but should the dike be ineffective, fuel could escape to the land outside the dike. A reasonable worst-case scenario could result in 2,000 of the 90,000 L of fuel breaching the dike in summer. Spill response and clean-up procedures would be implemented. The probability of any fuel escaping to the environment as a result of tank failure is considered very low.

Ensilage at the RAS Hatchery will be stored in a secure underground tank (5,000 L). An ensilage spill is most likely to occur during transfer of the ensilage prior to transport (e.g., break in the transfer line) to a third-party facility. All transfer processes will be monitored by personnel to ensure that any spill would be detected quickly. Pumping of the ensilage would be terminated as soon as possible in order to minimize the quantity of spilled.

The emergency scenario assumes the loss of 100 L of ensilage during transfer. The worst-case scenario assumes that 5,000 L of ensilage are spilled by the tanker truck collecting the ensilage at the RAS Hatchery site in summer.

Food grade formic acid (85%) is used to adjust the pH of the ensilage. Formic acid is stored in a secure container in a separate room. The emergency scenario assumes the loss of 500 L of formic acid during delivery to the on-site storage tank. The worst-case scenario assumes that the entire contents of the secure container (IBC) are spilled (i.e., the loss of 1,000 L of formic acid) in summer.

A spill of fish feed at the RAS Hatchery is not considered an emergency scenario. Feed will primarily be stored in silos outside of the hatchery buildings. A spill of feed to the surrounding environment will be cleaned up in accordance with Grieg NL's spill management plan (Appendix M). The feed would be collected using equipment and tools (loaders, trucks, shovels) and disposed at the local waste facility. This scenario is not considered further in the assessment.

### 2.8.3.2 Sea Cage Site Spills

At the sea cage sites, the types of spills that may occur are limited to fuel, ensilage, food-grade formic acid, and feed. Therapeutants and pesticides will not be stored at this site. For all spill scenarios outlined below (with the exception of a feed spill), Grieg NL's spill management plan for the RAS Hatchery

[12] As described in Section 27-Construction and Installation Standards (NL Regulation for "Storage and Handling of Gasoline and Associated Products Regulations, 2003" under the *Environmental Protection Act*) and for a diked area containing more than one storage tank, the diked area shall retain not less than 110% of the capacity of the largest tank or 100% of the capacity of the largest tank plus 10% of the aggregate capacity of all the other tanks, whichever is greater.

would be enacted and the Pollution Line contacted immediately. If necessary, a Response Organization may also be contacted to assist with environmental clean-up (Appendix M). Since most spills occur during transfer operations, low-level releases might be expected to occur as various operations are conducted on board the feed/accommodation barge. These operations include the handling of fuel, ensilage, formic acid and feed.

The emergency scenario of a spill of feed in the sea would involve a break in the feed delivery line between the barge and the sea cages. If a separation or rupture in the line were to occur, the change in pressure would be detected by the sensor systems and an alarm would sound. Feeding would be stopped immediately. The amount of feed spilled into the surrounding environment for this emergency scenario is assumed to be ~1 kg. The break in the feed delivery line would be repaired and an ROV could be used to assess and determine the impact on the seafloor. Feed spill procedures would be followed (Appendix M).

The emergency scenario of a fuel leak at sea assumes a break in the refuelling hose to the feed/accommodation barge. Sensors would detect the change in pressure and alarms would sound. It is assumed that 100 L of fuel (diesel) could be released into the sea before refuelling could be stopped. Spill response procedures for fuel would be enacted (e.g., containment booms, absorption pillows, immediate contact with Pollution Line and/or Response Organization). Barges will be equipped with and personnel trained in the use of a spill response kit. In addition, support organizations such as the Pollution Line and a contracted Response Organization will be available to assist with environmental cleanup.

A potential emergency scenario of an acid spill could occur during delivery of formic acid to the barges. The formic acid is delivered by a resupply vessel in IBCs. An IBC could be dropped while being lifted from the resupply vessel to the barge using a crane. The container is designed to have neutral buoyancy but if it were to sink, an ROV would be used to assist in retrieval and placement on the barge. The containers are sealed and should not release the formic acid. However, in the event the container has been compromised either during the drop or upon retrieval, the maximum amount of formic acid that would spill would be 1,000 L. The formic acid would be diluted by the surrounding sea water. Formic acid biodegrades in water and has a low potential to bioaccumulate (from MSDS; Univar 2016).

The worst-case scenario spill would result if there was a vessel collision with the feed/accommodation barge at one of the sea cage sites in the Rushoon BMA, resulting in an uncontrolled release of fuel, formic acid, ensilage, sewage, and feed. If all feed silos and tanks on board the feed/accommodation barge were full to maximum capacity, a vessel collision could compromise the storage integrity of up to 600 mt of feed, 30,000 L of fuel (diesel), 1,000 L of formic acid, 5 $m^3$ of sewage, and 75 mt of ensilage. No therapeutants, pesticides or other hazardous chemicals will be stored on the barge. The probability of this worst-case scenario is considered very low as the feed/accommodation barges have heavy-duty safety bumpers extending from the water line to the top of the main deck hand rail around the entire vessel. A vessel strike would most likely cause damage above the water line which would prevent the storage compartments from emptying. In addition, the strike would have to penetrate the safety bumpers, the outside wall of the barge and the inside walls of the storage tanks.

Should the entire contents of the feed/accommodation barge be spilled, the following would likely occur. Upon release to salt water, the acid and ensilage would be diluted. The feed would sink to the seafloor and likely be consumed by scavengers. An ROV would be used to assess and determine the impact on the seafloor. Formic acid biodegrades in water and has a low potential to bioaccumulate (Univar 2016). The ensilage does not pose any health risks since the acid is used to stabilize waste and deactivate pathogens (Dixon et al. 2012). A loss of fuel poses the highest risk to the environment. Grieg NL would immediately enact its spill response plan for fuel as outlined in Appendix M. Containment booms along with absorption pillows, pads and/or socks will be deployed to begin immediate recovery of the fuel. The

pollution line as well as a contracted Response Organization would be contacted to assist with environmental cleanup.

### 2.8.4 Hatchery Services Failure

The emergency scenario involving the failure in the electricity supply at the RAS Hatchery, would result in minimal disruption to the operation and is not likely to have any environmental consequences. The RAS Hatchery will be equipped with two on-site back-up generators. In the event of power failure, one of the generators would start automatically and provide full site service, with the second unit providing redundancy for use as required. Newfoundland Power would be notified of their service failure, and requested to repair the connection immediately.

The potential loss of water supply represents a worst-case scenario for the RAS Hatchery. Should the water supply line from the groundwater well become severed, an alarm would immediately sound and alert operators to the loss of water supply. Since the system is recirculating, fish would not be affected in the short term. Actions would be initiated immediately to repair the line and re-establish the water supply source. Other actions would be taken to maintain water quality in the recirculating supply. Processes such as feeding would be suspended. The system has a buffer with extra water in the denitrification system (seven tanks capacity in the Smoltification Facility and three tanks capacity in the Post-Smolt Facility). Therefore, an extended period of near-normal operation can be sustained in the absence of access to the water supply. This would allow ample time to determine the cause of the failure and to conduct needed repairs (e.g., arrange for the services of welders and equipment (pipe) suppliers to carry out repair work). These malfunctions are not assessed further.

### 2.8.5 Lost/Estranged Gear

The scenario where gear would become lost or estranged is similar to the conditions described above for escape of fish from a sea cage.

The emergency scenario would occur if one sea cage at a site were to be compromised, resulting in its partial collapse. This could be caused by extreme weather conditions and exacerbated by the failure of operational procedures for securing the sea cage. The result of such an event could be the loss of gear, including netting, lines, and structural elements of a sea cage. This aspect of an emergency scenario is considered in the fish escape scenario.

The worst-case scenario could occur as a consequence of a severe weather event such as a hurricane. It is conceivable that all 12 cages at a site (e.g., Long Island), including the mooring system, could collapse if proper precautionary measures were not taken to secure the site. While much of the gear would likely remain in place, entangled in the various mooring lines, some gear might break free to drift and create both a navigation hazard and a source for entanglement with other (e.g., fishing) gear present in the region. This aspect of a worst-case scenario is considered in the fish escape scenario.

### 2.8.6 Accidents to be Assessed

Accident scenarios to be assessed for the EIS are summarized in Table 2.25. These were selected to represent reasonable worst-case and emergency scenarios that have potential to affect VECs.

**Table 2.25. Summary of accident scenarios for assessment.**

| Accident Type | Scenario Type | Location | Size | Timing | Rationale |
|---|---|---|---|---|---|
| Fish Escape | Emergency | Rushoon BMA | Loss of one sea cage (160,000 salmon; 16,000 lumpfish) | Spring/ early summer | Resulting from severe weather and failure to implement operational procedures for securing site. The Rushoon BMA is closest to scheduled salmon rivers. During spring/ early summer smolt will be returning to sea. |
| Fish Escape | Worst Case | Rushoon BMA | Loss of 12 sea cages (2,000,000 salmon; 200,000 lumpfish) | Spring/ early summer | Resulting from severe weather (hurricane-like), inaccurate weather forecasting, and failure to implement operational procedures for securing site. The Rushoon BMA is closest to scheduled salmon rivers. During spring/ early summer smolt will be returning to sea. |
| Mass Mortality | Emergency | RAS Hatchery | 1,000 salmon | Any time of year | Resulting from low oxygen levels. |
| Mass Mortality | Worst Case | RAS Hatchery | 6,000,000 fish | February | Resulting from ISA during month of maximum no. of salmon in the RAS Hatchery. |
| Mass Mortality | Emergency | Rushoon BMA | 1,000 salmon | August | Resulting from low oxygen levels and/or warmer water temperatures. |
| Mass Mortality | Worst Case | Rushoon BMA | 6,000,000 fish | July | Resulting from ISA (and depopulation order) immediately before harvest, when salmon are largest size (4 kg). The Rushoon BMA is closest to scheduled salmon rivers. |
| Spill | Emergency | RAS Hatchery | 100 L diesel fuel | Summer | Resulting from refueling incident. |
| Spill | Worst Case | RAS Hatchery | 2,000 L diesel fuel | Summer | Resulting from breach in fuel tank. |
| Spill | Emergency | RAS Hatchery | 100 L ensilage | Summer | Resulting from transfer incident. |
| Spill | Worst Case | RAS Hatchery | 5,000 L ensilage | Summer | Resulting from loss of entire tank capacity. |
| Spill | Emergency | RAS Hatchery | 100 L formic acid | Summer | Resulting from transfer incident. |
| Spill | Worst Case | RAS Hatchery | 1,000 L formic acid | Summer | Resulting from loss of entire tank capacity. |
| Spill | Emergency | Rushoon BMA | 1 kg feed | Summer | Resulting from breach in feed line. |
| Spill | Emergency | Rushoon BMA | 100 L diesel fuel | Summer | Resulting from refueling incident. |
| Spill | Emergency | Rushoon BMA | 1,000 L formic acid | Summer | Resulting from loss of entire IBC. |
| Spill | Worst Case | Rushoon BMA | 600 mt feed; 30,000 L diesel fuel; 1,000 L formic acid; 5 $m^3$ sewage; 75 mt ensilage | Summer | Resulting from a vessel collision with feed/accomodation barge and loss of all storage tanks. Rushoon BMA closest to Sensitive Areas. |

Note: PSA is Post-Smolt Facility, Building A. SF is Smoltification Facility.

# 3.0 Effects Assessment Methodology

The Proponent (Grieg NL) is required through the Provincial environmental assessment process, pursuant to the *Environmental Protection Act*, to prepare an EIS for the proposed Placentia Bay Atlantic Salmon Aquaculture Project. The purpose of the EIS, as specified in the EIS Guidelines (Appendix A) issued by the NL Department of Municipal Affairs and Environment, is to identify potential environmental effects associated with the project activities, identify appropriate mitigative measures, predict the significance of residual effects and determine whether or not the proposed project is likely to cause significant adverse impacts on the environment.

Two general types of effects are considered as per the Guidelines:

1. Effects of the environment on the Project; and
2. Effects of the Project on the environment, including the biophysical and human environments.

Although this assessment falls under the provincial process, the method of effects assessment used for the Project generally follows the *Canadian Environmental Assessment Act* (CEAA 2012) and its associated Operational Policy Statement (CEA Agency 2015a).

Cumulative effects are incorporated within the procedures in accordance with CEAA (CEA Agency 1994, 2015b) as adapted from Barnes and Davey (1999) and used in many recent EAs in the Province.

## 3.1 Scoping

Scoping of an assessment mainly includes scoping of issues and determining the spatial and temporal extent of the assessment, selecting which components (i.e., sensitive and/or representative species or species-groups and associated habitats) to assess, and selecting which project activities to analyze. Scoping was conducted according to the following steps, not necessarily in chronological order.

- Detailed review of EIS Guidelines prepared by the NL Department of Municipal Affairs and Environment with input from other government departments, and the interested public;
- Review of relevant information on Project activities and literature on the effects of salmon aquaculture operations;
- Consultations with key groups and the public at various stages of the assessment; and
- Consultations with provincial and federal agencies.

## 3.2 Consultations

In preparation for the proposed Project and the required EIS, the Proponent and its consultants met with relevant government agencies, representatives of the fishing industry and other stakeholders and interest groups as well as the general public in communities that may be affected positively or negatively by the Project. The purpose of these consultations was to describe the Project, identify any interests, issues, and concerns, and to gather additional information relevant to the EIS. Public meeting followed protocol legislation and policy as per Appendix B in the EIS Guidelines.

A consultation report has been prepared as required by the EIS Guidelines and is provided in Appendix D. The report includes issues and concerns raised during consultations and highlights where in the EIS these

concerns have been addressed. Table 3.1 provides a summary of government and stakeholder groups consulted.

**Table 3.1. Groups consulted by Grieg NL for the Placentia Bay Atlantic Salmon Aquaculture Project, June 2015–March 2018.**

| Group | Sub-group | Department/Association |
|---|---|---|
| Government | Federal | Department of Fisheries and Oceans (DFO) |
| | | Environment and Climate Change Canada (ECCC) |
| | | Canada Food Inspection Agency (CFIA) |
| | | Transport Canada (TC) |
| | Provincial | Department of Fisheries and Land Resources (DFLR) |
| | | Department of Municipal Affairs and Environment (DMAE) |
| | | Department of Services and Climate Change |
| | | Department of Advanced Education, Skills and Labour (AESL) |
| | | Department of Health (Eastern Health and pertinent government/community groups) |
| | | Department of Tourism Culture, Industry and Innovation (TCII) |
| | | Provincial Archaeology Office (PAO) |
| | Municipal | Community Mayors, Councils and Staff throughout the Burin Peninsula |
| | | Local Service District Committees |
| Government-associated Groups | - | Placentia Bay Integrated Management Committee (PBIMC) |
| | | Placentia Bay Traffic Committee |
| | | Memorial University of Newfoundland and Marine Institute (MUN/MI) |
| International | - | Saint Pierre et Miquelon (business and government) |
| Stakeholder Groups | Existing Economic Development Groups | Burin Peninsula Joint Council (BPJC) |
| | | Burin Peninsula Chamber of Commerce (BPCC) |
| | | Burin Peninsula Regional Services Board |
| | | Community Business Development Corporations (CBDC) |
| | Heritage | Placentia West Heritage Committee |
| | | Heritage Run Tourism Association |
| | Businesses | Individual potential suppliers |
| | | Community Business Development Corporation (CBDC) |
| | Education/Training Groups | College of the North Atlantic (CNA) |
| | | Marine Institute (MI) |
| | | Keyin College |
| | FFAW-Unifor and Local Fishers | Boat Harbour, Baine Harbour, Petit Forte, South East Bight, Rushoon, Arnold's Cove, Long Harbour |
| | Salmon Enhancement Associations | Salmonid Council of Newfoundland and Labrador |
| | | Atlantic Salmon Federation (ASF) |
| | | Salmonid Association of Eastern Newfoundland (SAEN) |
| | | Newfoundland and Labrador Coalition for Aquaculture Reform (NL-CAR) |

### 3.2.1 Interests and Concerns

The interests and concerns raised in discussions with regulators and stakeholders were documented and are detailed in the Consultation Report (Appendix D). Furthermore, the key issues and concerns raised are summarized in Table 5.1 of this EIS and these issues helped guide the environmental planning for the Project.

## 3.3 Valued Environmental Components (VECs)

In conducting environmental assessments over the years, agencies and the public have found it useful to focus the assessment of a project through the identification of Valued Environmental Components[13], referred to as VECs. VECs are biological, physical, cultural, and economical components determined to be of most concern with respect to being affected by the project.

Identification and selection of the VECs for the Project was accomplished through a series of steps including: issues scoping through regulatory and public consultation; meetings involving Project personnel and environmental consultants, review of the EIS Guidelines, and consideration of recent environmental assessments for other projects in the province.

The EIS Guidelines for the Project specified that VECs for each of the following environmental components should be described: atmospheric, aquatic, terrestrial, land and resource use, heritage resources, communities, and economy, employment, and business.

Based on the approach described above, four biophysical VECs (Fish and Fish Habitat, Wild Atlantic Salmon, Species at Risk, and Sensitive Areas) and two socio-economic VECs (Demographics and Economy: Training, Employment and Business) have been selected to focus the assessment. The VECs are discussed at varying levels of detail depending on the potential for significant effects.

### 3.3.1 Fish and Fish Habitat

The Fish and Fish Habitat VEC only includes the marine environment given that the terrestrial footprint of the Project occurs entirely within a Marine Industrial Park. 'Fish habitat' is a wide-ranging concept that includes both physical and biological components, namely water quality, bathymetry, nature of the seafloor and benthos. The 'fish part' of the VEC includes both invertebrates and fishes. Discussion in the assessment will focus on commercial and *SARA* species. Snow crab and Atlantic cod, for example, are important commercial and cultural species. Snow crab and Atlantic cod are also good representative species given their relatively high levels of study. The Fish and Fish Habitat VEC is of interest from both a public and scientific perspective, at local, national and international scales.

### 3.3.2 Wild Atlantic Salmon

Wild Atlantic salmon was selected as a VEC versus including this species in the Species at Risk VEC (see below) given the repeated concern raised during consultations about the potential effects of the Project on this species. Wild Atlantic Salmon that occur in Placentia Bay are considered part of the South Newfoundland population of Atlantic salmon that was designated as 'Threatened' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

### 3.3.3 Species at Risk

'Species at Risk' are those species listed by the provincial *Endangered Species Act* (*ESA*) and/or on Schedule 1 of the *Species at Risk Act* (*SARA*). This VEC is of prime concern from both a public and scientific perspective, at local, national and international scales. Species at risk, which have been addressed in this assessment, are listed in Table 3.2. Wild Atlantic salmon are considered a separate VEC as noted above.

[13] The EIS Guidelines use Valued Ecosystem Components. This has been modified to Valued Environment Components to encompass both the biophysical and human environment aspects of the assessment.

**Table 3.2. Species considered at risk in Placentia Bay which have been assessed under the Species at Risk VEC.**

| Species | Federal *SARA* Status | Provincial *ESA* Status |
|---|---|---|
| **Fish** | | |
| White Shark (Atlantic pop.) | Endangered | Not listed |
| Northern Wolffish | Threatened | Not listed |
| Spotted Wolffish | Threatened | Not listed |
| Atlantic Wolffish | Special Concern | Not listed |
| American Eel | Threatened (COSEWIC) | Vulnerable |
| Banded Killifish (Newfoundland pop.) | Special Concern | Vulnerable |
| **Marine Mammals** | | |
| Blue Whale (Atlantic pop.) | Endangered | Not listed |
| North Atlantic Right Whale | Endangered | Not listed |
| Northern Bottlenose Whale (Scotian Shelf pop.) | Endangered | Not listed |
| Fin Whale | Special Concern | Not listed |
| Sowerby's Beaked Whale | Special Concern | Not listed |
| **Sea Turtles** | | |
| Leatherback Sea Turtle (Atlantic pop.) | Endangered | Not listed |
| Loggerhead Sea Turtle | Endangered | Not listed |
| **Birds** | | |
| Ivory Gull | Endangered | Endangered |
| Piping Plover | Endangered | Endangered |
| Red Knot | Endangered | Endangered |
| Barrow's Goldeneye (Eastern pop.) | Special Concern | Vulnerable |
| Harlequin Duck (Eastern pop.) | Special Concern | Vulnerable |

### 3.3.4 Sensitive Areas

Assessment of potential effects on sensitive areas, i.e., specially designated areas that could be affected by Project activities will be included in the EIS. In accordance with a recent SEA for southern Newfoundland, a 'sensitive area' is defined as: 1) an area that is afforded some level of protection under federal or provincial legislation; 2) an area that may be under consideration for such legislative protection; or 3) an area that is known to have particular ecological or cultural importance and is not captured under federal or provincial regulatory framework (C-NLOPB 2010).

### 3.3.5 Demographics

The major concern of community leaders on the Burin Peninsula is the decline in population. The population of the Burin Peninsula has been declining for the past 15 years. Reflecting a province-wide rural trend, there were 5,000 fewer people on the Peninsula in 2016 than in 2001. Community leaders see the proposed aquaculture project as a means to retain residents through employment, not in a boom/bust situation but as the start of a new, sustainable industry: "some people say this project is the savior of Burin' (P. Pike. Mayor, St. Lawrence, 21 February 2018).

### 3.3.6 Economy: Training, Employment, and Business

This VEC encompasses aspects of the socio-economic environment that are important to all citizens. Employment and business opportunities associated with the Project have been identified though the public consultation process as key priorities in the local communities. The economy as a whole will benefit from the taxes that the Project and its employees pay to different levels of government. This income can be used by governments to address a wide range of social and economic needs.

Some people will benefit directly or indirectly from Project employment, from the skills acquired through training and from the experience. New industrial projects generally benefit the surrounding area through direct and indirect employment, and as employee and business spending generates induced employment and income effects throughout the local economy. However, the effects on some individuals and groups can be negative; for example, wage inflation caused by the Project may adversely affect local businesses, while an increase in the cost of living may adversely affect those on low and fixed incomes.

## 3.4 Component Studies

The EIS Guidelines for the Project required that the Proponent conduct four Component Studies:

- Wild Atlantic Salmon;
- Fish and Fish Habitat;
- Cultural, Recreational and Commercial Importance of the Waters of Placentia Bay; and
- Aqualine Midgard Sea-cage Study.

The Component Studies generally have the following format: (i) Rationale / Objectives; (ii) Study Area; (iii) Methodology; and (iv) Study Outputs. As requested, these component studies are included as part of the EIS submission (see Volume 3). Where appropriate, relevant aspects of the Component Studies have been included directly in the EIS.

## 3.5 Data Gaps

Grieg NL has identified data gaps for baseline and potential effects information for each VEC under consideration in the EIS. Information gaps resulting from lack of previous research or practices (e.g., lack of sufficient time series data) have been assessed.

In addition to work required for specified component studies, Grieg NL was required to collect data on the environmental characteristics (bottom type, water profile) of the sea cage sites as part of the aquaculture licensing procedure. Additionally, there will be monitoring of the sea cage sites throughout the Project. This will provide ongoing, near real-time data.

## 3.6 Boundaries

The boundaries of the Study Area have been defined using CEA Agency (2003) as guidance. The scope of the assessment includes both temporal and geographic or spatial considerations. The considerations include the entire Project schedule from construction through Operations and Decommissioning. The geographic area considered in the assessment includes not just the land-based facility and sea cage sites but also the area within which environmental components could be affected. The Affected Area is the geographic extent of a specific potential effect on a VEC. It varies according to the timing and type of project activity in question and the sensitivities of the species. Thus, there are many affected areas or geographic extents in this EIS.

### 3.6.1 Temporal

The temporal boundaries of the Project extend from the start of Construction through Decommissioning. There is some overlap in the Construction and Operation/Maintenance phases. The temporal boundaries of the different Project phases, assuming that the EIS is released in 2018, include:

- Construction from 2018–2022 (5 years).
- Operation and Maintenance from 2020–2032 (i.e., 10 years at full production), which could be extended as a result of continuous facility maintenance and site fallowing.
- Decommissioning and rehabilitation (estimated 2 years).

### 3.6.2 Spatial

The geographic extent of a specific potential effect on a VEC varies according to the timing and type of project activity in question and the sensitivities of the VEC. Thus, there are many potentially affected areas or geographic extents discussed in this EA. The following spatial boundaries were used.

#### 3.6.2.1 Project Area

The Project Area is the physical footprint of the project, including the land-based facility (RAS Hatchery) site and the proposed sea cage sites (Figure 3.1; see also Figure 2.8). The land-based facility falls entirely within the Marystown Marine Industrial Park.

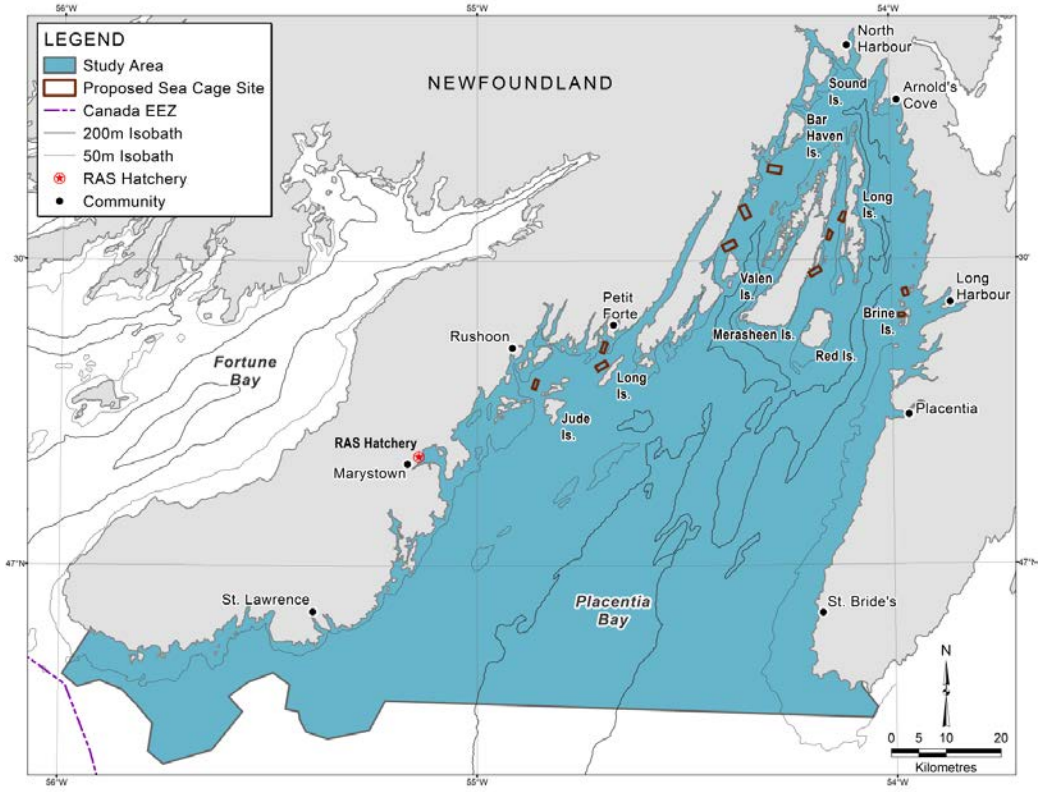



**Figure 3.1. The locations of the Study Area, proposed sea cage sites and the RAS Hatchery for Grieg NL's Placentia Bay Atlantic Salmon Aquaculture Project.**

#### 3.6.2.2 Study Area

The boundaries of the Study Area correspond to those of the Placentia Bay Extension EBSA (DFO 2012) (see Figure 3.1). This is considered the maximum extent wherein there is potential for effects of the

Project to occur; for example, the effects of potential escaped salmon on wild Atlantic salmon. Additionally, the socio-economic assessment also focuses on the Burin Peninsula.

## 3.7 Environmental Effects Assessment Procedures

The systematic assessment of the potential effects of the Project involved the following major steps:

1. preparation of interaction matrices (between project activities and the environment);
2. identification and evaluation of potential effects of project activities on VECs including description of mitigation measures and residual effects;
3. preparation of residual effects summary tables; and
4. evaluation of cumulative effects.

### 3.7.1 Identification and Evaluation of Environmental Effects

Interaction matrices identifying all possible Project activities that could interact with any of the VECs were prepared. The matrices include times and places where interactions could occur. The interaction matrices were used only to identify potential interactions; they made no assumptions about the potential effects of the interactions.

Interactions were then evaluated for their potential to cause effects, and the various effects or factors identified in the interaction matrix were grouped into the various VECs for further assessment. In instances where the potential for an effect of an interaction was deemed improbable or extremely remote, these interactions were not considered further. In this way, the assessment focused on key issues and the more substantive environmental effects (see subsequent assessments for each VEC).

In the biophysical assessment, an interaction was considered to be a potential effect if it could change the abundance or distribution of VECs, or change the prey species or habitats used by VECs. In the socio-economic assessment, an interaction was considered to be a potential effect if it could change the current socio-economic status of the potentially affected communities. The potential for an effect was assessed by considering:

- outcomes of the issues scoping and public consultation sessions;
- location and timing of the interaction;
- regulatory requirements on emissions or discharges, concentration limits of chemical or deleterious substances;
- consideration of the baseline information and modeling exercises;
- literature on similar interactions and associated effects;
- professional judgement and consultation with other experts (when necessary); and
- results of similar effects assessments.

When data were insufficient to allow certain or precise effects evaluations, predictions were made based on professional judgement. In such cases, the uncertainty is documented.

### 3.7.2 Classifying Anticipated Environmental Effects

The concept of classifying environmental effects simply means determining whether they are negative or positive. The following includes some of the key factors that are considered for determining negative environmental effects, as per the CEA Agency guidelines (CEA Agency 1994):

- negative effects on the health of biota;
- loss of rare or endangered species;
- reductions in biological diversity;
- loss or avoidance of critical/productive habitat;
- fragmentation of habitat or interruption of movement corridors and migration routes;
- transformation of natural landscapes;
- discharge of persistent and/or toxic chemicals;
- toxicity effects on human health;
- loss of, or detrimental change in, current use of lands and resources for traditional purposes;
- foreclosure of future resource use or production; and
- negative effects on human health or well-being.

Positive effects or benefits are also identified and assessed in the EIS.

### 3.7.3 Mitigation Measures

Mitigation measures appropriate for each effect predicted in the matrix were identified and the effects of various Project activities (i.e., within project cumulative effects) were then evaluated assuming that appropriate mitigation measures are applied. Effects predictions were made taking into consideration both standard and project-specific mitigations and can thus be considered "residual effects".

### 3.7.4 Evaluation Criteria for Assessing Biophysical Environmental Effects

Several criteria were taken into account when evaluating the nature and extent of environmental effects on a given VEC as per the Guidelines and standard assessment procedure. A table is provided for each VEC, indicating the results of the effects analysis – see Section 7.0. These criteria include (CEA Agency 1994):

- magnitude;
- geographic extent;
- duration and frequency;
- reversibility; and
- ecological, social, cultural and economic context.

#### 3.7.4.1 Magnitude

Magnitude describes the nature and extent of the environmental effects for each activity. The biological measures to be included in the definition of magnitude are not clearly established and provided in any single document of authority. Definitions of magnitude are similar to those used for industry EAs in Atlantic Canada including assessments of projects in Placentia Bay (NLRC 2007; Vale 2008; LGL 2013). For this EA, the magnitude of effects can be rated as:

- **Major -** An effect from the Project on a VEC is rated major if it is judged to result in a 10%, or greater, change in the size or health of a population or the carrying capacity of its habitat. A change in a population can result from an absolute reduction in population size or from displacement of animals to areas outside the area of consideration.

- **Moderate** - An effect from the Project on a VEC is rated moderate if it is judged to result in a 1% to less than 10% change in the size or health of a population or the carrying capacity of its habitat.
- **Minor** - An effect from the Project on a VEC is rated minor if it is judged to result in a less than 1% change in the size or health of the population or the carrying capacity of its habitat.
- **Negligible** - Negligible effects are from those interactions that are judged to have either no or minimal non-observable effects.

It is recognized that in most cases, it is not possible to precisely measure such percent changes. However, these percentage levels are used to provide the reader with a clear understanding of the expected relative magnitude of potential effects from the Project based upon existing information and professional judgement

When evaluating the magnitude of predicted effects, certain VECs have special status. For example, effects on endangered species such as leatherback sea turtles, were given more weight than were similar effects on other species.

Project activities are not expected to result in the mortality of species listed on Schedule 1 of *SARA*. A reduction in population size of species listed as Endangered or Threatened on Schedule 1 of *SARA* (i.e., mortality of an individual) is considered "major" in magnitude.

The categorization of magnitude includes consideration of scientific literature, modelling results, and the use of professional judgement. The magnitude ranking contributes to the assessment of significance.

### 3.7.4.2 Geographic Extent

The geographic extent or scale of effects refers to the specific area ($km^2$) affected by the project activity, which may vary depending on the activity and the relevant VEC. Geographic extent can be categorized as:

- <1 $km^2$
- 1–10 $km^2$
- 11–100 $km^2$
- 101–1,000 $km^2$
- 1,001–10,000 $km^2$
- >10,000 $km^2$

It should be noted that an area of 100 km² is a circle with a radius of 5.6 km around a defined point. A circular area of 1,000 km² would have a radius of about 17.8 km and an area of 10,000 km² would have a radius of about 56 km.

### 3.7.4.3 Duration and Frequency of Effects

Duration categories (time period effects are expected to occur) include:

- <1 month (short-term)
- 1–12 months (short-term)
- 13–36 months (medium-term)

- 37–72 months (medium-term)
- >72 months (long-term)

One should remember that the duration of an effect might be longer than the duration of the project activities that cause it. Therefore, one should not assume that once a project activity has ceased, its effects on the environment are no longer of concern.

Frequency for biophysical effects addresses interactions with short but repeated duration. Frequency is usually expressed in terms of a one-year cycle.

### 3.7.4.4 Reversibility

Reversibility refers to the ability of a VEC to return to either an equal or improved condition at the end of the Project. It should be noted that a biological effect may be irreversible at the individual level (e.g., mortality of an individual animal) but reversible at the population level.

### 3.7.4.5 Ecological/Social-cultural and Economic Context

The ecological, socio-cultural and economic context describes the current status of the area affected by the proposed Project in terms of existing environmental effects. Three levels were considered:

- pristine area,
- area affected by human activity, and
- area with existing evidence of adverse effects.

Based on the presence of shipping and fishing activity within and near the Study Area, the ecological, socio-cultural and economic context was classified as an area affected by human activity.

### 3.7.4.6 Significance of Environmental Effects

Significant environmental effects are those that are considered to be of sufficient magnitude, duration, and geographic extent to cause a change in the VEC that will alter its status or integrity beyond an acceptable level. Establishment of the criteria is based on professional judgement, but should be transparent and repeatable. An effect can be considered significant (negative by definition), not significant, or positive. In this EA, a significant effect is defined as one having either:

- *A major magnitude; or*
- *A moderate magnitude for a duration >1 year over a geographic extent >100 km$^2$.*

### 3.7.4.7 Level of Confidence

An assessment of scientific certainty (i.e., low, medium, and high levels of confidence) is provided based on confidence in the scientific information available when an effect is judged to have a particular negative effect on a VEC. Level of confidence can be assessed as:

- Low: Based on incomplete understanding of cause-effect relationships and/or incomplete data specific to the Project Area.
- Medium: Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationships using data specific to the Project Area.
- High: Based on good understanding of cause-effect relationships and data specific to the Project Area.

### 3.7.5 Evaluation Criteria for Assessing Socio-economic Effects

The socio-economic methodology used in this assessment is that used in Newfoundland and Labrador Refinery Project EIS (Volume 4 *in* NLRC 2007), with some minor adjustments. While the basic process of assessment is the same as for a biophysical assessment and the attributes considered in the socio-economic assessment are comparable to the biophysical assessment, the definitions and the effects rankings are different (see Tables 3.3 and 3.4). A significant environmental effect is one considered to be of sufficient magnitude, duration, frequency, geographic extent, and/or reversibility that it causes a change in a VEC that will alter its status or integrity beyond an acceptable level. Assessment is based on professional judgment, is repeatable and transparent. Note that with this methodology, residual effects are significant, not significant, or positive. A significant socio-economic effect is:

> *An effect which is highly distinguishable and results in strong concern or strong support among stakeholders or results in substantive changes in the well-being of residents in the primary Study Area.*

**Table 3.3. Definitions of attributes used in the socio-economic effects assessment process.**

| Attribute | Definition |
|---|---|
| Direction | Describes the ultimate long-term trend of the effect. |
| Magnitude | Describes the severity or intensity of the effect; typical measurements of magnitude indicate gains or losses in features or changes in conditions. |
| Geographic extent | Describes the area over which the particular effect will occur and is similar to the spatial boundaries of the assessment. |
| Duration | Refers to how long an effect will occur and is closely related to the project phase or activity that could cause the effect. |
| Frequency | Is associated with duration and refers to the number of occurrences that can be expected during each phase of the project. |
| Reversibility | Is the ability of the human community (i.e., economy, society and culture) to return to conditions that existed prior to the adverse project effect. If project effects are positive, this attribute is not applicable. |
| Level of Confidence | Enables the analyst to assign a level of confidence to the prediction, based on an understanding of the limitations of the prediction exercise. |
| Certainty | Enables the analyst to assign a level of probability that the effects will occur. |
| Mitigation or Enhancement Success | Enables the analyst to determine how well mitigation contributes to lessening of adverse effects or how well enhancement measures contribute to positive effects. |
| Significance | An overall measure of the effect on the receptor. |

For this assessment, effects are judged assuming the implementation of Project mitigation measures, i.e., an assessment of residual effects.

**Table 3.4. Effects ratings used for assessing socio-economic effects.**

| Effects Ratings | |
|---|---|
| **Direction** | |
| Adverse | Effect is worsening or is not desirable. |
| Neutral | There is no effect. |
| Positive | Effect is improving or is desirable. |
| **Magnitude** | |
| Negligible | Does not have a measurable effect on valued socio-economic components. |
| Low | Has a measurable effect on socio-economic components but is of short-term duration. |
| Medium | Has a measurable effect on socio-economic components but is of medium duration. |
| High | Has a measurable and sustained effect on socio-economic components. |
| **Geographic Extent** | |
| Local | Effect is limited to the Burin Peninsula. |
| Regional | Effect extends to the Study Area. |
| Provincial | Effect extends throughout the province of Newfoundland and Labrador. |
| Sub-National/National | Effect extends beyond Newfoundland and Labrador. |
| **Duration** | |
| Short-term | Effect is expected to last less than two years. |
| Medium-term | Effect is expected to last between two and ten years. |
| Long-term | Effect extends throughout operation phase or beyond. |
| **Frequency** | |
| Rare | Effect occurs infrequently and is difficult to predict. |
| Intermittent | Effect occurs infrequently but when it will occur can be predicted. |
| Continuous | Effect occurs continuously. |
| **Reversibility** | |
| Yes | VEC is capable of returning to an equal, or improved, condition once the disturbance has ended. |
| No | VEC is not capable of returning to an equal, or improved, condition once the disturbance has ended. |
| **Level of Confidence** | |
| Low | Information provided should be considered as having a low probability of being absolutely accurate. |
| Medium | Information provided should be considered as having a medium probability of being accurate. |
| High | Information provided should be considered as having a high probability of being accurate. |
| **Certainty** | |
| Low | The effect can be considered to have a low probability of occurring. |
| Medium | The effect can be considered to have a medium probability of occurring. |
| High | The effect can be considered to have a high probability of occurring. |
| **Mitigation of Enhancement Success** | |
| Highly Effective | Mitigation measures allow any negative effects to the socio-economic indicator to be eliminated and the indicator returns to its original condition. Enhancement measures result in a measurable positive change in the socio-economic indicator. |
| Moderately Effective | Mitigation measures allow any negative effects to the socio-economic indicator to be partially eliminated and there is no permanent negative impact. Enhancement measures will result in a slight positive change in the socio-economic indicator. |
| Minimally Effective | Mitigation measures do not eliminate negative effects to the socio-economic and there is major change in socio-economic indicator with a permanent negative impact. Enhancement measures do not result in any positive changes in the socio-economic indicator. |
| **Significance** | |
| Negligible | No effects. |
| Minor | Low-level effects are distinguishable. These are usually limited to the short-term and are geographically circumscribed but are not considered disruptive to normal socio-economic conditions even if widespread and sustained[a]. |
| Moderate | Effects are clearly distinguishable and result in elevated awareness or concern among stakeholders or materially affect the well-being of defined populations/communities. Usually are short- to medium-term in duration and are amenable to management if they occur over the longer term. |
| High or Major | Effects are highly distinguishable and result in strong concern or support among stakeholders or result in substantive changes in the well-being of defined populations/communities. |

[a] Typically, minor socio-economic effects are not considered to require mitigation or management action to either enhance benefits or control adverse impacts. Moderate and significant effects require cooperative and coordinated impact management on the part of the proponent, governments and affected populations. Moderate effects can typically be managed by such action to result in a range of outcomes acceptable to most key stakeholders. Significant effects require decisive management action to either reduce adverse or optimize beneficial impact outcomes.

### 3.7.6 Cumulative Effects

Cumulative effects refer to the effect a project or activity has on the environment when combined with the effects of other past, existing and reasonably foreseeable projects and activities. Projects and activities that will be considered in the cumulative effects assessment include other human activities in Placentia Bay. The assessment also considers the cumulative effects of within-project activities.

### 3.7.7 Accidental Events Assessment

Grieg NL has developed accidental event scenarios to indicate reasonable "worst-case" scenarios that may occur during the Project. Emergency case scenarios have also been developed and assessed. In actual practice, every measure will be taken to prevent such occurrences and to have a high level of emergency preparedness in place. Nonetheless, for the purposes of effects assessment, 16 scenarios were identified for consideration. The effect on each VEC is described, followed by an assessment of the effects using the criteria and rating system described above.

### 3.7.8 Follow-up and Monitoring

Environmental effects monitoring (EEM) or follow-up monitoring are designed to confirm effects predictions and to establish the effectiveness of mitigation measures. The process of effects predictions will therefore provide a basis for the development of appropriate and focused monitoring programs, which will be developed and implemented as required. In many cases, the data collected in support of the EIS will provide a basis for EEM design.

# 4.0 Existing Environment

A description of the existing biophysical environment within the Study Area is provided including relevant components of the atmospheric, aquatic, and terrestrial environments. The description of the socio-economic environment includes relevant components of the land and resource use, heritage resources, communities, economy, employment, and business. Emphasis is placed on describing VECs.

## 4.1 Atmosphere

### 4.1.1 Overview

Oceans Limited prepared an analysis of the metocean conditions for the northern half of Placentia Bay, the results of which are presented in Appendix V and summarized in the following subsections. Data sources used to analyze precipitation, air temperature and wind speed and direction include the MSC50 Wind and Wave Reanalysis dataset, the National Hurricane Centre's Tropical Storm dataset, two SmartBay buoys, and several ECCC Weather Stations located throughout the Study Area (see Figure 2.1 *in* Appendix V).

### 4.1.2 Climate and Meteorology

The climate and meteorology in the Study Area is described in Section 2.2 of Appendix V. Typical of marine environments, climate conditions in Placentia Bay are influenced by its surrounding waters and the passage of high- and low-pressure circulation systems. Weather in marine regions generally includes cooler summers and milder winters than continental regions, with a narrower annual temperature range and overall more humid conditions. Increased humidity in marine regions results in reduced visibility (e.g., due to fog), low cloud heights and high precipitation. Monthly and annual minimum, maximum and mean values for precipitation, temperature and wind speed, along with prevailing wind direction and indications of recent climate change observations and trends in the Study Area are provided in Sections 4.1.2.1–4.1.2.4. Where precipitation, air temperature and wind speed measurements were unavailable specifically within a BMA, data from nearby sources (e.g., weather stations and SmartBay buoys) were utilized (see Figure 2.1 *in* Appendix V). Storm events are summarized in Section 4.2.2.5 below.

#### 4.1.2.1 Precipitation

Precipitation in northern Placentia Bay is described in Section 2.6 of Appendix V. Precipitation values were obtained from four ECCC climate stations in northern Placentia Bay: Red Harbour (west of the Rushoon BMA), Long Harbour (within the Long Harbour BMA), and Arnold's Cove and Come by Chance (north of the Merasheen and Red Island BMAs) (see Figure 2.1 *in* Appendix V). Monthly and annual minimum, maximum and mean precipitation values for the Rushoon, Merasheen, Red Island and Long Harbour BMAs are provided in Table 4.1. Mean annual precipitation values range from ~108–154 mm (minimum: 13 mm; maximum: 361 mm; during a given month), with maximum daily precipitation values of ~108–199 mm for all four BMAs. On average, the Rushoon BMA receives the highest precipitation during a given month.

**Table 4.1. Monthly and annual minimum ('min'), maximum ('max') and mean precipitation values (mm) for the Rushoon, Merasheen, Red Island and Long Harbour BMAs. Location names in parentheses indicate representative ECCC climate stations. Values inclusive of all available data sources for each BMA.**

| Month | Rushoon BMA (Red Harbour) | | | Merasheen and Red Island BMAs (Come by Chance & Arnold's Cove) | | | Long Harbour BMA (Long Harbour) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean |
| Jan | 101.0 | 278.0 | 162.9 | 37.8 | 213.7 | 124.2 | 42.0 | 202.1 | 127.4 |
| Feb | 54.2 | 226.0 | 149.1 | 17.2 | 265.2 | 103.6 | 24.4 | 207.7 | 111.6 |
| Mar | 78.0 | 279.3 | 144.3 | 42.9 | 171.0 | 104.0 | 42.5 | 218.4 | 110.0 |
| Apr | 65.4 | 361.0 | 145.5 | 20.8 | 196.9 | 89.6 | 21.9 | 240.9 | 101.9 |
| May | 49.6 | 245.6 | 146.6 | 28.8 | 153.8 | 90.8 | 28.8 | 157.2 | 92.7 |
| Jun | 53.8 | 186.3 | 114.9 | 42.2 | 300.5 | 121.7 | 17.8 | 249.2 | 112.8 |
| Jul | 57.3 | 195.2 | 124.4 | 21.1 | 233.4 | 90.4 | 13.0 | 223.4 | 92.3 |
| Aug | 80.6 | 196.2 | 120.2 | 28.2 | 204.0 | 96.8 | 53.2 | 343.6 | 110.5 |
| Sep | 92.6 | 294.6 | 179.3 | 33.8 | 196.2 | 109.6 | 52.3 | 222.7 | 124.5 |
| Oct | 117.6 | 355.5 | 207.2 | 33.7 | 259.4 | 134.2 | 52.6 | 311.2 | 148.0 |
| Nov | 74.6 | 273.0 | 176.2 | 33.0 | 185.8 | 116.2 | 62.8 | 208.4 | 125.9 |
| Dec | 142.0 | 231.6 | 174.3 | 56.2 | 207.2 | 113.3 | 60.8 | 168.2 | 117.6 |
| Annual | 49.6 | 361.0 | 153.7 | 17.2 | 300.5 | 107.9 | 13.0 | 343.6 | 114.6 |

Source: Appendix V.

### 4.1.2.2 Air Temperature

Air temperature in northern Placentia Bay is described in Section 2.5 of Appendix V. Monthly and annual minimum, maximum and mean air temperature values for the Rushoon, Merasheen, Red Island and Long Harbour BMAs are provided in Table 4.2. The Marticot Harbour and Long Harbour ECCC climate stations are within the Rushoon and Long Harbour BMAs, respectively. Otherwise, the Red Harbour climate station is west of the Rushoon BMA, and the Argentia station is south of the Long Harbour BMA. There are no climate stations within the Merasheen or Red Island BMAs. The Come By Chance and Arnold's Cove climate stations are north of these two BMAs (see Figure 2.1 *in* Appendix V). Air temperature is not expected to vary much throughout the northern Placentia Bay region on a given day. The mean annual air temperature for all four BMAs is ~5ºC, with minimum and maximum temperature ranges of approximately -30–30ºC.

### 4.1.2.3 Wind Speed and Direction

Wind speed within the BMAs is described in Section 2.3 of Appendix V. Monthly and annual minimum, maximum and mean wind speed values for the Rushoon, Merasheen and Long Harbour BMAs are provided in Table 4.3. Mean wind speeds are ~8 m/s (minimum: 0.0 m/s; maximum: ~30 m/s) or ~29 km/h (~16 knots) for all three BMAs. Wind speed and direction statistics are not available for the Red Island BMA due to lack of observations and modelled data in the area. Due to the proximity of the islands to the east and west of the Red Island BMA, prevailing winds would be north-northeast to south-southwest, with the islands occasionally serving as wind breaks, particularly for the Butler Island and Red Island proposed sea cage sites.

**Table 4.2. Monthly and annual minimum ('min'), maximum ('max') and mean air temperature values (ºC) for the Rushoon, Merasheen, Red Island and Long Harbour BMAs. Location names in parentheses indicate representative ECCC climate stations. Values inclusive of all available data sources for each BMA.**

| Month | Rushoon BMA (Red Harbour & Marticot Harbour) | | | Merasheen and Red Island BMAs (Come by Chance & Arnold's Cove) | | | Long Harbour BMA (Long Harbour & Argentia) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean |
| Jan | -24.5 | 12.0 | -3.5 | -25.6 | 11.0 | -4.6 | -24.0 | 15.1 | -2.8 |
| Feb | -28.5 | 9.0 | -4.1 | -28.9 | 14.5 | -5.3 | -25.0 | 16.0 | -3.2 |
| Mar | -22.0 | 12.5 | -2.0 | -25.0 | 15.0 | -2.2 | -22.5 | 17.2 | -1.0 |
| Apr | -17.0 | 17.0 | 2.1 | -18.0 | 20.0 | 2.3 | -14.0 | 21.0 | 2.6 |
| May | -6.0 | 25.5 | 6.0 | -8.0 | 20.0 | 6.0 | -6.7 | 20.6 | 6.2 |
| Jun | -2.0 | 26.0 | 10.2 | -3.3 | 25.0 | 9.7 | -5.0 | 25.0 | 10.0 |
| Jul | 0.0 | 28.5 | 14.3 | 1.0 | 27.5 | 14.0 | -1.0 | 26.1 | 14.4 |
| Aug | 0.5 | 29.5 | 16.2 | 1.0 | 29.0 | 15.4 | 1.7 | 30.6 | 15.8 |
| Sep | -1.5 | 30.0 | 13.1 | -1.7 | 26.5 | 12.5 | -2.5 | 27.0 | 13.0 |
| Oct | -7.0 | 21.5 | 8.5 | -8.0 | 23.0 | 7.7 | -6.0 | 22.5 | 8.6 |
| Nov | -14.0 | 17.5 | 4.1 | -15.0 | 16.1 | 3.2 | -12.0 | 21.1 | 4.6 |
| Dec | -23.0 | 13.0 | -0.6 | -24.0 | 14.4 | -1.7 | -20.0 | 16.1 | 0.2 |
| Annual | -28.5 | 30.0 | 5.4 | -28.9 | 29.0 | 4.8 | -25.0 | 30.6 | 5.7 |

Source: Appendix V.

**Table 4.3. Monthly and annual minimum ('min'), maximum ('max') and mean wind speed values (m/s) for the Rushoon, Merasheen and Long Harbour BMAs (data unavailable for the Red Island BMA). Values inclusive of all available data sources for each BMA.**

| Month | Rushoon BMA | | | Merasheen BMA | | | Long Harbour BMA | | |
|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean |
| Jan | 1.0 | 25.3 | 10.6 | 1.7 | 25.1 | 10.6 | 0.2 | 30.3 | 9.8 |
| Feb | 0.5 | 26.3 | 10.1 | 0.7 | 26.9 | 10.1 | 0.1 | 30.8 | 9.4 |
| Mar | 0.6 | 26.9 | 9.3 | 0.1 | 26.9 | 9.3 | 0.1 | 26.7 | 8.7 |
| Apr | 0.4 | 20.5 | 8.0 | 0.6 | 20.3 | 8.0 | 0.1 | 25.8 | 7.6 |
| May | 0.3 | 21.3 | 6.3 | 0.4 | 19.1 | 6.4 | 0.0 | 23.4 | 6.1 |
| Jun | 0.1 | 19.5 | 5.7 | 0.2 | 19.4 | 5.7 | 0.0 | 20.6 | 5.6 |
| Jul | 0.2 | 22.2 | 5.4 | 0.3 | 22.8 | 5.4 | 0.1 | 22.2 | 5.5 |
| Aug | 0.3 | 24.4 | 6.0 | 0.4 | 22.8 | 6.0 | 0.1 | 25.6 | 5.9 |
| Sep | 0.4 | 26.5 | 7.2 | 0.6 | 26.9 | 7.3 | 0.1 | 29.9 | 6.9 |
| Oct | 0.9 | 30.0 | 8.6 | 0.9 | 28.3 | 8.6 | 0.1 | 28.6 | 8.0 |
| Nov | 0.5 | 23.8 | 9.4 | 0.8 | 23.4 | 9.5 | 0.0 | 28.0 | 8.8 |
| Dec | 1.1 | 25.4 | 10.4 | 1.5 | 24.6 | 10.4 | 0.1 | 30.0 | 9.6 |
| Annual | 0.1 | 30.0 | 8.1 | 0.1 | 28.3 | 8.1 | 0.0 | 30.8 | 7.7 |

Source: Appendix V.

The prevailing wind direction in Placentia Bay is a southwest to west flow throughout the year. During the winter, west to northwest winds are prevalent, with a counter-clockwise shift beginning in March and April resulting in predominant southwest winds during the summer. The tropical-to-polar temperature gradient strengthens during the fall, returning to prevailing westerly winds by late-fall and into the winter.

### 4.1.2.4 Climate Change

Section 2.7 of Appendix V describes climate change in the North Atlantic and eastern Canada. The number of icebergs off Newfoundland and Labrador is positively correlated with the Labrador spring ice extent, with a decrease in the sea ice extent due to climate variability likely resulting in fewer icebergs

near the proposed sea cage sites. Sea levels have been increasing on a global scale as a result of climate change, primarily due to thermal expansion and glacier melt. The rate of sea level change varies regionally, with some areas, generally those located near glaciers and ice sheets, experiencing a decrease in sea level while other regions observe a rise. A sea level rise of ~0.6 m is anticipated for the waters off southern Newfoundland, including Placentia Bay, by the 2081–2100 period.

An overall decrease in pressure and a poleward shift in the jet stream at a rate of 0.17–0.19 degrees/decade occurred during 1979–2001, implying an increase in jet stream altitude in the Northern Hemisphere. These changes were consistent with an increase in mean equator-to-pole temperature. Altered jet stream strength, latitude and altitude may affect the formation and evolution of storms in the mid-latitudes and hurricanes in sub-tropical regions, as reflected in a significant decrease in mid-latitude and increase in high-latitude cyclone frequency during 1959–1997, consistent with increases in winter Northern Hemisphere temperatures.

To help support climate change adaptation, flood risk mapping studies are being updated in Newfoundland and Labrador using climate change projections. This new mapping will assist in regulating new developments in flood-prone areas, help minimize flood damage, and restrict activities that could degrade water resources (MAE 2018). No updated mapping has been completed to date for flood risk areas in the Study Area. Section 4.2.2.4 below provides a summary of flood risk areas in the Study Area.

### 4.1.3 Air Emissions

Air emissions from Project activities are limited to those from vessel operations, construction equipment for the RAS Hatchery, and potential operation of back-up generators at the RAS Hatchery. Air emissions, including sources, in the Study Area have previously been described in the Long Harbour Commercial Nickel Processing Plant EIS (see Section 2.1, Atmospheric Environment; Volume 2 Part 1 *in* Vale 2008) and the Newfoundland and Labrador Refinery Project EIS (see Section 3.2, Air Quality, Biophysical Environment, Part 1 *in* NLRC 2007).

In general, current existing sources of greenhouse gas emissions near the proposed Project Area include the North Atlantic Refining Limited oil refinery in Come by Chance, Newfoundland Transshipment Terminal in Whiffen Head (near Arnold's Cove), CN Ferry Terminal, Port of Argentia, Vale Long Harbour nickel processing facility, commercial (fishing, transport, ferry) and recreational vessels, vehicles, and fish processing plants. The Marystown shipyard and Cow Head Fabrication Facility may become future sources of greenhouse gas emissions, but have been idle since December 2015.

Air quality conditions in the Placentia Bay region are monitored as part of GNL's Environmental Science and Monitoring Program. Air quality parameters measured at the Burin National Air Pollution Surveillance Program (NAPS) Station include nitric oxide, nitrogen dioxide, nitrogen oxides, ozone, sulfur dioxide, carbon monoxide, and particulate matter (10 and 2.5 microns [μ]) (GNL 2018). Average air quality values were well below maximum acceptable concentrations according to Air Pollution Control Regulations as measured in mid-spring 2018 (Table 4.4). The ambient concentration of ozone was nearest its maximum accepted value at ~46%. All other parameters with Regulatory values were within ≤17% of maximum accepted concentrations.

**Table 4.4. Average air quality values measured at the Burin NAPS Station 010901, 23 March–2 May 2018.**

| | Nitric Oxide (NO) (µg/m$^3$) | Nitrogen Dioxide ($NO_2$) (µg/m$^3$) | Nitrogen Oxides (µg/m$^3$) | Ozone ($O_3$) (µg/m$^3$) | Sulfur Dioxide ($SO_2$) (µg/m$^3$) | Carbon Monoxide (CO) (µg/m$^3$) | Particulate Matter (µg/m$^3$) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | 10 µ | 2.5 µ |
| **Average Value** | 0.1 | 0.8 | 0.8 | 73.8 | -0.3 | 142.8 | 8.6 | 2.4 |
| **Max. Accepted Value[a]** | - | 400 | - | 160 | 900 | - | 50 | 25 |

Source: GNL (2018).
[a] Air Pollution Control Regulations maximum acceptable concentration.

### 4.1.4 Ambient Noise

Relevant in-air ambient noise levels associated with the Project would be existing conditions at the proposed sea cage sites. Project activities at the RAS Hatchery occur within an existing Marine Industrial Park in Marystown. Existing noise levels were previously described for Long Harbour in the Long Harbour Commercial Nickel Processing Plant EIS (see Section 2.1.4, Volume 2 Part 1 *in* Vale 2008). Placentia Bay is a predominantly rural area, with relatively low ambient noise levels typical of small, coastal communities. Other than noise associated with existing industrial activity (see Section 4.1.3 above), the majority of in-air ambient noise levels in the Study Area would likely arise from local vehicle and marine vessel traffic, such as transport and Canadian Coast Guard vessels, fishing boats, ferries and recreational vessels.

## 4.2 Aquatic

### 4.2.1 Overview

Aquatic aspects of the physical environment in Placentia Bay including water depth and quality, river locations, ocean currents and waves, ice conditions, flood and tidal zones, and storms are described below. Many aspects of the physical environment can have direct effects on the Project. This section also provides a description of existing environmental conditions for the Fish and Fish Habitat, Wild Atlantic Salmon, Species at Risk, and Sensitive Areas VECs.

### 4.2.2 Physical Environment

The bathymetry of Placentia Bay is irregular with numerous banks and troughs. A deep channel on the eastern side of Placentia Bay has water depths extending to ~300 m in some locations. Generally, water depths are shallower on the western side of Placentia Bay relative to the eastern side, with the exception of various deep troughs. Numerous rivers flow into Placentia Bay. Physical characteristics of the Study Area, including substrate characterization, are further described in LGL (2018b *in* Volume 3).

#### 4.2.2.1 Location of Rivers

There are numerous rivers that flow into Placentia Bay including 20 scheduled salmon rivers and four non-scheduled salmon rivers (Porter et al. 1974a,b) (Figure 4.1). In addition, Shalloway Pond Brook in the Argentia vicinity has documented occurrences of Arctic char and rainbow trout (Porter et al. 1974a,b),

both salmonid species. As detailed in LGL (2018a *in* Volume 3), the mouths of the majority of scheduled and non-scheduled salmon rivers in Placentia Bay are located >20 km from a proposed sea cage site.

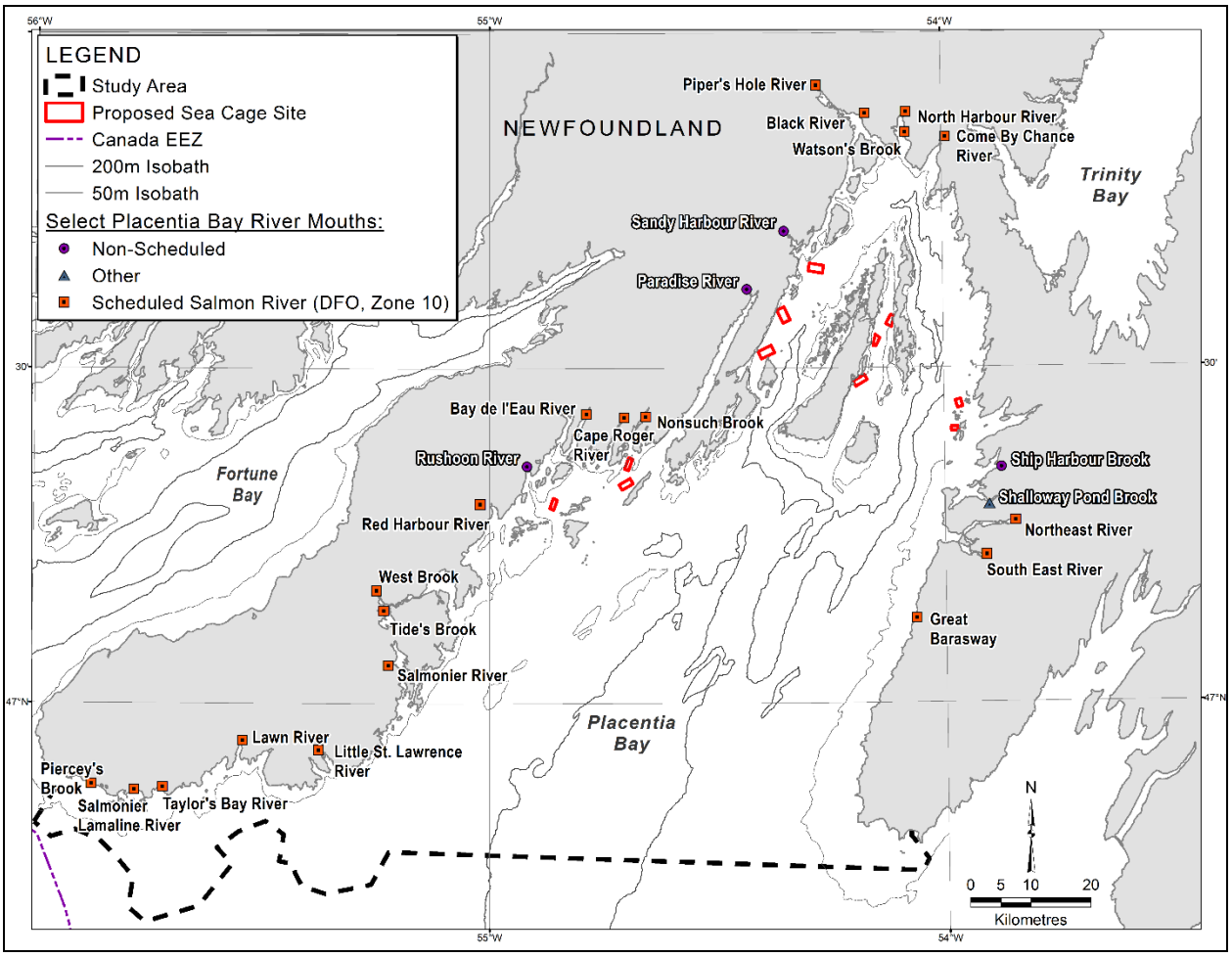



**Figure 4.1. Locations of scheduled and non-scheduled salmon rivers in Placentia Bay.**

### 4.2.2.2 Ocean Currents

Ocean currents within Placentia Bay are discussed in Section 3.1 of Appendix V. The near-surface currents in Placentia Bay flow in a counter-clockwise orientation, although this circulation pattern is inconsistent at deeper water depths. The flow in Placentia Bay is influenced by the predominantly southwesterly winds, the Labrador Current, and, to a lesser extent, tides. The inshore branch of the Labrador Current follows the Avalon Peninsula's bathymetric contours. The Labrador Current likely divides north of Green Bank, a portion of the Grand Banks south of Placentia Bay and east of the Halibut Channel, where the bathymetric contours shift from an east/west orientation to north/south, with a portion of the Labrador Current flowing into Placentia Bay and having a major influence on the overall current variability in the Study Area.

Ocean current data was collected within and near the Rushoon, Merasheen, Red Island and Long Harbour BMAs by the Department of Physics and Physical Oceanography (MUN), the Bedford Institute of

Oceanography, the Marine Institute School of Ocean Technology (via SmartBay Buoy), and DHI for Grieg NL (see Figure 3.1 *in* Appendix V for the location of current meter moorings in Placentia Bay). Mean, maximum and spring tide tidal current speeds for the four BMAs are presented in Table 4.5. Where data were available, the mean current speeds ranged from ~8–16 cm/s (~0.3–0.6 km/h or ~0.2–0.3 kn) for the BMAs, with a maximum speed of 79 cm/s (~3 km/h or ~2 kn). Spring tide tidal currents were 5–10 cm/s (~0.2–0.4 km/h or ~0.1–0.2 kn).

**Table 4.5. Mean, maximum ('max'), and spring tide tidal current speed values (cm/s) for the Rushoon, Merasheen, Red Island and Long Harbour BMAs. Values inclusive of all available data sources for each BMA.**

| BMA | Location Relative to BMA | Depth (m) | Current Speed (cm/s) | | Spring Tide Tidal Current (cm/s) |
|---|---|---|---|---|---|
| | | | Mean | Max | |
| Rushoon | South of BMA | 20 | 10.3 | 49.7 | 8 |
| | South of BMA | - | 9.1 | 37.3 | |
| | Proposed Sea Cage Site - Gallows Harbour | 30 | - | 5 | |
| | Proposed Sea Cage Site - Long Island | 30 | - | 15 | |
| | Proposed Sea Cage Site - Oderin Island | 30 | - | 5 | |
| Merasheen | North & South of BMA | 36 | 7.9 | 36.5 | 5–6 |
| | Proposed Sea Cage Site - Ship Island | 30 | - | 30 | |
| | Proposed Sea Cage Site - Chambers Island | 30 | - | 14 | |
| | Proposed Sea Cage Site - Valen Island | 30 | - | 10 | |
| Red Island | Proposed Sea Cage Sites | 30 | - | 15 | - |
| Long Harbour | Eastern Head of Placentia Bay | 20 | 14.5 | 75 | 10 |
| | Middle of Channel between Red Island & Long Harbour | 16 | 16 | 79 | |
| | Southwest of Long Harbour | 23 | 12.5 | 75 | |
| | Proposed Sea Cage Site - Brine Islands | 30 | - | 25 | |
| | Proposed Sea Cage Site - Iona Islands | 30 | - | 25 | |

Source: Appendix V.
'-' Denotes data unavailable.

### 4.2.2.3 Wind and Wave Action

Wind and wave action is described in Section 3.2 of Appendix V. A sea state may be composed of a wind wave, swell, or a combination of a wind wave and one or more swells. The wave climate of Placentia Bay is dominated by extra-tropical storms, predominantly during October through March. Storms are further summarized in Section 4.2.2.5. The majority of wave energy travels from the west/south-southwest to the east/east-northeast in the Rushoon BMA, and the southwest to the northeast in the Merasheen and Long Harbour BMAs. Wave energy direction is not available for the Red Island BMA.

Wind climate data for 1954–2015 from the MSC50 North Atlantic wind and wave climatology database were analysed for the northern Placentia Bay area. Monthly and annual mean and maximum wave height values for the Rushoon, Merasheen, Red Island and Long Harbour BMAs are provided in Table 4.6. Wave height values for the Red Island BMA were modelled for a location north of Red Island. While not entirely representative of conditions near the proposed sea cage sites within the Red Island BMA, these values provide a better synopsis of conditions than data from the open Bay. Mean wave heights are approximately 1 m or less for the BMAs, with maximum wave heights of ~8 m.

Extreme mean and maximum significant wave heights, such as those induced by storm events, were estimated based on probability for the Rushoon, Merasheen and Long Harbour BMAs for the next 100 years, and are summarized in Table 4.7. Data were not available to perform an estimation for the Red Island BMA. Probable estimated extreme mean and maximum significant wave height values during

1-, 10-, 25-, 50- and 100-year periods are greatest for the Rushoon BMA, followed by the Merasheen and Long Harbour BMAs.

**Table 4.6. Monthly and annual mean and maximum ('max') wave height values (m) for the Rushoon, Merasheen, Red Island and Long Harbour BMAs. Values inclusive of all available data sources for each BMA.**

| Month | Rushoon BMA | | Merasheen BMA | | Red Island BMA[a] | | Long Harbour BMA | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Max | Mean | Max | Mean | Max | Mean | Max |
| Jan | 1.5 | 6.2 | 1.0 | 6.1 | 0.7 | 2.8 | 1.1 | 7.9 |
| Feb | 1.4 | 6.7 | 1.0 | 6.4 | 0.7 | 2.6 | 1.1 | 7.5 |
| Mar | 1.3 | 6.7 | 0.9 | 6.5 | 0.6 | 2.7 | 0.9 | 7.0 |
| Apr | 1.1 | 4.6 | 0.7 | 4.3 | 0.6 | 2.1 | 0.8 | 7.0 |
| May | 0.9 | 5.0 | 0.6 | 4.2 | 0.4 | 2.3 | 0.5 | 3.9 |
| Jun | 0.8 | 4.1 | 0.5 | 3.7 | 0.4 | 1.8 | 0.5 | 4.0 |
| Jul | 0.8 | 4.6 | 0.5 | 4.3 | 0.4 | 2.0 | 0.5 | 3.4 |
| Aug | 0.8 | 6.0 | 0.6 | 5.2 | 0.4 | 2.3 | 0.5 | 4.0 |
| Sep | 1.0 | 6.9 | 0.7 | 6.2 | 0.5 | 2.4 | 0.6 | 5.0 |
| Oct | 1.1 | 7.8 | 0.8 | 7.2 | 0.5 | 3.2 | 0.8 | 5.8 |
| Nov | 1.2 | 6.2 | 0.9 | 5.5 | 0.6 | 2.9 | 0.9 | 6.9 |
| Dec | 1.4 | 6.9 | 1.0 | 6.2 | 0.7 | 3.2 | 1.0 | 7.8 |
| Annual | 1.1 | 7.8 | 0.7 | 7.2 | 0.5 | 3.2 | 0.8 | 7.9 |

Source: Appendix V.

[a] Significant wave height (i.e., the average height of the highest third of the waves; its value roughly approximates the characteristic height observed visually).

**Table 4.7. Estimated mean and maximum ('max') extreme significant wave height values (m) for the Rushoon, Merasheen, and Long Harbour BMAs (data unavailable to estimate values for the Red Island BMA). Values inclusive of all available data sources for each BMA.**

| BMA | 1-year | | 10-year | | 25-year | | 50-year | | 100-year | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Max | Mean | Max | Mean | Max | Mean | Max | Mean | Max |
| Rushoon | 4.8 | 9.5 | 6.0 | 11.7 | 6.4 | 12.5 | 6.7 | 13.2 | 7.1 | 13.8 |
| Merasheen | 3.1 | 8.6 | 3.9 | 10.7 | 4.2 | 11.6 | 4.5 | 12.2 | 4.7 | 12.9 |
| Long Harbour | 2.3 | 6.6 | 2.8 | 8.2 | 3.0 | 8.8 | 3.2 | 9.0 | 3.3 | 9.4 |

Source: Appendix V.

### 4.2.2.4 Flood and Tidal Zones

Tidal heights for stations throughout Placentia Bay were obtained from the Canadian Tide and Current Tables and the Canadian Tides and Water Levels Data Archive databases, and summarized in Tables 3.12–3.14 *in* Section 3.4 of Appendix V. Mean water levels are 1.1–1.6 m within and/or near the four BMAs, ranging from mean low and high water tide levels of 0.5–2.5 m, respectively. Recorded extreme data were available for Argentia, with tide levels from -0.4–3.4 m.

A storm surge is a pronounced increase in sea level associated with the passage of storm systems, defined as the difference between the observed water level and predicted astronomical tide. This sea level rise is typically produced by the combined forces of wind stress acting on the ocean and the inverted barometer effect due to storm-related low atmospheric pressure. Near the shoreline of Placentia Bay, the height of a storm surge could exceed 0.7 m. During storm events in September 2010 (Hurricane Igor) and January 2004, storm surges of ~0.03 m were observed at Argentia, resulting in a local sea level rise to 2.6 m as a result of the combined tidal and storm surge heights.

Although generally less pronounced than onshore storm surges, negative storm surges associated with offshore winds can result in a decrease in water level below the astronomical tide level, creating unusually shallow water if they occur near low tide. During December 2006, an intense low-pressure system passing west of Placentia Bay produced strong- to gale-force northerly winds, resulting in offshore winds forcing water out of the Bay and a negative storm surge of -0.7 m at Argentia. Storms are further summarized in Section 4.2.2.5 below.

The processes and conditions that result in floods are often predictable and usually occur in the same areas, known as floodplains (MAE 2018). Areas at risk for flooding are typically subdivided into floodway and flood fringe zones. The floodway is the portion of a floodplain with the highest risk of flooding, and where flood waters are deepest and the most destructive. The outer portion of the flood zone, the flood fringe, has a reduced risk of flooding, and the water is generally slower and less hazardous than the floodway (MAE 2018). Flood risk mapping in Newfoundland and Labrador delineates the floodway as zones where floods have a return period of 20 years (i.e., 5% chance of flood in a given year), and flood risk areas have been mapped for 38 communities in the Province (MAE 2018). Within the Study Area, Rushoon and Placentia have been identified as flood risk areas. The community of Rushoon encroaches upon the flood plain of Rushoon Brook, and residences in this area have been subjected to periodic flooding, including severe floods in 1973 and 1983 that were the result of factors such as heavy rain, mild temperatures, ice jam and/or a break in ice cover (GNL 1986). Tidal waters flow through a narrow opening (the "Gut") from "Placentia Road" into Northeast Arm, between the north end of Placentia and the town of Jerseyside (GNL 1985). Placentia and Jerseyside have experienced minor flooding as a relatively regular occurrence on an annual or near annual basis (GNL 1985). Maps and associated hydrotechnical studies of the Rushoon and Placentia area flood plains are made freely available online by the Government of Newfoundland and Labrador (GNL 1986).

### 4.2.2.5 Storms

Portions of Sections 2.3, 2.4, 2.7.1 and 3.2 *in* Appendix V, and Section 4.1.2.4, Climate Change, describe storm patterns and conditions around Newfoundland and/or within the Study Area. In addition to mid-latitude low pressure systems in the region, tropical cyclones often travel northwards toward Newfoundland, beyond the influence of the warm waters of the Gulf Stream. The tropical cyclone season around Newfoundland typically occurs from June–November, although cyclones may occur beyond this period. Once these cyclones move over cold, Newfoundland waters, they lose their source of latent heat energy and typically begin to transition into fast-moving, rapidly developing extratropical cyclones. An average 46% of tropical cyclones formed in the Atlantic transform into extratropical cyclones, resulting in an increase in cyclone size and producing large waves, gale- to hurricane-force winds and intense rainfall. The likelihood of a tropical cyclone transitioning into an extratropical cyclone increases during the latter half of Newfoundland's tropical cyclone season, with the highest probability during October.

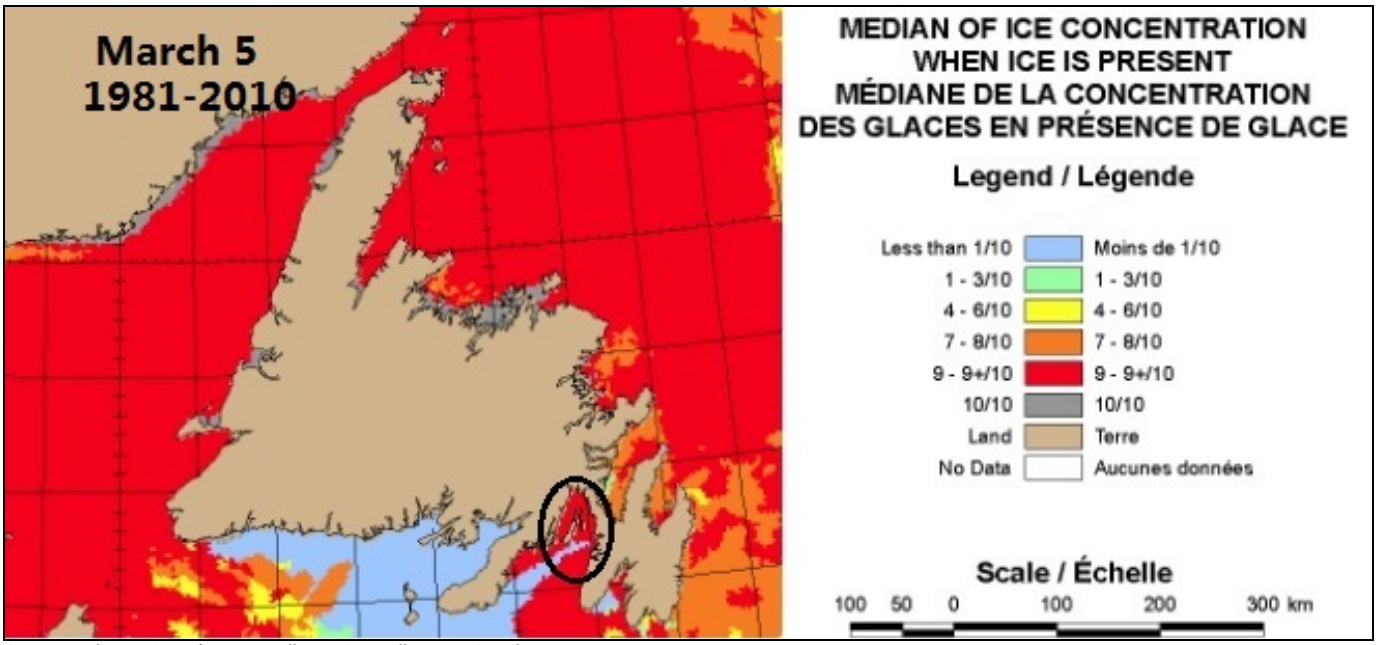
The number of tropical storms that have developed within the Atlantic Basin has increased during the last 19 years. This increase is attributed to naturally occurring cycles in tropical climate patterns near the equator, known as the 'tropical multi-decadal signal'. Despite this increase, there has not been a corresponding significant increase in the number of storms which have entered the Canadian Hurricane Response Zone or which have passed within 278 km (150 nm) of the BMAs.

A subset of tropical cyclone climatology data (April–September, 1960–2015) was analyzed from the National Hurricane Centre's best-track dataset, obtained from the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Centre Historical Hurricane Tracks online database. Data were analyzed for all storms within a 150-nm buffer zone of the Rushoon, Merasheen, Red Island or Long Harbour BMAs. Since 1960, 56 tropical systems passed within 150 nm of the BMAs (see Table 2.16 and

Figure 2.6 *in* Appendix V). These tropical systems occurred during June–October, with most systems appearing during September. Few of these systems maintained hurricane strength, including three Category 1, one Category 2 and one Category 3 strength hurricanes. The most intense of these hurricanes was Hurricane Ella, which entered the area on 5 September 1978 with maximum sustained wind speeds of 54.0 m/s (~195 km/h or ~105 kn) and a central pressure of 960 mb.

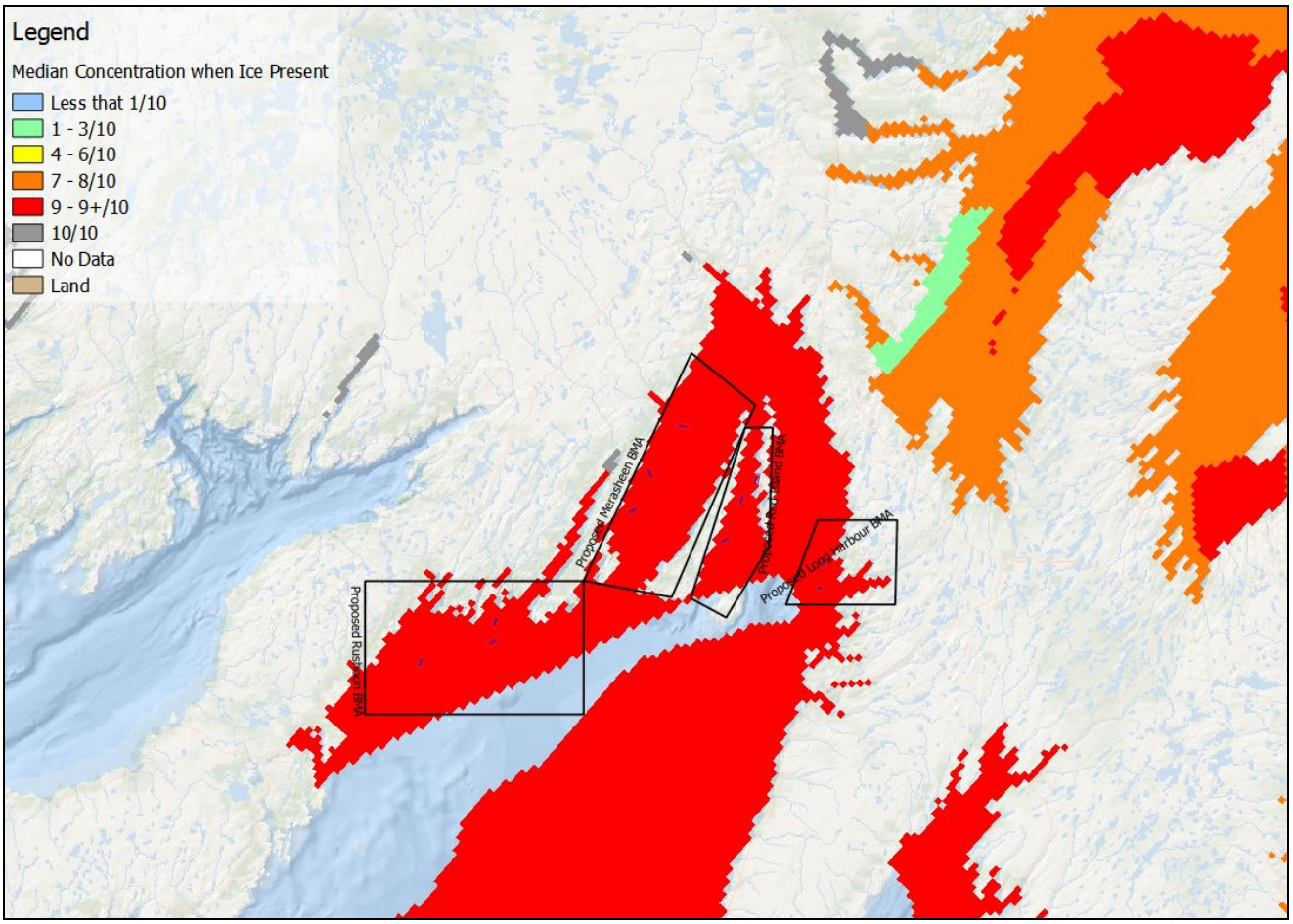
### 4.2.2.6 Ice

During periods of lower than normal wintertime sea level pressure over the North Atlantic, the Labrador Sea ice boundary extends further south towards Newfoundland during the spring. Placentia Bay is relatively ice-free compared to other bays surrounding Newfoundland. Sea ice and icebergs within the Study Area are described in Section 3.3 of Appendix V. Ice is only present in Placentia Bay from mid-February until mid-April, with the highest likelihood of ice presence during early-March. A weekly analysis of the Canadian Ice Service database of 30-year (1981–2010) median ice concentration when ice is present in Placentia Bay indicated a median ice concentration of 9 to 9+/10ths within the Rushoon, Merasheen, Red Island and Long Harbour BMAs during the week beginning on 5 March (Figures 4.2–4.3). The frequency of sea ice presence within the BMAs during this period is 1–15% (Figure 4.4).



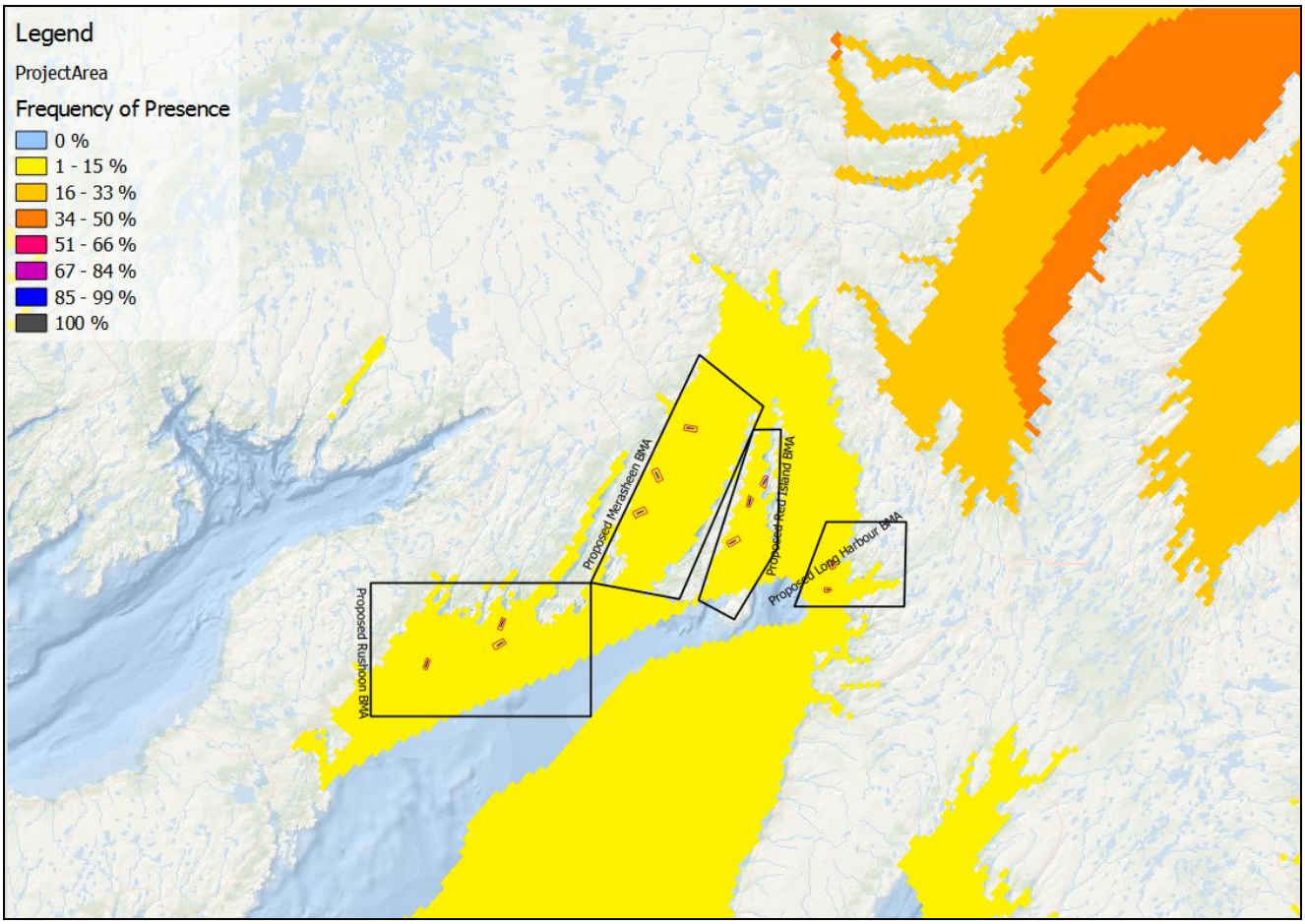

Source: Figure 3.14 *in* Appendix X; Canadian Ice Service.

**Figure 4.2. Median of ice concentration when ice is present for the week of 5 March, 1981–2010.**




Source: Figure 3.15 *in* Appendix X; Canadian Ice Service.

**Figure 4.3. Median of ice concentration when ice is present for the Rushoon, Merasheen, Red Island and Long Harbour BMAs for the week of 5 March, 1981–2010.**




Source: Figure 3.16 *in* Appendix X; Canadian Ice Service.

**Figure 4.4. Frequency of ice presence for the Rushoon, Merasheen, Red Island and Long Harbour BMAs for the week of 5 March, 1981–2010.**

Weekly sea ice charts for 2008–2017 for the northern half of Placentia Bay were analyzed and summarized in terms of percent frequency of ice conditions for February–April, the months during which sea ice may be present in the Study Area (Table 4.8). Values provided are "worst-case scenarios"; for example, if half of northern Placentia Bay was covered in 1/10$^{th}$ ice and half classified ice free, the value is provided as 1/10$^{th}$ for the whole northern Placentia Bay area. During 2008–2017, the concentration of the majority of sea ice was <1/10$^{th}$ (i.e., percent frequency of zero for ice concentration tenths 1 to 9+ during conditions of open water, bergy water or fast ice). An exception to the norm, the northern half of Placentia Bay contained 5/10ths coverage of sea ice during the week beginning 5 February during one year within the 2008–2017 period. Open water conditions are prevalent from mid-February to mid-April. Bergy water and fast ice conditions begin during mid-March, with fast ice disappearing by the end of April.

During 1960–2015, six icebergs of growler- to medium-size were sighted within the four BMAs, three in Rushoon and one each within Merasheen, Red Island and Long Harbour (see Table 3.11 *in* Appendix V). One of the icebergs sighted within the Rushoon BMA was of unknown size. None of these icebergs were within the immediate vicinity of the proposed sea cage sites, with the exception of a medium-sized berg

near the Iona Islands proposed sea cage site in the Long Harbour BMA during 1996 (see Figure 3.17 *in* Appendix V). Icebergs enter Placentia Bay from the Avalon Peninsula, with their presence and frequency dependent on factors such as iceberg concentration, ocean currents and wind.

**Table 4.8. Percent frequency of weekly sea ice concentration for the northern half of Placentia Bay, February–April, 2008–2017.**

| Month | Week Start Date | Percent Frequency of Sea Ice Condition | | | | Percent Frequency Tenths of Sea Ice Concentration | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ice Free | Open Water | Bergy Water | Fast Ice | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 9+ |
| Feb | 5 | 70 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| | 12 | 40 | 50 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 19 | 20 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 26 | 30 | 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mar | 5 | 40 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 12 | 40 | 40 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 19 | 50 | 20 | 0 | 20 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 26 | 60 | 20 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Apr | 2 | 40 | 30 | 20 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 9 | 40 | 40 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 16 | 60 | 10 | 20 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 23 | 60 | 10 | 10 | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 30 | 70 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Source: Table 3.10 *in* Appendix V.
Ice Free = No ice present.
Open Water = Large area of freely navigable water in which ice is present in concentrations <1/10. No ice of land origin is present.
Bergy Water = Area of freely navigable water in which ice of land origin is present. Other ice types may be present, although the total concentration of all other ice is <1/10.
Fast Ice = Ice which forms and remains fast along the coast. May be attached to shore, ice wall/front, between shoals or grounded icebergs. Vertical fluctuations may be observed during changes of sea level. Can extend to >100 km from the coast. May be >1 year old. If >2 m above sea level, referred to as an "ice shelf".

### 4.2.2.7 Water Quality

Water quality characteristics in the Study Area, more specifically, at the proposed sea cage sites are described in LGL (2018b *in* Volume 3). The outfall database of the Water Resources Portal maintained by the Government of Newfoundland and Labrador Department of Municipal Affairs and Environment (GNL n.d.) was utilized to compile a list of communities within the Study Area with known or possible outfalls for sewage effluent and/or other waste water discharges into the marine environment (Table 4.9, Figure 4.5). Where no outfalls are indicated for a community within the Water Resources Portal database, it is possible that one or more residences within the community discharge sewage and/or septic tank effluent directly into the sea. Marystown and Placentia have the most known outfalls within the Study Area, the majority of which discharge raw effluent.

There are four Blivet waste water treatment systems installed in the community of Marystown. All four systems discharge their treated effluent to dedicated exfiltration galleries installed in- or nearshore. One of these units is installed in the Marine Industrial Park for treatment of the Park's sanitary sewer. Effluent from this Blivet is discharged to an exfiltration gallery located on the Park's shore. Marystown also has an operational Abydoz engineered wetlands system, which diverts and treats a relatively small portion of its sanitary sewer contents.

**Table 4.9. Existing outfalls for sewage effluent and/or other waste water discharge from communities in the Study Area.**

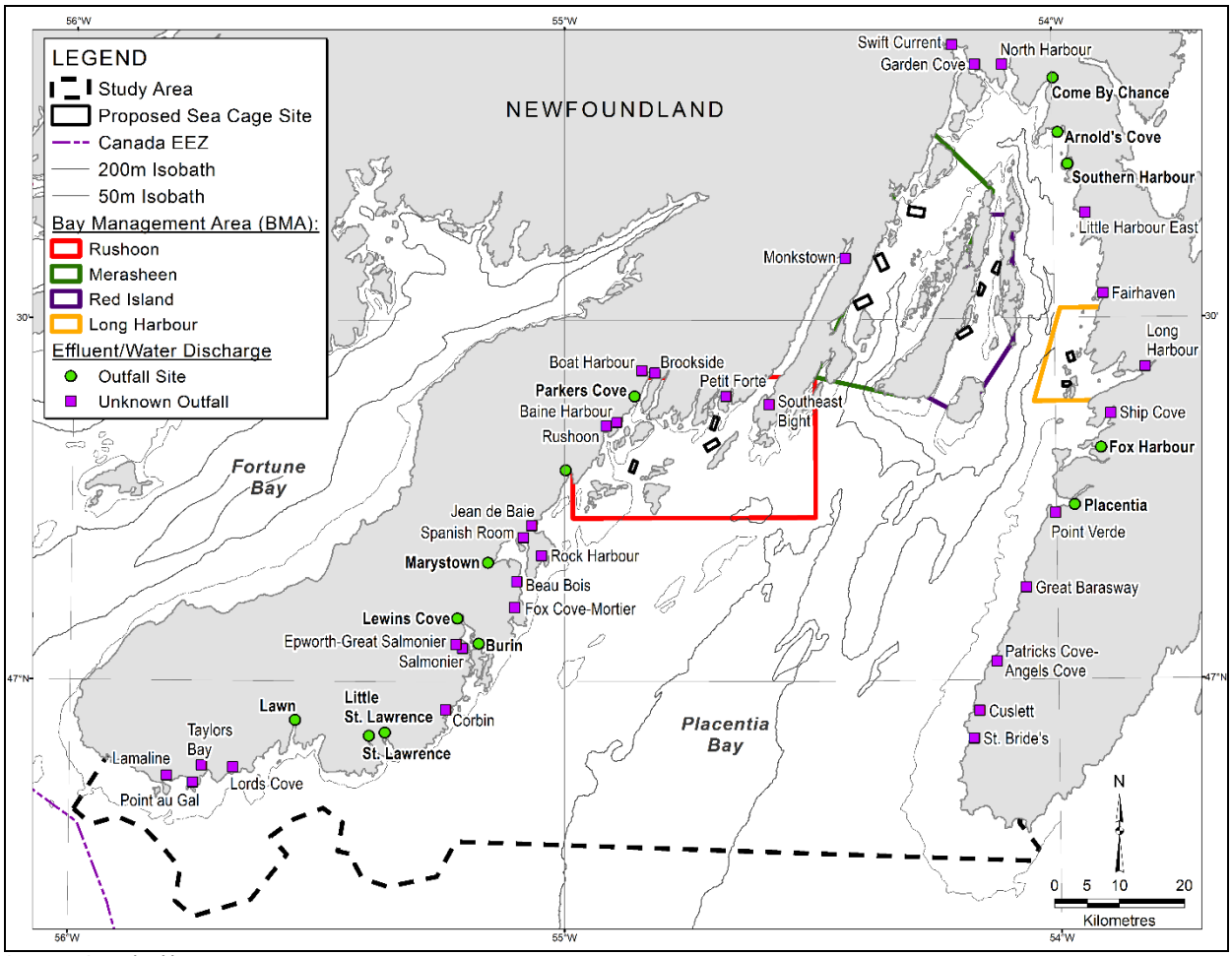
| Community | Community Type | Number of Outfalls | Treatment |
|---|---|---|---|
| Arnold's Cove | Municipality | 3 | Septic (2)<br>Raw (1) |
| Baine Harbour | Municipality | None | * |
| Beau Bois | Local Service District | None | * |
| Boat Harbour | - | None | * |
| Brookside | - | None | * |
| Burin | Municipality | 11 | Raw |
| Come By Chance | Municipality | 1 | Raw |
| Corbin | - | None | * |
| Cuslett | - | None | * |
| Epworth-Great Salmonier | Local Service District | None | * |
| Fairhaven | Local Service District | None | * |
| Fox Cove-Mortier | Municipality | None | * |
| Fox Harbour | Municipality | 3 | Septic |
| Garden Cove | Local Service District | None | * |
| Great Barasway | - | None | * |
| Jean de Baie | Local Service District | None | * |
| Lamaline | Municipality | None | * |
| Lawn | Municipality | 3 | Septic |
| Lewin's Cove | Municipality | 4 | Septic |
| Little Harbour East | Local Service District | None | * |
| Little St. Lawrence | Local Service District | 1 | Septic |
| Long Harbour-Mount Arlington Heights | Municipality | None | * |
| Lord's Cove | Municipality | None | * |
| Marystown | Municipality | 36 | Septic (1)<br>Raw (35) |
| Monkstown | - | None | * |
| North Harbour | Local Service District | None | * |
| Parkers Cove | Municipality | 2 | Raw |
| Patrick's Cove-Angels Cove | Local Service District | None | * |
| Petit Forte | Local Service District | None | * |
| Placentia[a] | Municipality | 32 | Blivet (1)<br>Unspecified Treatment (1)<br>Raw (30) |
| Point au Gaul | - | None | * |
| Point Verde | Municipality | None | * |
| Red Harbour | Local Service District | 1 | Raw |
| Rock Harbour | Municipality | None | * |
| Rushoon | - | None | * |
| Salmonier | - | None | * |
| Ship Harbour | Local Service District | None | * |
| Southeast Bight | Municipality | None | * |
| Southern Harbour | Local Service District | 2 | Raw |
| Spanish Room | Municipality | None | * |
| St. Bride's | Municipality | None | * |
| St. Lawrence | Local Service District | 10 | Raw |
| Swift Current | - | None | * |
| Taylor’s Bay | Municipality | None | * |

Source: GNL (n.d.).

‘-‘ Denotes information not available.

* Denotes community does not have outfalls indicated in the Government of Newfoundland and Labrador’s Department of Municipal Affairs and Environment Water Resources Portal database, but one or more residences may be discharging raw sewage or septic tank effluent directly into the sea.

[a] Includes Argentia Vale Inco Demonstration Hydrometallurgical Plant, which utilized a Blivet wastewater treatment system and has been closed since June 2017.




Source: GNL (n.d.).

**Figure 4.5. Communities with known and possible ('unknown') outfalls for sewage effluent and/or other waste water discharge in the Study Area.**

The Long Harbour Nickel Processing Plant began operations in 2014 (Vale 2017). This commercial-scale hydrometallurgical ('hydromet') facility releases non-recyclable, treated excess process water (i.e., effluent), storm water and sewage into the marine waters of Long Harbour (Vale 2011). Prior to release, on-site effluent and sewage treatment plants, and polishing and sedimentation ponds are utilized to treat these discharges in accordance with government standards, including the *Metal Mining Effluent Regulations* (Vale 2011). The volume and quality of released effluent are routinely monitored, and effluent can be pumped back through the treatment process repeatedly prior to release if any discharge constituent is not in compliance with regulatory limits (Vale 2011). Treated effluent, which is colourless and transparent, is diverted into a pipeline and released >5 km out into Long Harbour relative to the plant, where the deep water currents flow in an outward direction and assist in relatively rapid dispersal (Vale 2011). After compliance testing, the effluent is mixed with ≤25% seawater by volume before being released, in order to assist the prevention of gypsum scaling inside the effluent release pipeline (Vale 2011).

### 4.2.3 Fish and Fish Habitat

The description of fish and fish habitat is presented from two perspectives: (1) an overview of fish and fish habitat in the Study Area (i.e., Placentia Bay Extension EBSA); and (2) a more detailed description of fish and fish habitat in the marine Project Area (i.e., sea cage sites). The components of fish and fish habitat that will be discussed in this section include:

- marine water;
- marine sediment;
- bathymetry;
- plankton (including ichthyoplankton and invertebrate eggs and larvae);
- marine invertebrates and fishes;
- marine birds; and
- marine mammals and sea turtles.

#### 4.2.3.1 Study Area Overview

The physical characteristics of Placentia Bay allow its waters to support a wide variety of planktonic, benthic, and pelagic communities. Characteristics of the Bay, such as its typically ice-free conditions, sufficient mixing of ocean waters and excellent sources of nutrients, allow a diverse range of species to flourish.

Although marine birds, marine mammals and sea turtles are not really components of fish and fish habitat, the EIS guidelines require some discussion of these animal groups because of their reliance on invertebrates and fishes as food sources, as well as their potential interactions with the Atlantic salmon sea cages. Marine birds and mammals inhabit the inner portions of Placentia Bay and surrounding areas. During summer months, communities of gannets, cormorants, alcids, gulls, and terns nest along rocky cliffs and islands. Several species of migratory birds, such as shearwaters, also over-winter and forage in these waters during summer months. Thirteen species of marine mammals, including baleen and toothed whales, are also considered seasonal visitors to Placentia Bay.

There are a variety of fish habitat types in Placentia Bay. Catto et al. (1999) presented a biological and geomorphological classification of Placentia Bay in which they identified five regional subdivisions of shoreline biological communities:

1. Cape Shore (Cape St. Mary's to northern tip of the Argentia Peninsula);
2. Northeast Placentia Bay (northern tip of Argentia Peninsula to North Harbour);
3. The Swift Current Estuarine Region (North Harbour to Prowsetown, including Sound Island, Woody Island, and Bar Haven Island);
4. Northwest Placentia Bay (Merasheen Island, Long Island, the Ragged Islands archipelago, Isle Valen, Presque Harbour, Paradise Sound, and the adjacent mainland shores of Newfoundland); and
5. Burin Peninsula.

The Geologic Survey of Canada (GSC) and Canadian Hydrographic Service (CHS) recently conducted systematic mapping of Placentia Bay, Newfoundland using multibeam sonar and sub-bottom profilers (Shaw et al. 2011). Interpretation of the multibeam data was supported by seismic data, sidescan sonograms, bottom photographs, video, submersible observations and grab samples, resulting in the

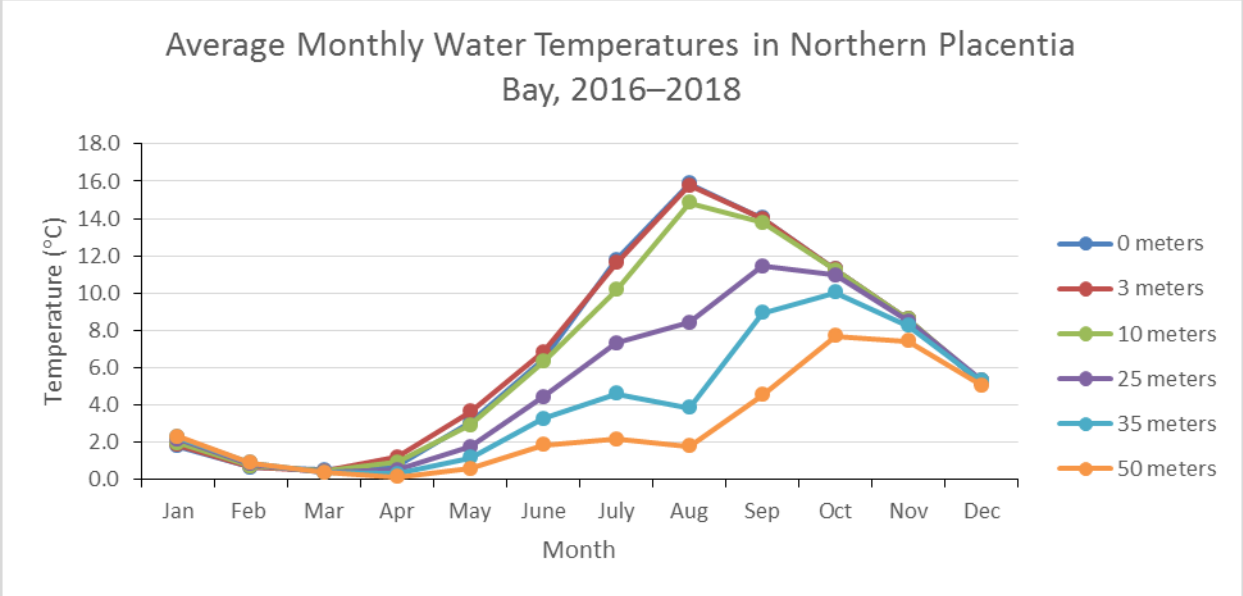
generation of a high-resolution seascape dataset (Shaw et al. 2011). The output was georeferenced spatially using Geographic Information System (GIS) software (ESRI's ArcGIS Software Package) and then digitized and coded. High resolution outputs (5-m grid resolution GIS Shapefiles) and graphical outputs have been generated according to referenced coordinates. A key finding of the mapping of Placentia Bay included the complexity of the seafloor of Placentia Bay, including huge fields of ridges on the west side of the bay which likely provide good habitat for invertebrates and fishes.

***Marine Water***

Marine water quality relates to the composition of water as affected by natural processes and human activities. It includes not only chemical composition, but also biological and physical characteristics. The quality of water is also related to specific use and is usually measured in terms of constituent concentrations. The primary role of seawater being considered here is its importance as a component of fish habitat.

*Water Temperature*

Since early 2016, Grieg NL has been regularly collecting seasonal water temperature data profiles of the upper 50-m of the water column at 11 different locations (i.e., proposed sea cage sites) in the northern part of Placentia Bay (see Figure 2.1). Figure 4.6 presents the 2016–2018 average monthly water temperatures at each of the water column locations using combined data from the 11 sampling locations. As expected, the average monthly water temperatures decrease with depth, at least during the April–November period. Water temperatures are consistent between sampling depths during the December–March period. The 2016–2018 average monthly water temperatures range from approximately 0–16°C.

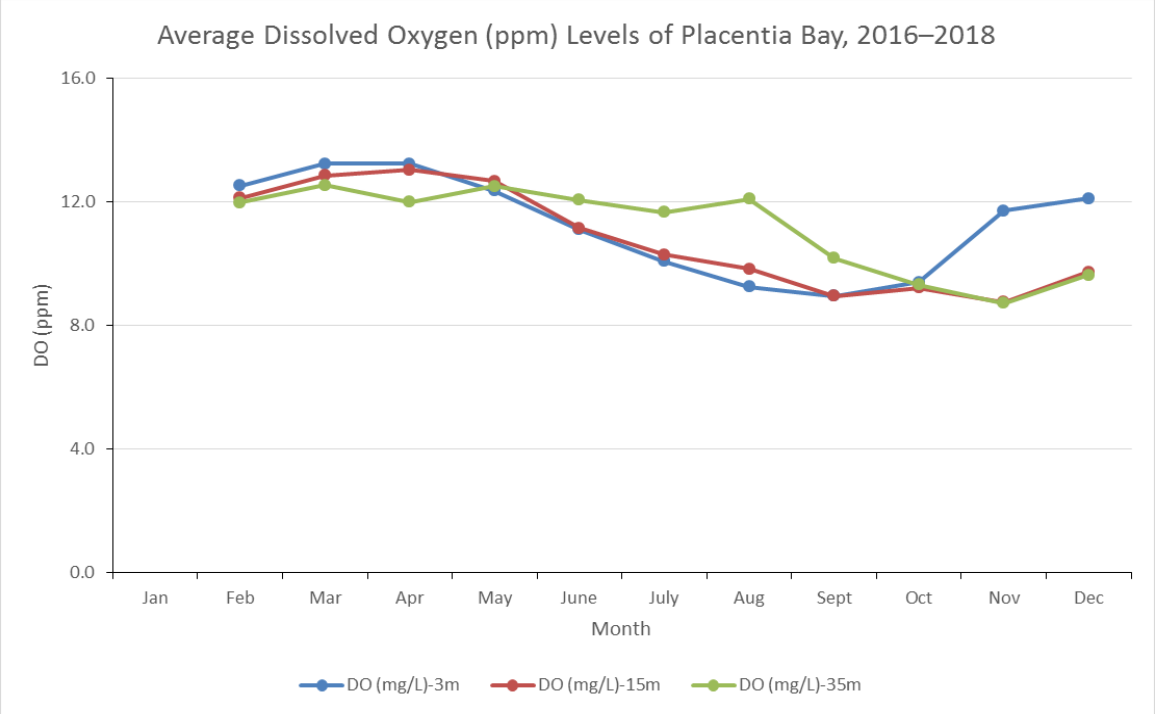



Source: Grieg NL (2018) (unpublished data).

**Figure 4.6. Average monthly water temperatures in northern Placentia Bay in the upper 50-m of the water column, 2016–2018 (data collected at each of the 11 proposed sea cage sites are combined).**

*Dissolved Oxygen*

Since early 2016, Grieg NL has been regularly collecting seasonal dissolved oxygen data profiles of the upper 50-m of the water column at 11 different locations (i.e., proposed sea cage sites) in the northern part of Placentia Bay (see Figure 2.1). Figure 4.7 presents the 2016–2018 average monthly dissolved oxygen levels at each of the water column locations using combined data from the 11 sampling locations. The average monthly dissolved oxygen levels are somewhat variable. At the 3-m depth, they are highest during November–May (12–14 ppm) and lowest during August–October (9–10 ppm). At the 15-m depth, they are highest during February–May (12–14 ppm) and lowest during August–December (9–10 ppm). At the 35-m depth, they are highest during February–August (12–14 ppm) and lowest during September–December (9–10 ppm). None of the average monthly dissolved oxygen levels associated with the 2016–2018 monitoring by Grieg NL were below 8 ppm (Figure 4.7). Mansour et al. (2008) indicate that dissolved oxygen levels in seawater <6 ppm can be considered an indication of hypoxic conditions.




Source: Grieg NL (2018) (unpublished data).

**Figure 4.7. Average monthly dissolved oxygen levels in northern Placentia Bay in the upper 50-m of the water column, 2016–2018 (data collected at each of the 11 proposed sea cage sites are combined).**

Salinity data were not collected by Grieg NL during its 2016–2018 water quality monitoring program.

*Marine Sediment*

Marine sediments provide habitat for infaunal and epibenthic biota, which in turn interact with non-benthic marine organisms. The composition of benthic biotic assemblages is dependent largely on sediment particle size and water depth. The offshore fish habitat in Placentia Bay is less diverse than the nearshore habitat. Bottom substrate types are variable, typically characterized by varying proportions of

fine sediment (mud, sand), medium sediment (gravel, cobble), coarse sediment (rubble, boulder) and bedrock. The maximum water depths in Placentia Bay exceed 300 m.

Sediments also influence the environmental fate of many chemical substances in marine ecosystems by acting as both sinks and sources of substances that enter the marine environment. Surficial sediments sampled at four locations in the northern part of Placentia Bay (Come By Chance Refinery, Woody Island/Sound Island, Red Island, and Long Island) were analyzed for aromatic hydrocarbons (Kiceniuk 1992). Overall, the highest levels of bioavailable aromatic hydrocarbons were found in sediment collected at Woody Island/Sound Island and Port Royal Arm on the west side of Long Island. Ramey and Snelgrove (2003) collected surficial sediments at six stations in the northern part of Placentia Bay (H, C, W1, W2, E1, and E2) and one station in the middle of southern Placentia Bay (O) (Figure 4.8). Sediments sampled in northern Placentia Bay were characterized by higher proportions of clay, carbon and nitrogen.

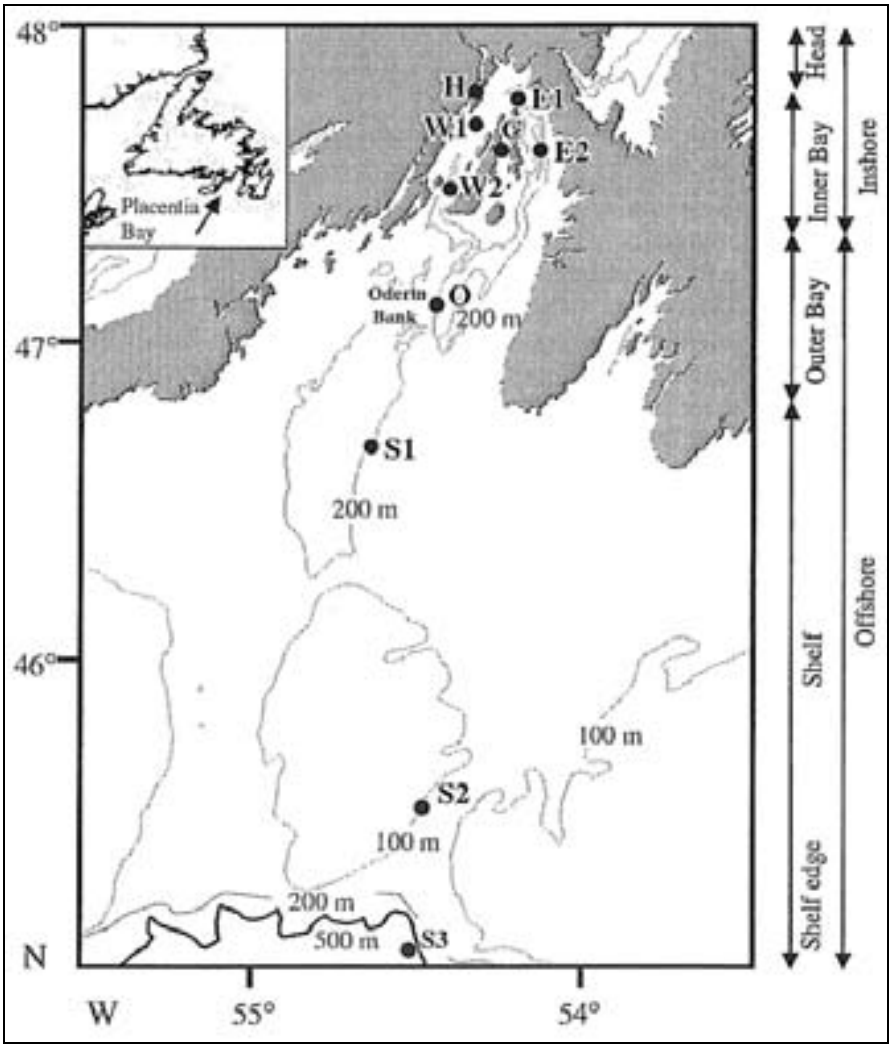



**Figure 4.8. Locations of Sediment Sampling in Placentia Bay by Ramey and Snelgrove (2003).**

*Plankton in Placentia Bay*

Plankton are small and microscopic organisms that either drift pelagically or actively swim in the marine environment. This group includes phytoplankton (photosynthesizing plants), zooplankton (small crustaceans), and the eggs and larval stages of fishes (i.e., ichthyoplankton) and invertebrates. Plankton form the basis of the marine food web.

Phytoplankton standing crop (as *chlorophyll a* concentrations) was measured in water samples collected at seven locations in Placentia Bay in June and August 1998 (Ramey and Snelgrove 2003). Samples were collected at a depth of 5-m at six locations in the northern part of the bay and one location in the central part of southern Placentia Bay. In both June and August, *chlorophyll a* concentrations were generally higher in northern Placentia Bay, the northernmost stations having the highest concentrations. Ramey and Snelgrove (2003) indicated that these trends were consistent with those shown by the Sea-Viewing, Wide-Field-of-View Sensor Spacecraft (SeaWiFS) in April, July and September of that same year. Overall, *chlorophyll a* concentration was highest in April, presumably a result of the spring phytoplankton bloom.

DFO Newfoundland Region has conducted zooplankton sampling (including icthyoplankton) in Placentia Bay. Ichthyoplankton is defined as the free-floating egg and larval stages of fishes. Fish stomach analysis also provided information on zooplankton. The diet of capelin captured within Placentia Bay in January and May/June 1999 was investigated by O'Driscoll et al. (2001). Sampling sites during both sampling times were located throughout Placentia Bay. *Temora* spp. and *Metridia* spp. were the most abundant copepods in the diet of capelin collected in January. The proportion of *Calanus* spp. in the capelin diet had increased by the spring sampling. Large capelin caught in Placentia Bay in spring fed mainly on *hyperiid* amphipods. The seasonal diet of Atlantic cod in Placentia Bay was also investigated during this period. Planktonic invertebrates identified in the cod stomachs included various amphipods, cnidarians and copepods (Mello and Rose 2005a).

Data related to the distribution of pelagic eggs of American plaice, Atlantic cod, and cunner (*Tautogolabrus adspersus*) have been compiled by Bradbury et al. (2003). Plaice and cod eggs were most abundant on the west side of Placentia Bay, particularly in the vicinity of Bar Haven Island and off the southern Burin Peninsula (see Section 4.2.6.2, Placentia Bay Extension EBSA). Notable abundances of Stage II eggs of both American plaice and cod were found immediately southwest of Merasheen Island. Cunner eggs were distributed more widely, occurring primarily in waters proximate to Marystown, between Marystown and Paradise Sound, off the Cape Shore, offshore of Paradise Sound, and extensively throughout the large islands of inner Placentia Bay.

Bradbury et al. (2003) also provided distributional data of larvae of Atlantic cod, cunner, capelin, and sand lance (*Ammodytes* sp.), based on field sampling in June and August 1998. Cod larvae were most abundant in western Placentia Bay waters off the Burin Peninsula; cunner larvae in the northern part of Placentia Bay and off the southern Burin Peninsula; and capelin larvae in western Placentia Bay waters off the southern Burin Peninsula and southern Merasheen Island and Red Island. Sand lance larvae were most abundant in waters off the Cape Shore, in the central part of southern Placentia Bay, and off the southern Burin Peninsula. Of the four species, cod larvae were the least abundant. Patchiness in distribution generally increased during development of all three species with pelagic eggs (Atlantic cod, American plaice, and cunner). The range of estimated patchiness during development was highest for pelagic schooling species with demersal eggs (e.g., capelin, sand lance) (Bradbury et al. 2003).

Spatial distribution patterns during the egg and early larval period of cod, American plaice, and cunner were consistent with passive transport out of the western side of Placentia Bay following spawning in the

northern part of the bay. Bradbury et al. (2003) hypothesized that observed spatial patterns in older larvae, seasonal size increases in larvae from demersal eggs, and ontogenetic changes in patchiness reflect active processes. In other words, larger larvae may actively contribute to changes in their spatial distribution. The authors concluded that both swimming ability and behaviour become increasingly important in determining spatial distribution patterns during development of pelagic larvae. Ichthyoplankton surveys conducted during the spawning and post-spawning seasons of 1997 and 1998 indicated that Atlantic cod egg densities were highest during early spring of both years, subsequently decreasing during spring and summer (Bradbury et al. 2000). The distributions of different egg and larval stages suggested that the eggs and larvae were released from spawning locations and developed during transport in the cyclonic flow from the southeast and around Placentia Bay towards the southwest (i.e., counter-clockwise flow). During the two years of study, Stage I cod eggs were concentrated at Perch Rock in the southeastern part of southern Placentia Bay, at Bar Haven in the northwestern part of northern Placentia Bay, and at Oderin Bank in the western part of southern Placentia Bay. The data suggested that substantial inshore cod spawning consistently occurs at the same locations in Placentia Bay. While the reasons for this are still uncertain, algal biomass is typically highest in the northern and western parts of Placentia Bay, and may therefore provide greater food resources for hatching larvae.

Bradbury et al. (2001) suggested that the effects of predation on cod egg mortality are small relative to the advective effects within the Placentia Bay system. The interaction between advection and temperature-dependent vital rates of eggs may have dramatic consequences for coastal retention of eggs and larvae produced within Placentia Bay.

*Marine Benthos in Placentia Bay*

The term “benthos” refers to those plants and animals that live either upon (i.e., epibiota) or within (infauna) the seabed sediment. Benthic communities are typically composed of many taxonomic groups that use a variety of feeding methods. Many species of fish, birds, and mammals feed on marine benthos. The seasonal diet of Atlantic cod in Placentia Bay was investigated between 1997 and 2000. Numerous types of benthic invertebrates were identified in the cod stomachs, including various echinoderms, amphipods, molluscs, polychaetes, and decapods (Mello and Rose 2005a). The diversity of species in fish stomachs is indicative of the diversity of species that occur in Placentia Bay. For the purposes of this EIS, marine benthos refers to the invertebrate species only.

A study conducted in the 1970s identified 84 gammarid and two caprellid amphipod species in Placentia Bay (Fenwick and Steele 1983). The first major study on sedentary macrofauna in muddy substrates in Placentia Bay was conducted in 1998 (Ramey and Snelgrove 2003). Benthic macrofauna were sampled at seven locations within Placentia Bay, six at depths within a 210–230 m range, and the other at a depth of 67 m (Ramey and Snelgrove 2003). Six of the sampling stations were located in the northern part of Placentia Bay north of latitude 47º25’N (see Figure 4.8) (shallowest one at the head of Placentia Bay inside of Bar Haven Island [H], two in the Western Channel between mainland and Merasheen Island [W1 and W2], two in the Eastern Channel between mainland and Long Island [E1 and E2], one in Central Channel between Merasheen Island and Long Island [C]), and one was near Oderin Bank [O] (latitude 47º11’N). Locations of these six sampling stations relative to shore ranged from 0.6–4.0 km. The single sampling station in southern Placentia Bay (i.e., ‘O’) was located 23 km from the Cape.

Based on various statistical analyses, distinct infaunal communities occurred at the seven sampling stations (see Figure 4.8). The highest macrofaunal density was found at the station in southern Placentia Bay (i.e., ‘O’), while the lowest densities were observed at sampling stations in northern Placentia Bay. Vertical distribution of macrofauna in samples collected in southern Placentia Bay was more extensive than that for samples collected in the northern part of the bay. At all stations, macrofaunal density was

highest in the upper three cm of seabed sediment compared to the 3–10 cm fraction (Ramey and Snelgrove 2003).

Species richness (i.e., number of species per station) at all of the northern stations was less than that observed at the southern Placentia Bay station. In northern Placentia Bay, species richness was highest at the shallowest station (H) and least at the northernmost Western Channel station (W1) (Ramey and Snelgrove 2003). The dominant taxa at all seven sampling stations included numerous polychaete species, the bivalve *Thyasira* sp., and various ribbon worm species (Nemertea). The amphipod *Byblis gaimardi* was found at the southern Placentia Bay station but not at the northern stations. The most abundant polychaete species was *Cossura longocirrata*. While the polychaete *Pectinaria granulata* was abundant at the shallow northern station 'H', it was either rare or absent at all of the other six stations. The bivalve *Thyasira* sp. was most abundant at station 'O' in southern Placentia Bay, and at stations 'C' and 'W2' in the northern part of the bay (Ramey and Snelgrove 2003).

Ramey and Snelgrove (2003) suggested that broad-scale changes in sediment-dwelling macrofaunal communities in Placentia Bay may be related to surface water characteristics such as *chlorophyll a* levels. At the more inshore stations, high levels of organic carbon influenced macrofaunal assemblages which were similar in structure to those typically observed in organic-rich areas. Surface *chlorophyll a* concentration was positively correlated with sedimentary organic carbon, the most important predictor of infaunal abundance.

Marine benthic habitats in the vicinity of the Newfoundland Transshipment Terminal at Whiffen Head were assessed in 1996 (JWEL 1996). The survey was conducted in shallow subtidal areas and in several deeper subtidal areas (10 to >20 m depth). Three substrate types and their respective associated macrobenthos were identified.

1. Sand/cobble: sea urchins, sand dollars, scallops;
2. Cobble/boulder: sourweed (*Desmarestia* spp.), coralline algae, sea anemones, mussels, sea urchins; and
3. Boulder/bedrock: rockweed (*Fucus* spp.), sea anemones, mussels, sea urchins, cunners.

The shallow subtidal areas assessed by JWEL (1996) were predominantly boulder/bedrock and cobble/boulder habitats. The sand/cobble type of habitat occurred primarily in areas where depth exceeded 10 m. The coarser substrate habitats were also common in the deeper subtidal area (JWEL 1996). Other biota observed during the habitat survey at Whiffen Head included cord weed (*Chorda filum),* sea colander kelp (*Agarum cribrosum*), sea stars, winter flounder, yellowtail flounder, ocean pout, lumpfish, and Atlantic cod (JWEL 1996).

In 1990, subtidal marine sediment samples were collected at a station near Bar Haven Island (LFA 1991). Samples were collected at depths of 6 and 12 m. Average abundance of benthic fauna was higher in the deeper sediments. Polychaetes comprised the most abundant benthic invertebrate group in the shallow sediments, followed by molluscs, crustaceans, and echinoderms. The most abundant benthic animals were capitellid thread worms (polychaetes), chitons and limpets (molluscs), amphipods (crustaceans), and sea urchins (echinoderms) (LFA 1991). Crustaceans were the most abundant benthic invertebrate group in the deep sediments, followed by molluscs, echinoderms, and polychaetes (LFA 1991).

LGL (2007) conducted benthic habitat surveys by ROV in Long Harbour, Placentia Bay between October 2005 and October 2006. Two inshore shallow water hard substrate areas (maximum depth of 14.5 m), and one deeper water soft substrate area (60–74 m depth) were surveyed. The sediments observed at the

two shallow sites included sand, gravel, cobble, and small boulder(s). Associated biota observed at these sites included kelp, filamentous algae (red, brown, and green algae), coralline algae, eelgrass, Irish moss, periwinkles, hermit crabs, rock crabs, scallops, sea stars, sand dollars, cunner, winter flounder, mussels, and amphipods. Sediments observed at the deep site included silty sediments and occasional boulder clusters. Biota associated with silty sediments included winter flounder, American plaice, eelpouts (Zoarcidae), bivalves, sea stars, brittle stars, and small crustaceans, whereas sea anemones, sea urchins, and sea stars were most strongly associated with boulder clusters. Also noted at the deep site was a productive rocky area that rose up to 60 m water depth and was surrounded by soft substrate sediments. Biota associated with this area included sea stars, sun stars, sea urchins, corals, sea anemones, crabs, and Atlantic cod.

Benthic habitat sampling was conducted by Self-contained Underwater Breathing Apparatus (SCUBA) divers near Southern Head at the head of Placentia Bay in the early 2000s (Amec 2007). Surveys were conducted along several transects to document marine substrates, flora, and fauna in the near shore (maximum water depth of 43 m). Biota associated with marine sediments primarily comprised of hard substrates such as gravel, cobble, small and large boulders, and bedrock included sea urchins, sea stars, periwinkles, mussels and sea anemones. Biota primarily associated with marine sediments primarily comprised of sand and gravel included scallops and sand dollars. Other species which were encountered sporadically during the survey included winter flounder, hermit crab, tube worms, barnacles, lobster, rock crab, American plaice, Atlantic cod, skate, eel pout, and polychaetes. Macroflora observed frequently in diver transects included crustose algae on hard substrates, as well as sour weed, black whip weed, edible kelp, ribbed lace weed, leaf weed, green filamentous algae, kelp (*Laminaria* sp.), sea colander, red fern, and tubed weed.

The results of the marine benthic studies described above are similar in terms of the observed associations between substrate type, water depth and the flora and invertebrates comprising the biotic assemblages.

*Corals and Sponges*

According to Gilkinson and Edinger (2009), there are few data for the occurrence of corals and sponges in Placentia Bay. Most documented occurrences have been located in the southern part of the bay, particularly at the mouth and just outside Placentia Bay. Given the physical characteristics of Placentia Bay (i.e., depths >300 m, variable surficial sediment types), there is strong likelihood of corals and sponges occurring in the northern part of Placentia Bay.

*Invasive Species*

The current principal invasive species in Placentia Bay is the green crab (*Carcinus maenas*). Life stages (e.g., eggs, larvae, juveniles) of this European crustacean were likely brought to Newfoundland waters in bilge and ballast waters discharged by vessels sailing from the eastern North Atlantic Ocean. Green crab are known to disrupt eelgrass beds, important nursery areas for many marine species, and compete directly with native crustaceans including American lobster.

*Species Profiles*

This subsection provides summary information regarding the life histories and ecological associations for three commercially-important benthic invertebrate species that occur in the Study Area; snow crab, American lobster and sea scallop.

*Snow Crab*

Snow crab in Newfoundland waters typically occurs at water depths ranging between 60 and 400 m on substrates consisting of mud and gravel. The commercial fishery for snow crab has generally been very lucrative since the groundfish moratorium in 1992, but recent years have seen a downward turn in the stock (DFO 2016a). Spawning by snow crab typically occurs in spring and early summer. The eggs are carried by the females until larval hatch during the summer months when water temperatures are appropriate for development of the larvae. The larvae are pelagic and may remain in the water column for months. Eventually, the final pelagic larval stage settles to the seabed and continues development to maturity in the benthic habitat (DFO 2016a). After assuming the benthic habitat, snow crab feed on benthic organisms including polychaetes, echinoderms, and molluscs (DFO 2016a).

Based on recent analysis of DFO commercial fishery data for the 2015 season and consultation with commercial harvesters, snow crab is harvested in areas of Placentia Bay proximate to the sea cage sites in the Rushooon BMA.

*American Lobster*

The American lobster has a continuous distribution around the island of Newfoundland, occupying a relatively narrow band of rocky habitat over an approximate depth range of two to 40 m (Ennis 1984). The inshore lobster fishery is primarily conducted in areas with water depths of 15–20 m during spring and early summer and remains important for many fishers (DFO 2016b). Lobster mating typically occurs during the summer months, immediately after the female moults. Egg fertilization might not occur until late summer/fall, after which the female carries the developing eggs on the underside of her abdomen. Hatching occurs the following summer and the resultant larvae assume a pelagic existence. The planktonic larvae undergo four moults before settling to the benthic habitat. Development to the adult stage occurs on the ocean bottom (DFO 2016b). The American lobster is an opportunistic feeder and is known to consume a variety of food including crustaceans, echinoderms, molluscs, fishes, and polychaetes (DFO 2016b).

Based on consultations with commercial fishers, lobsters are harvested in areas of Placentia Bay that are close to the Gallows Harbour sea cage site and that overlap with the Long Island sea cage site, both in the Rushoon BMA. However, most lobster harvesting is conducted inshore of the sea cage locations.

*Sea Scallop*

Sea scallops are generally distributed throughout some of the shallow (<20 m) coastal regions around Newfoundland, occurring primarily on sand/gravel or gravel/pebble substrates. They are most abundant in shallow sheltered sandy locations, such as western Placentia Bay. Commercial and recreational harvesting of sea scallops occurs in areas around Newfoundland, including Fortune Bay, Placentia Bay, and St. Mary's Bay. Spawning typically occurs in September and October. Both the eggs and larvae are planktonic, the latter for about four weeks. The larva develops a "foot" that allows it to attach to an appropriate substrate and, once attached, it develops into the juvenile stage. After a period of growth, the juveniles lose their byssal attachments and lie freely on the ocean bottom for development to the adult stage. Larval sea scallops feed on phytoplankton, while the larger juveniles and adults typically feed on plankton and detritus (DFO 2016c).

Based on recent analysis of DFO commercial fishery data for the 2015 season, sea scallops are harvested commercially in areas proximate to the Ship Island, Red Island and Butler Island sea cage sites.

*Fishes in Placentia Bay*

While all of the numerous marine finfish species that occur in Placentia Bay have ecological importance, only some are considered important from a fisheries perspective. This subsection provides summary information regarding the life histories and ecological associations for species of both groups that are most relevant to the Project. Wild Atlantic salmon are discussed in LGL (2018b *in* Volume 3).

*Fishery and Ecological Importance*

*Atlantic Cod*

Atlantic cod has historically been one of the leading food fishes in the world, and until recent years was Newfoundland and Labrador's single most important commercial species. The various Atlantic cod populations have decreased precipitously during the past couple of decades, to the point where inshore Atlantic cod appear to be more abundant than those in the offshore areas (DFO 2017a).

Inshore cod spawning occurs in several bays in Newfoundland, including Placentia Bay. During 1997–1998, three cod spawning grounds were identified at Bar Haven, Perch Rock near Cape St. Mary's, and Oderin Bank in Placentia Bay (Lawson and Rose 2000a). Spawning typically occurs during the March–August period.

Juvenile cod remain pelagic during early growth after which they become associated with the seabed. First-year demersal juvenile cod have been found in shallow nearshore waters (<8 m depth) during autumn. First-year juvenile cod have been caught over a variety of substrate types in nearshore waters, including mud, sand, gravel, and cobble. It appears that the preferred inshore habitat for juvenile cod is characterized by dense beds of eelgrass in sheltered coves, although high numbers also occur in areas without eelgrass, both sheltered and exposed. Juvenile cod in inshore waters move from shallow to deep water as they mature to age three, but do not appear to mix with adult cod until they reach about age three to four (DFO 2017a).

Atlantic cod larvae and pelagic juveniles feed mainly on zooplankton. Early demersal stage juveniles in inshore areas continue to feed on zooplankton but then switch to benthic and epibenthic invertebrates (Scott and Scott 1988).

There is evidence that capelin is necessary for the optimal growth, condition, and reproductive potential of northern cod (Rose and O'Driscoll 2002). Between 1996 and 2001, cod were sampled in three areas off Newfoundland and Labrador, including Placentia Bay. During January and June sampling, capelin was found in 9.5 percent of the cod taken in Placentia Bay and constituted 22 percent of the diet in terms of weight. During both January and June sampling, stomach content weights were highest in Placentia Bay cod compared to cod from Trinity Bay and Hawke Channel. The condition of Placentia Bay cod was usually higher than the condition of cod sampled further north at Hawke Channel, possibly because potential contact between cod and capelin was higher in the southern areas.

*Juvenile Cod*

From September–December, 1997–1999, age 0 cod were surveyed at numerous shallow shoreline sites throughout Placentia Bay (Robichaud and Rose 2006). Sites included a variety of habitat types, although most of them had eelgrass. Generally, catches of age 0 cod were higher at sites in the northern part. Highest overall catches were made at Great Brule and Bar Haven North in the inner bay. This study also indicated a density-dependent range expansion for age 0 juvenile cod - that is, as cod abundance

increased, the number of occupied sites also increased. These juvenile cod were most likely found at sites with eelgrass, but with increasing abundance came increased occurrence at sites without eelgrass. Sites such as Great Brule and Bar Haven North may represent critical habitat since these two sites consistently had the highest abundances of these fish regardless of overall annual abundance. Habitat preferences and use of cover of one to four-year old juvenile cod in the inshore waters were investigated with the use of deep sea submersibles (Gregory and Anderson 1997) in areas ranging from 18–150 m. Age 2–4 juvenile cod were most often associated with areas of coarse substrate and high bathymetric relief (i.e., submarine cliffs). Age 1 juveniles were most often associated with areas of gravel substrate and low relief. Juvenile cod did not exhibit selection for substrates with macroalgae cover.

*Adult Cod*

The cod stock in Placentia Bay exhibits marked variations in abundance and composition over the course of an annual cycle. Based on data collected in 1999, (Mello and Rose 2005b), a patchy distribution comprised mostly of spawning, old (ages 7–9), large (>60 cm) cod were present in the inner part of Placentia Bay in April/May. The outer part of Placentia Bay had widely scattered and low fish density in April/May except for a higher density aggregation near Cape St. Mary's in May. By July, cod were more dispersed throughout Placentia Bay in small dense aggregations and abundance had increased four-fold. The cod found in Placentia Bay in July and early October were predominantly younger (ages 4–6) and smaller than those observed in April/May. The October distribution pattern was similar to that in July although fewer fish were located over the banks in the outer part of Placentia Bay. By November, most cod were located at the head of the bay in moderate to high-density aggregations. The November cod abundance had again decreased to levels similar to those observed in April/May and older, larger fish predominated. The variation in age and size of cod coincided with the expected influx of the non-resident young, small fish into Placentia Bay during the post-spawning period and their subsequent departure in the fall. In summary, Mello and Rose (2005b) showed that the cod stock in Placentia Bay experiences marked variations in abundance and composition over the annual cycle. The variations appear to be related to movement and mixing of fish from different populations.

Acoustic surveys in Placentia Bay in 1997 and 1998 identified three primary cod spawning grounds: (1) Bar Haven; (2) Oderin Bank; and (3) Perch Rock (Lawson and Rose 2000a). Ground use and spawning times differed between years. Mean spawning female densities were highest at Perch Rock in 1997 and at Oderin Bank in 1998. Peak spawning in 1997 occurred in April but not until June/July in 1998. In both years, cod spawned at sub- or near-zero temperatures.

Robichaud and Rose (2001) provided the first direct evidence through a telemetry study that cod undertaking long-distance feeding migrations may home to a specific spawning ground in consecutive years. Approximately 67 percent of the fish tagged at the Bar Haven spawning ground in April 1998 were relocated during the two years following spawning. All cod relocated during the 1999 and 2000 spawning seasons were within 10 km of the tagging location at Bar Haven. Several of the fish relocated outside of spawning season in 1999 and 2000 were as far as 110 km from the tagging location. Multi-year homing (1999 and 2000) was observed in 26 percent of the cod tagged at Bar Haven. Windle and Rose (2005) suggested that spatial familiarity may be a key factor in cod homing, reinforced through multiyear migrations. Relocation rates on the spawning ground were higher for male fish in all years, suggesting that female cod move in and out of male-dominated spawning aggregations (Robichaud and Rose 2003).

Different spawning aggregation structures have also been observed with the application of active acoustics (Rose 1993). The pelagic behaviour of an aggregation of cod was observed in deep water areas (>300 m) and spawning columns were observed in shallow water areas (~50 m). Some of these spawning columns extended as high as 20 m off the ocean floor.

Acoustic surveys and mark-recapture experiments conducted in the late 1990s investigated the seasonal movements and distribution of coastal cod in Placentia Bay (Lawson and Rose 1998, 2000b). Spawning cod tagged in the inner part of the bay in spring moved outwards along both the east and west sides of Placentia Bay during spring and summer, further on the east side, sometimes leaving Placentia Bay entirely. Lawson and Rose (2000b) estimated that 10–30 percent of the Placentia Bay cod may move in spring and summer into the adjacent stock area, 3L. The majority of tagged cod recaptured in spring the next year following tagging were taken in the bay, perhaps suggesting a return migration. Smaller cod (<50 cm) tended to remain resident in the inner bay and did not migrate as far as larger fish. The degree of aggregation was highest in spring and fall, and lowest in the summer. Cod moved to shallower water after spawning and occupied an increasingly narrow range of depths from spring to fall. Results presented by Lawson and Rose (2000b) were evidence of repeat spawning, year-round residence, and return migrations, suggesting the existence of a Placentia Bay coastal cod stock.

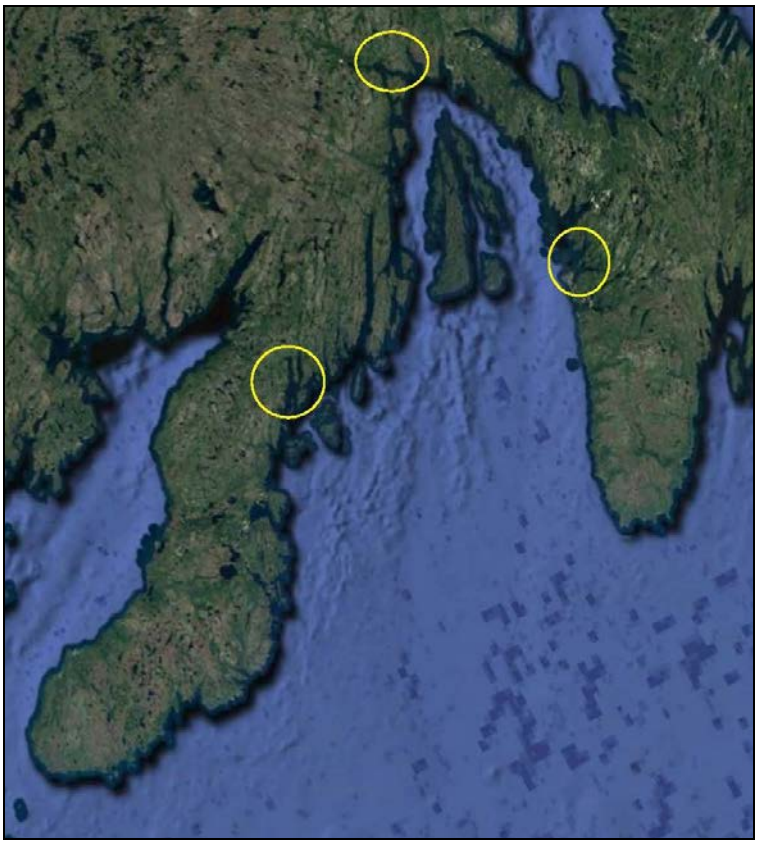
A mark-recapture study of Atlantic cod in NAFO Subdivision 3Ps was initiated in 1997 (Brattey and Healey 2005). Between 1997 and 2006, more than 66,000 cod were tagged at locations in inner and outer Placentia Bay, but primarily the former. Results of the study indicate that most of the recaptures of cod tagged within Placentia Bay occurred in Placentia Bay. Some of the cod tagged in Placentia Bay have been recaptured in other inshore areas within 3Ps, inshore areas outside of 3Ps (Cape St. Mary's to White Bay), and offshore areas within 3Ps.

Based on recent analysis of DFO commercial fishery data for the 2015 season, Atlantic cod were harvested commercially in areas proximate to the Oderin Island sea cage site in the Rushoon BMA and the Ship Island sea cage site in the Merasheen BMA. Another area identified as cod grounds by local harvesters overlaps the Valen Island sea cage site in the Merasheen BMA.

*Restoration of Eelgrass Beds*

Eelgrass beds are known to be important nursery areas for a number of marine fishes, including Atlantic cod. The areal extent of coastal eelgrass areas in Placentia Bay has decreased during the past 20 years, perhaps due to an increase in the local population of the invasive species green crab (K. Best, Fisheries Biologist, MI, pers. comm., 13 February 2018). In response to this areal decrease, the Coastal Restoration Project, managed by the MI in collaboration with FFAW, intends to restore eelgrass areas in Placentia Bay using internationally-recognized eelgrass transplantation methodology. One important aspect of site preparation for eelgrass restoration is the removal of green crab in an effort to reduce its population spread. To date, this research has provided increased understanding of green crab biology and how this crustacean may affect local ecology (i.e., competition with lobster, destruction of eelgrass beds (FFAW|Unifor 2018). Individual green crab removals are being conducted by fishers at nine locations in Placentia Bay in preparation for eelgrass restoration; three along the western shore of Placentia Bay (vicinity of Rushoon), two along the northern shore (vicinity of North Harbour), and four along the eastern shore (vicinity of Long Harbour) (Figure 4.9). All are located ≥5 km from any of the proposed sea cage sites (K. Best, Fisheries Biologist, MI, pers. comm., 13 February 2018).

The green crab harvest component of site preparation was begun in October 2017 (FFAW|Unifor 2017). 1 April 2018–31 March 2019 represents the first full year of green crab removal for the purpose of eelgrass site restoration preparation (K. Best, Fisheries Biologist, MI, pers. comm., 13 February 2018).



Source: K. Best, Fisheries Biologist, MI, pers. comm., 1 March 2018.

**Figure 4.9. Locations of eelgrass restoration sites (yellow circles) in which green crab are harvested for site preparation for the Coastal Restoration Project in Placentia Bay, NL.**

*Atlantic Herring*

There are five coastal herring stocks in east and southeast Newfoundland, one of which is the St. Mary's Bay-Placentia Bay (SMB-PB) stock (Wheeler et al. 2004; DFO 2017b). Although there are fall spawning herring, spring spawners appear to dominate most stocks. Atlantic herring generally spawn during May and June. These demersal spawners deposit adhesive eggs on stable bottom substrates, typically in shallow (<20 m depth) coastal waters, primarily on gravel or rocky bottom where there is an abundance of seaweed. Other documented spawning substrates include sand and bare rock. Eelgrass has been associated with herring spawning in some locations (Scott and Scott 1988).

The larvae that hatch from the demersal herring eggs are pelagic. The pelagic larvae and the juveniles that develop from them are known to make diel (night-to-day) vertical migrations. The juveniles and adults tend to avoid the surface waters during daylight hours, likely a strategy for avoiding avian predators. These pelagic schooling fish do not appear to have any substrate preference during juvenile and adult phases. Atlantic herring are visual feeders, consuming primarily plankton during daylight hours (Scott and Scott 1988).

Sjare et al. (2003) identified areas of herring aggregation in all five regional subdivisions of shoreline biological communities based on local ecological knowledge (Catto et al.1999). The primary areas

indicated include coastal waters between Lamaline and St. Lawrence on the southern part of the Burin Peninsula, around Boat Harbour/Brookside/Little Harbour West on the west side of Placentia Bay, at the head of Placentia Bay, and around the islands of inner Placentia Bay (Merasheen Island/Long Island).

Based on analysis of commercial fishery data for 2015, herring were harvested at the head of Placentia Bay, some distance away from any sea cage sites.

*Sea-run Brown Trout*

Westley and Fleming (2011) confirmed the presence of brown trout (*Salmo trutta*) in the following five Placentia Bay rivers: (1) Northeast River; (2) South East River; (3) Come By Chance River; (4) Piper's Hole River; and (5) Salmonier River (Burin Peninsula). There is potential for the occurrence of sea-run trout in these freshwater systems. Although there is no commercial fishery for sea-run trout, there is a recreational fishery.

*Ecological Importance*

*Lumpfish*

Lumpfish are semi-pelagic, spending much of their time far from the coast. Adult lumpfish exhibit seasonal migrations in Newfoundland waters, moving into shallow coastal waters to spawn in spring and early summer, and then returning to deeper offshore waters in late summer and early fall. Mature female lumpfish are commercially fished for their roe during the inshore spring-summer spawning season (Kearley 2012).

Lumpfish eggs adhere to the nest substrate, which is most often rock. Larval hatch typically occurs during May–June and the larvae attach to macroalgae and hard substrate by means of an adhesive disc. Juvenile lumpfish appear to remain in the coastal area up to age 1. They then adopt the semipelagic lifestyle characteristic of adult lumpfish and distribute themselves offshore (Scott and Scott 1988; Kearley 2012).

Free-swimming larvae and first-year juveniles feed on zooplankton. After adopting the semipelagic lifestyle, lumpfish switch to a variety of benthic and pelagic food items including ctenophores, amphipods, polychaetes, molluscs, fish and ichthyoplankton (Scott and Scott 1988; Kearley 2012).

*Capelin*

Capelin is one of the most ecologically fish species in the region since it is an important food species for many species of fish, marine birds and mammals. These pelagic fish exhibit inshore-offshore migrations associated with spawning. Capelin typically overwinter in offshore waters, move shoreward in early spring to spawn on appropriate beaches in spring/summer, and return to offshore waters in autumn. Exact timing of spawning appears to be highly dependent on water temperature. Juvenile capelin are found in Newfoundland bays but capelin larvae appear to be rapidly carried out of the bays and inshore areas by surface currents (DFO 2015b).

Five stock complexes of capelin have been recognized in the Newfoundland region based on spawning and overwintering locations, including the Saint-Pierre Bank stock that spawns on the south coast of Newfoundland (Carscadden et al. 1989).

Beach suitability for spawning is primarily dependent on substrate type, with capelin showing a preference for gravel. Suitable beaches are found in exposed, moderately exposed and sheltered locations.

Beach spawning by capelin is demersal with the eggs typically being deposited in the intertidal zone, although capelin are also known to deposit eggs in the subtidal zone in depths ranging up to 37 m (Carscadden et al. 1989).

Capelin larvae remain on the gravel, upon hatching, until they are flushed by wave action. Once flushed from the spawning sediments, the capelin larvae are pelagic and rapidly advected from embayments into open bays and eventually into the offshore. Adult capelin exhibit diel (night-to-day) vertical migrations in that they occupy the lower water column during the day and move upwards at night. During autumn, the diel vertical migration shows a reverse pattern (Scott and Scott 1988; Carscadden et al. 1989). Capelin feed on various plankton, including copepods and amphipods, mainly during non-spawning times. (Scott and Scott 1988).

The abundance and distribution of capelin in Placentia Bay were assessed using acoustic surveys in January, March, and June 1998, and in January 1999 (O'Driscoll and Rose 1999). Capelin biomass was highest in June 1998, estimated at 132,000 t in the outer bay. Estimated biomasses were much lower during the other three surveys, ranging from 390 t in January 1999 to 13,000 t in January 1998. In addition to these seasonal differences in spatial distribution, seasonal differences in vertical distribution were also observed. Capelin occurred near the surface at night and near the bottom during the day in June 1998. No diurnal vertical migration was evident during the other three survey times. Capelin tended to remain near the bottom during January and March. Most of the capelin observed during the four surveys were immature, approximately 75 percent measuring less than 130 mm.

The highest capelin densities observed during January 1998 occurred on the eastern side of outer Placentia Bay, and immediately to the south of Merasheen Island and Red Island (O'Driscoll and Rose 1999). In March 1998 the highest densities had shifted towards the western side of outer Placentia Bay and throughout more of the inner bay. June 1998 densities were distributed relatively evenly throughout outer Placentia Bay. The survey in January 1999 found the highest densities in Paradise Sound and towards the head of the bay.

Sjare et al. (2003) identified areas with capelin spawning beaches and offshore spawning areas based on local ecological knowledge. Capelin spawning beaches occur in all five of the regional subdivisions of shoreline biological communities described by Catto et al. (1999). Areas with offshore capelin spawning were identified in four of the five regional subdivisions; the exception was the Swift Current Estuarine Region. The most extensive area of offshore spawning activity was identified off the south coast of the Burin Peninsula.

*Sharks*

Sharks have been identified as fish with the potential of causing damage to aquaculture sea cages. This subsection provides a brief summary of their occurrences in Newfoundland waters. The four largest species of shark that occur in Newfoundland waters are (1) porbeagle shark; (2) shortfin mako shark; (3) blue shark; and (4) white shark. Brief profiles are provided for the first three in this subsection, and a profile of the white shark is included in the subsection on species at risk (i.e., Schedule 1 of the *SARA* and the *ESA*).

*Porbeagle Shark*

The porbeagle shark was designated as endangered by COSEWIC in May 2004. This large cold-temperate coastal and oceanic shark is distributed across the North Atlantic and is known to occur in southern Newfoundland waters during spring and summer (Scott and Scott 1988). The porbeagle shark is

typically most common on continental shelves but is also found far from land in ocean basins and occasionally close to shore. It mates within NAFO Subdivision 3Ps during late summer/fall, followed by the release of live young (pups) the following winter (Campana et al. 2001). The pupping occurs outside of Placentia Bay.

Porbeagle sharks are predators of various fish species and cephalopods (Campana et al. 2001). Pelagic species are the primary prey during the spring and summer, followed by a shift to groundfish species in the winter. This prey shift reflects the seasonal change of distribution of porbeagle (i.e., migration to deeper areas in fall and winter) (Campana et al. 2001).

*Shortfin Mako Shark*

The shortfin mako shark was designated as *threatened* by COSEWIC in April 2006. Shortfin makos are distributed circumglobally in all tropical and temperate seas. In Canadian Atlantic waters, it is typically associated with warm water in and near the Gulf Stream. There are no reliable population-level stock assessments available in the northwest Atlantic. Trend information based on declines in bycatch rates in the entire northwest Atlantic suggests that shortfin mako populations may have decreased in the past 15–30 years (COSEWIC 2017).

This shark is a highly migratory seasonal visitor (late summer and fall) to Canada's Atlantic coast, typically occurring anywhere from surface waters to depths of about 500 m. The life cycle of the shortfin mako is not completely understood. It is ovoviviparous (internal hatching) and likely breeds outside of Canadian waters. Few mature makos have been caught in Canadian waters (COSEWIC 2017).

*Blue Shark*

The blue shark occurs in oceanic pelagic and continental shelf pelagic habitats, ranging from the surface to at least 600 m depth and preferring temperatures of 12–20° C. Individuals show seasonal migrations, occurring on the continental shelf in the northwest Atlantic in summer and then moving into deeper off-shelf areas in November for the winter. The species has a single highly migratory population in the North Atlantic, of which a portion is present in Canadian waters seasonally (COSEWIC 2016).

*Bluefin Tuna*

While not common in Placentia Bay, bluefin tuna have been identified as a species of fish with the potential of causing damage to aquaculture sea cages. This subsection provides a brief summary of its occurrence in Newfoundland waters.

The bluefin tuna (*Thunnus thynnus*), the largest member of the mackerel-like fishes (family Scombridae), occurs on both sides of the Atlantic Ocean (Scott and Scott 1988). The species is at its northern range in Canada and often show unpredictable and changeable distribution (Archambault et al. 2001). Bluefin occur in Canadian waters from July–December over the Scotian Shelf, in the Gulf of St. Lawrence, and off Newfoundland (Archambault et al. 2001). The occurrence of bluefin tuna in Newfoundland waters has increased during recent years (G. Melvin, Research Scientist, DFO, pers. comm., 2015).

Bluefin tuna occur in Canadian waters for feeding purposes (Neilson 2009). These opportunistic feeders prey extensively on herring, mackerel, squid, and crustaceans (Archambault et al. 2001; Neilson 2009). It must be noted that the only information available on the distribution of the species (both temporal and seasonal) is commercial fisheries data as there are no fisheries-independent surveys for large pelagic species (Archambault et al. 2001).

In the west Atlantic, bluefin tuna are thought to spawn from mid-April to June in the Gulf of Mexico and Florida Straits (Archambault et al. 2001; see review by Rooker et al. 2007), far south of the SEA Area. Based on tagging studies, spawning may also occur in the central North Atlantic (Lutcavage et al. 1999). Juveniles are thought to occur over the continental shelf, primarily between 35°N and 41°N in summer and in offshore waters, at the same latitudes, in the winter (Archambault et al. 2001). Neilson (2009) noted that habitat for larval and juvenile stages of bluefin tuna occur outside of Canadian waters. Bluefin tuna has been identified as a candidate species by COSEWIC (Neilson 2009).

### 4.2.3.2 Project Area

***Water Quality***

Since early 2016, Grieg NL has regularly collected water temperature and DO data at all 11 sea cage sites (Grieg NL, unpublished data). The frequency of water quality data collection has been sufficient to provide measures throughout the year (i.e., variability due to seasonality has been captured).

Water temperature data were collected at six water depths; 0, 3, 10, 25, 35, and 50 m. This depth range was selected based on the 45 m vertical dimension of the sea cages to be used in this project. Summary statistics (i.e., mean, minimum, and maximum values) for the water temperature data at each sea cage site are presented in Table 4.10. The highest mean temperatures collected at each water column depth are highest for the sea cage sites in the Long Harbour BMA, while the lowest mean temperatures were observed at the sea cage sites in the Rushoon BMA. The lowest minimum water temperature of -0.5°C was observed at both the 25-m and 35-m depths at the Oderin Island sea cage site (Rushoon BMA) site in March, and at the 50-m depth at the Butler Island sea cage site (Red Island BMA) in April. The maximum water temperatures exceeding 17.0°C were observed in the upper three meters of the water column at the Rushoon, Merasheen and Red Island BMA sea cage sites in August.

Dissolved oxygen data were collected at three water depths: 3, 15 and 35-m. Summary statistics (i.e., mean, minimum, and maximum values) for the DO data at each sea cage site are presented in Table 4.11. The lowest mean DO levels were observed at the sea cage sites of the Long Harbour BMA, while mean levels at the other nine sea cage sites were quite similar. The highest maximum DO levels (i.e., 13.7–15.9 ppm) at 3-m and 15-m depths at all sea cage sites were typically observed during late spring (i.e., May and June). The timing of the highest maximum DO level at 35-m depth was more variable (e.g., in August for both the Merasheen and Long Harbour BMAs; May–July for the other two BMAs). The lowest minimum DO levels were observed at the Oderin Island sea cage site (e.g., 6.5–7.3 ppm). The timing for the lowest minimum DO levels was typically late summer/early fall for the sea cage sites in Rushoon and Merasheen BMAs, but slightly later (i.e., November) in the other two BMAs.

Mansour et al. (2008) examined DO content around salmon farm sea cages and specified a DO content level of <6 ppm as an indicator of hypoxic conditions. All DO measurements taken by Grieg NL at sea cage sites since 2016 have been >6 mg/L.

The full water quality data set collected to February 2018 by Grieg NL is in Appendix A of LGL (2018b).

**Table 4.10. Summary statistics for water temperature data (°C) collected at the proposed sea cage sites, March 2016–February 2018.**

| BMA/Sea Cage Site | Statistic | Sampling Depth | | | | | |
|---|---|---|---|---|---|---|---|
| | | Surface | 3-m | 10-m | 25-m | 35-m | 50-m |
| ***Rushoon BMA*** | | | | | | | |
| Oderin Island | Mean | 7.5 | 6.0 | 5.6 | 4.5 | 3.8 | 2.7 |
| | Min | -0.2 (Mar) | -0.2 (Mar) | -0.2 (Mar) | -0.5 (Mar) | -0.5 (Mar) | -0.4 (Mar) |
| | Max | 17.2 (Aug) | 17.0 (Aug) | 15.6 (Aug) | 12.3 (Oct) | 12.1 (Oct) | 10.3 (Oct) |
| Long Island | Mean | 7.5 | 6.0 | 5.7 | 4.8 | 3.9 | 2.8 |
| | Min | 0.2 (Mar) | 0.2 (Mar) | -0.1 (Mar) | -0.2 (Mar) | -0.2 (Mar) | -0.2 (Mar) |
| | Max | 16.7 (Aug) | 16.4 (Aug) | 16.0 (Aug) | 13.1 (Aug) | 12.5 (Sept) | 10.7 (Oct) |
| Gallows Harbour | Mean | 7.5 | 6.1 | 5.7 | 4.7 | 3.9 | 2.8 |
| | Min | 0.4 (Mar) | 0.3 (Mar) | 0.0 (Apr) | 0.0 (Apr) | -0.1 (Mar) | -0.1 (Mar) |
| | Max | 17.1 (Aug) | 16.6 (Aug) | 16.3 (Aug) | 12.9 (Aug) | 11.8 (Sept) | 10.2 (Oct) |
| ***Merasheen BMA*** | | | | | | | |
| Valen Island | Mean | 8.8 | 7.4 | 7.2 | 5.9 | 5.0 | 3.6 |
| | Min | -0.1 (Mar) | -0.1 (Mar) | 0.0 (Apr) | 0.0 (Apr) | -0.1 (Apr) | -0.2 (Apr) |
| | Max | 17.1 (Aug) | 17.0 (Aug) | 16.7 (Aug) | 14.3 (Aug) | 13.0 (Sept) | 10.9 (Oct) |
| Chambers Island | Mean | 8.0 | 7.5 | 7.2 | 5.9 | 4.9 | 3.6 |
| | Min | -0.1 (Mar) | -0.1 (Mar) | 0.0 (Mar) | 0.0 (Apr) | 0.0 (Apr) | -0.2 (Apr) |
| | Max | 17.1 (Aug) | 17.1 (Aug) | 16.9 (Aug) | 13.7(Sept) | 13.5 (Sept) | 10.8 (Oct) |
| Ship Island | Mean | 8.0 | 7.5 | 7.3 | 5.9 | 4.9 | 3.4 |
| | Min | -0.2 (Mar) | -0.2 (Mar) | 0.0 (Mar) | -0.1 (Apr) | -0.1 (Apr) | -0.2 (Apr) |
| | Max | 17.3 (Aug) | 17.3 (Aug) | 17.1 (Aug) | 13.8 (Sept) | 12.8 (Sept) | 10.4 (Oct) |
| ***Red Island BMA*** | | | | | | | |
| Darby Harbour | Mean | 7.6 | 7.1 | 7.0 | 5.8 | 4.7 | 3.3 |
| | Min | -0.1 (Apr) | -0.1 (Apr) | -0.1 (Apr) | -0.1 (Apr) | -0.2 (Apr) | -0.2 (Apr) |
| | Max | 17.0 (Aug) | 17.0 (Aug) | 16.9 (Aug) | 13.1 (Sept) | 11.8 (Sept) | 10.8 (Oct) |
| Red Island | Mean | 7.8 | 7.4 | 7.2 | 5.9 | 4.7 | 3.1 |
| | Min | -0.1 (Apr) | -0.1 (Apr) | -0.1 (Apr) | -0.1 (Apr) | -0.2 (Apr) | -0.3 (Apr) |
| | Max | 17.3 (Aug) | 17.2 (Aug) | 17.2 (Aug) | 13.6 (Sept) | 11.9 (Oct) | 11.3 (Oct) |
| Butler Island | Mean | 7.9 | 7.4 | 7.2 | 5.9 | 4.7 | 3.3 |
| | Min | -0.2 (Apr) | -0.2 (Apr) | -0.2 (Apr) | -0.2 (Apr) | -0.3 (Apr) | -0.5 (Apr) |
| | Max | 17.4 (Aug) | 17.3 (Aug) | 16.8 (Aug) | 12.8 (Sept) | 12.6 (Sept) | 11.3 (Oct) |
| ***Long Harbour BMA*** | | | | | | | |
| Iona Island | Mean | 10.3 | 10.5 | 10.0 | 8.5 | 6.6 | 4.3 |
| | Min | 2.0 (Dec) | 2.0 (Dec) | 2.0 (Dec) | 1.2 (May) | 0.7 (May) | 0.4 (May) |
| | Max | 16.3 (Aug) | 16.3 (Aug) | 15.9 (Aug) | 13.5 (Sept) | 10.9 (Sept) | 9.7 (Oct) |
| Brine Island | Mean | 10.4 | 10.5 | 10.0 | 8.5 | 6.7 | 4.7 |
| | Min | 2.0 (Dec) | 2.1 (Dec) | 2.0 (Dec) | 1.1 (May) | 0.4 (May) | 0.2 (May) |
| | Max | 16.4 (Aug) | 16.4 (Aug) | 15.9 (Aug) | 14.8 (Aug) | 11.2 (Oct) | 9.1 (Oct) |

Source: Grieg NL (unpublished data).
Note: Months in which minimum and maximum temperatures were observed are provided in parentheses.

## *Benthic Habitat*

### *Bathymetry and Substrate Type*

An essential step toward implementing effective management strategies for ocean systems is to identify biophysical patterns and processes that delineate benthic system functions (Brown et al. 2011 *in* Amec 2017a). The process of producing seafloor habitat maps incorporates disparate datasets from biological, geological, hydrographical and geophysical inputs to produce simplified spatial representation of the seafloor relating to the distribution of biological characteristics (Brown et al. 2011).

**Table 4.11. Summary statistics for dissolved oxygen data (mg/L [ppm]) collected at the proposed sea cage sites, February 2016–February 2018.**

| BMA/Sea Cage Site | Statistic | Sampling Depth | | |
|---|---|---|---|---|
| | | 3-m | 15-m | 35-m |
| ***Rushoon BMA*** | | | | |
| Oderin Island | Mean<br>Min<br>Max | 11.7<br>6.5 (Aug)<br>15.4 (May) | 11.8<br>6.9 (Aug)<br>15.6 (May) | 11.9<br>7.3 (Oct)<br>15.0 (July) |
| Long Island | Mean<br>Min<br>Max | 11.7<br>7.5 (Aug)<br>15.5 (May) | 11.7<br>7.6 (Aug)<br>15.6 (May) | 12.0<br>8.6 Sept)<br>15.6 (May) |
| Gallows Harbour | Mean<br>Min<br>Max | 11.6<br>8.2 (Aug)<br>15.6 (May) | 11.6<br>6.7 (Aug)<br>15.6 (May) | 11.9<br>7.9 (Aug)<br>15.1 (May) |
| ***Merasheen BMA*** | | | | |
| Valen Island | Mean<br>Min<br>Max | 11.4<br>8.2 (Aug)<br>15.7 (May) | 11.4<br>8.1 (Sept)<br>15.5 (May) | 11.8<br>8.5 (Sept)<br>19.3 (Aug) |
| Chambers Island | Mean<br>Min<br>Max | 11.4<br>8.5 (Aug)<br>15.5 (May) | 11.3<br>8.3 (Sept)<br>15.3 (May) | 11.8<br>8.4 (Sept)<br>15.2 (Aug) |
| Ship Island | Mean<br>Min<br>Max | 11.4<br>8.4 (Sept)<br>15.3 (May) | 11.4<br>8.3 (Sept)<br>15.4 (May) | 11.8<br>8.2 (Nov)<br>15.1 (Aug) |
| ***Red Island BMA*** | | | | |
| Darby Harbour | Mean<br>Min<br>Max | 11.6<br>8.7 (Nov)<br>15.7 (May) | 11.5<br>8.4 (Nov)<br>15.3 (May) | 12.0<br>8.4 (Sept)<br>15.2 (May) |
| Red Island | Mean<br>Min<br>Max | 11.5<br>8.4 (Sept)<br>15.9 (May) | 11.5<br>8.3 (Sept)<br>15.2 (May) | 12.0<br>8.2 (Nov)<br>15.2 (May) |
| Butler Island | Mean<br>Min<br>Max | 11.4<br>8.0 (Nov)<br>15.7 (May) | 11.5<br>7.8 (Nov)<br>15.3 (May) | 12.0<br>6.9 (Nov)<br>15.2 (May) |
| ***Long Harbour BMA*** | | | | |
| Iona Island | Mean<br>Min<br>Max | 10.5<br>8.8 (Nov)<br>13.7 (June) | 10.8<br>8.6 (Sept)<br>14.3 (May) | 11.6<br>8.7 (Nov)<br>15.2 (Aug) |
| Brine Island | Mean<br>Min<br>Max | 10.5<br>8.6 (Nov)<br>13.8 (June) | 10.8<br>8.6 (Nov)<br>14.2 (Aug) | 11.6<br>8.6 (Nov)<br>15.0 (Aug) |

Source: Grieg NL (unpublished data).
Note: Months in which minimum and maximum dissolved oxygen levels were observed are provided in parentheses.

In the sublittoral environment, limitations of conventional in-situ sampling methods (e.g., benthic grabs, dredges, video, etc.) impair the ability to synthesize the complexities of benthic system interactions because they provide detailed information on the seafloor that they sample but on a very localized/small scale. It remains challenging to derive accurate representation of the biophysical characteristics of the seafloor in an area without extensive survey designs and tightly spaced sampling station transects (Brown et al. 2011). Therefore, application of acoustic survey techniques such as the use of side-scan sonar systems and multibeam echo sounders provides wide-scale reconnaissance style surveying to produce accurate images of the seafloor (Brown et al. 2011).

Multibeam echosounders are able to provide bathymetric data detailing the terrain and structure (e.g., rugosity and/or steepness) of the seafloor as well as information that provides indication of substrate type (Dolan et al. 2009, Kaplan et al. 2010 *in* Amec 2017a). The relative hardness of the surficial sediment can be used for interpretation of some aspects of the physical habitat such as morphological structures and slopes (Dolan et al. 2009, Kaplan et al. 2010 *in* Amec 2017a). The interpretation of

backscatter data also requires supportive in-situ observations using conventional benthic survey methods to validate the interpretations and ground-truth the data (Dolan et al. 2009, Kaplan et al. 2010 *in* Amec 2017a). Using a GIS, the combination of multibeam acoustic survey data and conventional in-situ sampling data helps to synthesize seafloor habitat characterization maps (seascapes) according to geomorphology, texture and biota (Dolan et al. 2009, Brown et al. 2011, Shaw et al. 2011, Todd and Greene 2007, Whitmire et al. 2007 *in* Amec 2017a).

Proposed sea cage site area coverages represented by multibeam data were calculated (Table 4.12). Sea cage sites with less than 90% multibeam survey coverage were composited with CHS 10-m resolution bathymetry data and were subsequently surveyed using drop camera video at 100-m grid intervals by Grieg NL. For each proposed sea cage site, the depth range, percentage multibeam coverage and percentages of hard and soft substrate data are presented in Table 4.12. The baseline sea cage site characterization data were used to designate the potential sites as having either hard or soft bottoms. According to the *Monitoring Protocol for Hard Bottom Benthic Substrates under Marine Finfish Farms in Newfoundland and Labrador (NL)* under Annex 9 of the AAR, sea cage sites' seabed characteristics are suitable for aquaculture if "more than 50% of the lease area is hard bottom composed of rockwall, bedrock, boulders, rubble, cobble, gravel, or hard packed finer substrates" (AAR Annex 9; GC 2015).

**Table 4.12. Bathymetric and substrate specifics for the proposed sea cage sites.**

| BMA/Sea Cage Site | Depth Range (m) | Multibeam Coverage (%) | Hard Substrate (%) [No. of Sea Cages] | Soft Substrate (%) [No. of Sea Cages] |
|---|---|---|---|---|
| ***Rushoon BMA*** | | | | |
| Oderin Island | 39–98 | 100 | 66 [7] | 34 [5] |
| Long Island | 75–180 | 69 | 51 [8] | 49 [4] |
| Gallows Harbour | 140–170 | 16 | 16 [?] | 84 [?] |
| ***Merasheen BMA*** | | | | |
| Valen Island | 58–308 | 100 | 54 [1] | 46 [11] |
| Chambers Island | 16–308 | 98 | 55 [8] | 45 [4] |
| Ship Island | 144–159 | 100 | 38 [1] | 62 [11] |
| ***Red Island BMA*** | | | | |
| Darby Harbour | 16–147 | 93 | 71 [6] | 29 [6] |
| Red Island | 18–250 | 100 | 93 [12] | 7 [0] |
| Butler Island | 10–143 | 99 | 100 [12] | 0 |
| ***Long Harbour BMA*** | | | | |
| Iona Island | 54–108 | 95 | 70 [2] | 30 [4] |
| Brine Island | 40–100 | 2 | 78 [3] | 22 [3] |

Source: Amec 2017a.

The full benthic characterization report (Amec 2017a) is in Appendix B of LGL (2018b).

*Benthic Biota*

As indicated in the previous subsection, Grieg NL completed drop camera sampling at the three proposed sea cage sites with <90% multibeam coverage: (1) Gallows Harbour; (2) Long Island; and (3) Brine Island. Data related to surficial sediment composition and benthic biota occurrence were collected through analysis of the video. The substrate types observed were principally 'hard', including bedrock, gravel, and cobble. Neither fine sediments (i.e., mud) nor large boulders were observed during Grieg NL's drop camera surveys. Coralline algae were observed in various proportions at all three sites. Benthic fauna observed included Cnidarians (e.g., sea anemones, jellyfish), echinoderms (e.g., brittle stars, feather stars, sea stars, sea urchins, sea cucumbers), molluscs (e.g., scallops, clams, whelks), crustaceans

(e.g., shrimp, crabs) and fishes (e.g., sculpins). The full benthic habitat data set collected by Grieg NL is contained in Appendix C of LGL (2018b).

The flora and fauna observed during baseline video sampling by Grieg NL are similar to the biota observed during a baseline study conducted in bays with aquaculture operations during 2003–2011 in southern Newfoundland. As per regulatory requirements for the aquaculture finfish site application process, Hamoutene et al. (2017) evaluated baseline benthic survey video collected in the Fortune Bay/Bay D'Espoir area. A total of 752 stations at 22 sites, depths ranging from 2–100 m, were analyzed. All sites had mixed substrate types, with most grain sizes being represented at each site. They reported that the most frequently observed taxa were sea anemones (39%), algae (28%), coralline algae (27%), brittle stars (26%), sea stars (14%), and kelp (14%). Feather stars, sea urchins, sand dollars, mussels, scallops, shrimp, polychaetes, tunicates, crabs, and fish were also observed during their baseline survey. Overall, the benthic habitats surveyed were characterized by low productivity, low abundance of individual animals and patchy distributions of biota (Hamoutene et al. 2017).

Analysis of DFO commercial fisheries data and consultation with Placentia Bay fishers indicated that lobster, snow crab and sea scallop, important commercial species, occur in the vicinities of some of the proposed sea cage sites. Profiles for these invertebrates have been provided earlier in this fish and fish habitat section.

*Fishes*

The key fish species relevant to this project that can occur in the Project Area are the same ones profiled and discussed earlier in this fish and fish habitat section. These species include:

- Atlantic cod;
- Atlantic herring;
- Sea-run brown trout;
- Lumpfish;
- Capelin;
- Various shark species; and
- Bluefin tuna.

### 4.2.4 Wild Atlantic Salmon

This section provides a brief description of the wild Atlantic salmon occurring in Placentia Bay.

#### 4.2.4.1 Status

The South Newfoundland population of Atlantic salmon, to which Placentia Bay salmon belong, exhibited a significant net decline in abundance of mature individuals over the last three generations at the time of preparation of the Assessment and Status Report (COSEWIC 2010). Due to the limited information related specifically to wild Atlantic salmon in Placentia Bay (Salmon Fishing Area 10 [SFA 10]), information in this section focuses on the greater demographic of the South Newfoundland population (Designatable Unit 4 [DU 4]). Information that applies specifically to wild Atlantic salmon in Placentia Bay is clearly indicated.

COSEWIC designated the South Newfoundland population of Atlantic salmon as *Threatened* in 2010 (COSEWIC 2010). The Assessment and Status Report referred to the population as "A wildlife species

likely to become endangered if limiting factors are not reversed". It also indicated that "The numbers of small (one-sea-winter) and large (multi-sea-winter) salmon have both declined over the last three generations, about 37% and 26%, respectively, for a net decline of all mature individuals of about 36%." COSEWIC (2010) identified fisheries, including the commercial fishery in the territorial waters of St. Pierre et Miquelon, illegal fishing, and bycatch mortality, Atlantic salmon aquaculture, and lower survival at sea due to changing marine conditions as some of the potential threats and limiting factors associated with the South Newfoundland population of Atlantic salmon.

A population viability analysis related to conservation spawning requirements for Atlantic salmon in the South Newfoundland population was conducted by Robertson et al. (2013). They concluded that there was low probability (<30%) that Atlantic salmon in DU4 would meet the conservation spawning requirements for population recovery within the following 15 years. A few years later, Robertson et al. (2017) noted that no additional actions had been taken to support recovery of the South Newfoundland population.

#### 4.2.4.2 Distribution

The range of the South Newfoundland population of Atlantic salmon extends from Mistaken Point on the Avalon Peninsula (~46°38'N, 53°10'W) to Cape Ray at the southwestern extreme of the island of Newfoundland (~47°37'N, 59°19'W); essentially the entire south coast of Newfoundland (COSEWIC 2010). There are 104 rivers identified in DU4, of which 48 are scheduled salmon rivers (COSEWIC 2010; DFO 2017a). In Placentia Bay, there are 20 scheduled salmon rivers and at least four non-scheduled salmon rivers. Non-scheduled salmon rivers are defined as those other than scheduled salmon rivers that are documented as being used by Atlantic salmon.

#### 4.2.4.3 Migratory Patterns

Most Atlantic salmon are anadromous, meaning that mature fish migrate from the marine environment into freshwater systems to spawn. After hatching, Atlantic salmon spend several months to several years in their natal freshwater habitat, developing through various life history stages. Once development to smolt stage has occurred, salmon migrate downstream to the ocean to begin the marine phase of their life history. Once at sea, Atlantic salmon typically exhibit large-scale migrations, overwintering in feeding grounds off Labrador and western Greenland (COSEWIC 2010). Upon sexual maturation, the salmon return to their natal freshwater habitat to spawn. Some individuals may spawn more than once in their lifetime (i.e., repeat spawners) whereas others may only spawn once. Some stocks have been known to return to spawn after only a few months at sea, whereas others return after spending one winter (i.e., grilse) or more at sea. Low marine survival for overwintering salmon is considered one of the greatest threats to wild Atlantic salmon abundance in Newfoundland and Labrador (DFO 2017a). Mature salmon typically return to freshwater during May–October. Based on data collected at counting fences established on some of the scheduled salmon rivers in Newfoundland, most returning Atlantic salmon migrate upstream during late June to mid-July (Dempson et al. 2017). Spawning usually occurs in October and November (Scott and Scott 1988; COSEWIC 2010), after which spent salmon will either return to sea or stay in freshwater until the following spring (COSEWIC 2010).

While anadromous and non-anadromous Atlantic salmon typically differ in habitat preference and feeding, there are no significant morphological differences between the two (Riley et al. 1989 *in* Gibson and Haedrich 2006). Some non-anadromous populations occurring in freshwater systems above physical barriers that prevent upstream movement are referred to as 'landlocked'. Atlantic salmon that remain in freshwater for their entire life cycle are termed "resident," whereas anadromous salmon are called "migrants." In Newfoundland, non-anadromous salmon are often called "ouananiche".

Specific Atlantic salmon migratory corridors in Placentia Bay have not been identified in the literature. However, a study planned for Placentia Bay this year will hopefully provide some information on the migratory corridors in the bay (B. Dempson, DFO Research Scientist, pers. comm., 12 April 2018).

### 4.2.4.4 Genetic Population Structure

The genetic structure of the South Newfoundland Atlantic salmon population has been described by Verspoor (2005), Adams (2007), and Palstra et al. (2007) *in* COSEWIC 2010). They suggest that there are fewer genetic differences among the fish in the South Newfoundland population compared with other populations on the island. Bradbury et al. (2014) examined genetic spatial structure of wild Newfoundland salmon populations, including the South Newfoundland population, to investigate how habitat and climate have influenced it. They conducted modelling using the input variables watershed size (i.e., basin area, average river width), winter severity (i.e., temperature, annual snowfall), pH, and temperature climate (i.e., temperature, annual precipitation) to determine which factors most influenced genetic divergence among wild salmon populations. Watershed size, in particular freshwater habitat area (i.e., basin area), was found to be the most important factor influencing wild salmon population genetic structure.

In 2013, there was a single large escape event in an aquaculture operation on the south coast of Newfoundland (DFO 2017a). Genetic analyses of juvenile salmon from Fortune Bay and Bay d'Espoir were conducted in 2015 and 2016. In 2015, 159 diploid escapees were detected, but none were detected in 2016. The analyses provided evidence that in 17 of the 18 sampling locations, 35% of all juveniles were either farmed salmon or first- or second-generation hybrids. It was determined that some of the hybrids were capable of reproducing. There were also older individuals (escapees prior to 2013) found among the detected hybrids. In general, smaller stocks of salmon were found to have greater levels of hybridizations than larger stocks (DFO 2017a). DFO (2017a) indicated that further follow-up monitoring will be conducted. Note that these escapes involved sea cages that were not Aqualine Midgard System cages proposed for the Grieg NL project.

Verspoor et al. (2015) suggest that there is greater risk of genetic and ecological effects from farmed salmon escapees on wild salmon populations that are considered at risk (e.g., threatened), since smaller depressed stocks (i.e., lower abundances) will be more vulnerable to impacts of genetic contribution (i.e., genetic drift) than larger healthier stocks.

### 4.2.4.5 Abundance

Two general methods of estimating Atlantic salmon abundance include: (1) analysis of counting fence data on returning salmon, and (2) analysis of Atlantic salmon recreational fishing data provided by anglers. Only one river in Placentia Bay, specifically the Northeast River, currently has an operating counting fence (G. Veinott, DFO Research Scientist, pers. comm., 5 March 2018). DFO (2017c) recently completed a mid-season review of Atlantic salmon returns to NL rivers in 2017. Northeast River, near the community of Placentia in the eastern part of Placentia Bay, was one of the rivers assessed (see Figure 4.1). Projected numbers of returning salmon were compared with mean numbers of returns during the previous five years. Northeast River had particularly low returns in 2017, about 80% fewer salmon returning than what was projected. In a supporting document to the 2016 Newfoundland and Labrador Atlantic salmon stock assessment (DFO 2017a), Veinott et al. (2018) finalized 2016 assessment data for the Atlantic salmon stock returning to Northeast River. There was a counting fence on Northeast River during 1984–2002, but the salmon stock was not assessed again until 2015. Therefore, a five-year mean for total salmon returns could not be calculated for this river. Despite the lack of a five-year mean of returns, it was determined that Northeast River had achieved 438% of its egg conservation

requirement, placing it in a "Healthy Zone" in terms of DFO's Precautionary Approach Framework (G. Veinott, DFO, pers. comm., 5 March 2018; Veinott et al. 2018). Nonetheless salmon returns to this river in 2017 declined by approximately 58% compared to returns in 2016 (G. Veinott, DFO, pers. comm., 5 March 2018). Low marine survival is suggested as one of the primary reasons for the low numbers of returning salmon to Northeast River and other rivers in Placentia Bay (Robertson et al. 2017; Veinott et al. 2018). The preliminary 2017 estimated range of the number of mature Atlantic salmon in Placentia Bay stocks, which are a component of the South Newfoundland population, is 2,828-5,099 (G. Veinott, DFO Research Scientist, pers. comm., 4 May 2018).

Recreational salmon fishing data for most rivers in Placentia Bay are probably the best available indicator of salmon abundance within the Study Area as a whole. Table 4.13 presents recreational angling data for 18 of the 20 scheduled salmon rivers in Placentia Bay during the 2012–2016 period. During this time, 10,980 salmon were caught, of which 4,429 salmon were retained and 6,461 were caught and released. The locations of these scheduled rivers are shown in Figure 4.1 *in* Section 4.2.2.1.

**Table 4.13. Atlantic Salmon Recreational Fishery Statistics for Scheduled Atlantic Salmon Rivers in Placentia Bay (2012–2016).**

| River Name | Effort (rod days) | Number of Salmon Retained | Number of Salmon Released | Total Number of Salmon Caught | CPUE |
|---|---|---|---|---|---|
| Great Barasway* | 58 | 14 | 8 | 22 | 0.38 |
| South East River (Placentia) | 5,047 | 372 | 690 | 1,062 | 0.21 |
| Northeast River (Placentia) | 4,063 | 482 | 526 | 1,008 | 0.25 |
| Come By Chance River | 2,961 | 279 | 648 | 927 | 0.31 |
| North Harbour River | 1,641 | 263 | 215 | 478 | 0.29 |
| Watson's Brook* | 96 | 3 | 55 | 58 | 0.60 |
| Black River | 769 | 122 | 92 | 214 | 0.28 |
| Piper's Hole River | 5,486 | 580 | 1,218 | 1,798 | 0.33 |
| Nonsuch Brook* | 9 | 0 | 0 | 0 | 0.00 |
| Cape Rodger River | 3,623 | 606 | 1,115 | 1,721 | 0.48 |
| Bay de l'eau River | 5,260 | 852 | 1,246 | 2,098 | 0.40 |
| Red Harbour River | 783 | 115 | 45 | 160 | 0.20 |
| Tide's Brook | 5,133 | 546 | 375 | 921 | 0.18 |
| Salmonier River* | 127 | 5 | 12 | 17 | 0.13 |
| Lawn River* | 215 | 19 | 47 | 66 | 0.31 |
| Taylor's Bay River* | 83 | 18 | 15 | 33 | 0.40 |
| Salmonier Lamaline River | 1,589 | 136 | 147 | 283 | 0.18 |
| Piercey's Brook* | 62 | 17 | 7 | 24 | 0.39 |

Source: G. Veinott, Research Scientist, Atlantic Salmon, DFO, pers. comm., 19 February 2018 (unpublished data).

* Denotes that fewer than 5 years of data used to calculate totals and catch per unit effort (CPUE). No data were provided for two other scheduled rivers in Placentia Bay: (1) West Brook; and (2) Little St. Lawrence River.

## 4.2.5 Species at Risk

Species at Risk (SAR) are defined in this EIS as those species designated/listed under the *Species at Risk Act* (*SARA*), the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and/or Newfoundland and Labrador's *Endangered Species Act* (*ESA*).

The *SARA* was agreed upon by the Canadian Federal Government in December 2002, with various provisions coming into effect in June 2003 (e.g., independent assessments of species by COSEWIC) and June 2004 (e.g., prohibitions against harming or harassing listed *endangered* and *threatened* species or damaging or destroying their critical habitat). Species are listed under *SARA* on Schedules 1–3. Schedule 1 is the official list of wildlife species at risk in Canada, and only those species designated as *endangered*, *threatened* or *extirpated* on Schedule 1 of *SARA* have immediate legal implications. Once a

species/population is designated under *SARA*, protection and recovery measures are implemented. Schedules 2 and 3 of *SARA* identify those species listed by COSEWIC as "at risk" prior to October 1999, which must be reassessed using revised criteria prior to consideration for Schedule 1 of *SARA*.

The COSEWIC is "an independent advisory panel to the Minister of Environment and Climate Change Canada that meets twice a year to assess the status of wildlife species at risk of extinction. Members are wildlife biology experts from academia, government, non-government organizations and the private sector responsible for designating wildlife species in danger of disappearing from Canada" (COSEWIC website 2018). Species in Canada that have not yet been assessed by COSEWIC, but are suspected of being at risk, are identified by Species Specialist Sub-committees (SSCs) or by the Aboriginal Traditional Knowledge (ATK) Sub-committee as candidate species for detailed status assessment. Candidate species may also include species that were previously assessed by COSEWIC as *not at risk* or *data deficient*, for which newly available information suggests they may be at risk in Canada (COSEWIC website 2018).

Newfoundland and Labrador's *ESA* "provides special protection for plant and animal species considered to be *endangered*, *threatened*, or *vulnerable* in the province, and fulfils [the provincial] commitment under the *National Accord for the Protection of Species at Risk*" (DFLR 2018). The *ESA* includes provincial native species, subspecies and populations, excluding marine fish, bacteria and viruses. With few exceptions, the *ESA* is not applicable to introduced species. Status designation under the *ESA* follows recommendations by COSEWIC and/or the Species Status Advisory Committee (SSAC; an independent provincial committee of government and non-government scientists). The province's Wildlife Division "coordinates the assessment and listing of species at risk, and develops recovery and management plans, monitoring programs, and research projects to promote their conservation" (DFLR 2018).

Aquatic species/populations and land birds that potentially occur in the Study Area and are listed/designated under the *SARA*, COSEWIC and/or *ESA* are provided in Table 4.14. Candidate species under consideration by COSEWIC or SSAC (*ESA*) are also listed.

#### 4.2.5.1 Recovery Strategies, Action Plans and Management Plans for Species at Risk

Under *SARA*, a 'recovery strategy' and corresponding 'action plan' must be prepared for *endangered* and *threatened* species/populations (DFO 2016a). A 'management plan' must be prepared for species/populations with *special concern* status.

Recovery strategies are developed by teams made up of technical experts, including from universities, conservation groups, industry, wildlife management boards, Aboriginal organizations, and federal and provincial government officials (DFO 2016a). Recovery strategies outline short-term objectives and long-term goals for the protection and recovery of species at risk, and must be completed within one and two years of a species being listed as *endangered* and *threatened*, respectively (DFO 2016a). Recovery strategies can be modified over time. Final recovery strategies have been prepared for 12 species/populations currently with *endangered* or *threatened* status under Schedule 1 and the potential to occur in the Study Area: (1) northern and spotted wolffishes (Kulka et al. 2007); (2) blue whale (Atlantic population; Beauchamp et al. 2009); (3) North Atlantic right whale (DFO 2014); (4) northern bottlenose whale (DFO 2016e); (5) leatherback sea turtle (Atlantic population; ALTRT 2006); (6) Red Crossbill (ECCC 2006); (7) Common Nighthawk (ECCC 2016a); (8) Olive-sided Flycatcher (ECCC 2016b); (9) Eskimo Curlew (considered extinct in the Study Area; ECCC 2007a); (10) Ivory Gull (ECCC 2014); (11) Piping Plover (ECCC 2012); and (12) Red Knot (ECCC 2017a). During 2016–2017, DFO planned to develop and post a recovery strategy for white shark (Atlantic population) (DFO 2016b), but this document is not yet available.

**Table 4.14. *SARA*-, COSEWIC- and *ESA*-listed aquatic species/populations and land birds that may occur in the Study Area.**

| Species | | *SARA* | | | COSEWIC | | | | *ESA* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **End.** | **Thr.** | **Sp. Con.** | **End.** | **Thr.** | **Sp. Con.** | **Cnd.** | **End.** | **Thr.** | **Vul.** | **Cnd.** |
| **Marine Fish** | | | | | | | | | | | | |
| White Shark (Atlantic pop.) | *Carcharodon carcharias* | Sch. 1 | | | X | | | | | | | |
| Northern Wolffish | *Anarhichas denticulatus* | | Sch. 1 | | | X | | | | | | |
| Spotted Wolffish | *Anarhichas minor* | | Sch. 1 | | | X | | | | | | |
| Atlantic Wolffish | *Anarhichas lupus* | | | Sch. 1 | | | X | | | | | |
| Atlantic Cod | *Gadus morhua* | | | Sch. 3 | | | | | | | | |
| Atlantic Cod (NL pop.) | *Gadus morhua* | | | | X | | | | | | | |
| Atlantic Cod (Laurentian North pop.) | *Gadus morhua* | | | | X | | | | | | | |
| Porbeagle Shark | *Lamna nasus* | | | | X | | | | | | | |
| Atlantic Bluefin Tuna | *Thunnus thynnus* | | | | X | | | | | | | |
| Cusk | *Brosme brosme* | | | | X | | | | | | | |
| Deepwater Redfish (Gulf of St. Lawrence – Laurentian Channel pop.) | *Sebastes mentella* | | | | X | | | | | | | |
| Winter Skate (Eastern Scotian Shelf – Newfoundland pop.) | *Leucoraja ocellata* | | | | X | | | | | | | |
| Acadian Redfish (Atlantic pop.) | *Sebastes fasciatus* | | | | | X | | | | | | |
| American Plaice (NL pop.) | *Hippoglossoides platessoides* | | | | | X | | | | | | |
| Deepwater Redfish (Northern pop.) | *Sebastes mentella* | | | | | X | | | | | | |
| Lumpfish | *Cyclopterus lumpus* | | | | | X | | | | | | |
| White Hake (Atlantic and Northern Gulf of St. Lawrence pop.) | *Urophycis tenuis* | | | | | X | | | | | | |
| Basking Shark (Atlantic pop.) | *Cetorhinus maximus* | | | | | | X | | | | | |
| Roughhead Grenadier | *Macrourus berglax* | | | | | | X | | | | | |
| Smooth Skate (Laurentian-Scotian pop.) | *Malacoraja senta* | | | | | | X | | | | | |
| Spiny Dogfish (Atlantic pop.) | *Squalus acanthias* | | | | | | X | | | | | |
| Thorny Skate | *Amblyraja radiata* | | | | | | X | | | | | |
| Alewife | *Alosa pseudoharengus* | | | | | | | MP | | | | |
| American Shad | *Alosa sapidissima* | | | | | | | MP | | | | |
| Pollock | *Pollachius virens* | | | | | | | MP | | | | |
| Atlantic Mackerel | *Scomber scombrus* | | | | | | | MP | | | | |
| Greenland Shark | *Somniosus microcephalus* | | | | | | | MP | | | | |
| **Anadromous Fish**[a] | | | | | | | | | | | | |
| Atlantic Salmon (South Newfoundland pop.) | *Salmo salar* | | | | | X | | | | | | |
| Atlantic Sturgeon (Maritimes pop.) | *Acipenser oxyrinchus* | | | | | X | | | | | | |
| **Catadromous Fish**[b] | | | | | | | | | | | | |
| American Eel | *Anguilla rostrata* | | | | | X | | | | | X | |
| **Freshwater Fish** | | | | | | | | | | | | |
| Banded Killifish (Newfoundland pop.) | *Fundulus diaphanus* | | | Sch. 1 | | | X | | | | X | |
| Mummichog | *Fundulus heteroclitus* | | | | | | | | | | | X |
| Arctic Char | *Salvelinus alpinus* | | | | | | | LP | | | | |

| Species | | *SARA* | | | COSEWIC | | | | *ESA* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **End.** | **Thr.** | **Sp. Con.** | **End.** | **Thr.** | **Sp. Con.** | **Cnd.** | **End.** | **Thr.** | **Vul.** | **Cnd.** |
| Lake Trout | *Salvelinus namaycush* | | | | | | | LP | | | | |
| **Molluscs** | | | | | | | | | | | | |
| Eastern Pearl Mussel | *Margaritifera margaritifera* | | | | | | | LP | | | | |
| **Marine Mammals** | | | | | | | | | | | | |
| Blue Whale (Atlantic pop.) | *Balaenoptera musculus* | Sch. 1 | | | X | | | | | | | |
| North Atlantic Right Whale | *Eubalaena glacialis* | Sch. 1 | | | X | | | | | | | |
| Northern Bottlenose Whale (1: Scotian Shelf pop./ 2: Davis Strait-Baffin Bay-Labrador Sea pop.) | *Hyperoodon ampullatus* | S(1) Sch. 1 | | | (1) X | | (2) X | | | | | |
| Fin Whale (Atlantic pop.) | *Balaenoptera physalus* | | | Sch. 1 | | | X | | | | | |
| Sowerby's Beaked Whale | *Mesoplodon bidens* | | | Sch. 1 | | | X | | | | | |
| Harbour Porpoise (Northwest Atlantic pop.) | *Phocoena phocoena* | | Sch. 2 | | | | X | | | | | |
| Humpback Whale (Western North Atlantic pop.) | *Megaptera novaeangliae* | | | Sch. 3 | | | | | | | | |
| Killer Whale (Northwest Atlantic / Eastern Arctic pop.) | *Orcinus orca* | | | | | | X | | | | | |
| Cuvier's Beaked Whale | *Ziphius cavirostris* | | | | | | | HP | | | | |
| Sperm Whale | *Physeter macrocephalus* | | | | | | | MP | | | | |
| Hooded Seal | *Cystophora cristata* | | | | | | | MP | | | | |
| Harp Seal | *Pagophilus groenlandicus* | | | | | | | LP | | | | |
| **Sea Turtles** | | | | | | | | | | | | |
| Leatherback Sea Turtle (Atlantic pop.) | *Dermochelys coriacea* | Sch. 1 | | | X | | | | | | | |
| Loggerhead Sea Turtle | *Caretta caretta* | Sch. 1 | | | X | | | | | | | |
| **Birds - Land** | | | | | | | | | | | | |
| Red Crossbill | *Loxia curvirostra percna* | Sch. 1 | | | | X | | | X | | | |
| Bank Swallow | *Riparia riparia* | | Sch. 1 | | | X | | | | | | |
| Barn Swallow | *Hirundo rustica* | | Sch. 1 | | | X | | | | | | |
| Bobolink | *Dolichonyx oryzivorus* | | Sch. 1 | | | X | | | | | X | |
| Chimney Swift | *Chaetura pelagica* | | Sch. 1 | | | X | | | | X | | |
| Common Nighthawk | *Chordeiles minor* | | Sch. 1 | | | X | | | | X | | |
| Olive-sided Flycatcher | *Contopus cooperi* | | Sch. 1 | | | X | | | | X | | |
| Peregrine Falcon | *Falco peregrinus anatum / tundrius* | | | Sch. 1 | | | | | | | X | |
| Rusty Blackbird | *Euphagus carolinus* | | | Sch. 1 | | | X | | | | X | |
| Short-eared Owl | *Asio flammeus* | | | Sch. 1 | | | X | | | | X | |
| Evening Grosbeak | *Coccothraustes vespertinus* | | | | | | X | | | | | |
| Gray-cheeked Thrush | *Catharus minimus* | | | | | | | | | | X | |
| Newfoundland Gray-cheeked Thrush | *Catharus minimus minimus* | | | | | | | LP | | X | | |
| **Birds - Aquatic** | | | | | | | | | | | | |
| Eskimo Curlew[c] | *Numenius borealis* | Sch. 1 | | | X | | | | X | | | |
| Ivory Gull | *Pagophila eburnea* | Sch. 1 | | | X | | | | X | | | |
| Piping Plover | *Charadrius melodus melodus* | Sch. 1 | | | X | | | | X | | | |
| Red Knot | *Calidris canutus rufa* | Sch. 1 | | | X | | | | X | | | |

| Species | | *SARA* | | | COSEWIC | | | | *ESA* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **End.** | **Thr.** | **Sp. Con.** | **End.** | **Thr.** | **Sp. Con.** | **Cnd.** | **End.** | **Thr.** | **Vul.** | **Cnd.** |
| Barrow's Goldeneye (Eastern pop.) | *Bucephala islandica* | | | Sch. 1 | | | X | | | | X | |
| Harlequin Duck (Eastern pop.) | *Histrionicus histrionicus* | | | Sch. 1 | | | X | | | | X | |
| Red-necked Phalarope | *Phalaropus lobatus* | | | | | | X | | | | | |
| Lesser Yellowlegs | *Tringa flavipes* | | | | | | | HP | | | | |
| Killdeer | *Charadrius vociferus* | | | | | | | MP | | | | |
| Short-billed Dowitcher | *Limnodromus griseus* | | | | | | | MP | | | | |
| American Golden-plover | *Pluvialis dominica* | | | | | | | MP | | | | |

Source: COSEWIC website (2018); DFO (2018a); DFLR (2018); and *SARA* website (2018); accessed March 2018.
Legend: "End." = Endangered; "Thr." = Threatened; "Sp. Con." = Special Concern; "Cnd." = Candidate Species; "Vul." = Vulnerable (equivalent to Special Concern); "Sch." = Schedule; "HP" = High Priority; "MP" = Mid Priority"; "LP" = Low Priority; "pop." = population(s); "NL" = Newfoundland and Labrador.
[a] Anadromous fish inhabit marine waters and migrate to fresh waters to spawn.
[b] Catadromous fish inhabit fresh waters and migrate to marine waters to spawn.
[c] Although a portion of the southwards migration route of Eskimo Curlew traditionally included NL before the population collapsed in the late-1800s, Eskimo Curlew are thought to be extinct in the Study Area, with no confirmed breeding records in North America for over 100 years, or confirmed sighting records since 1963 (COSEWIC 2009).

Action plans are created after recovery strategies are completed (DFO 2016a). Action plans summarize projects and activities designed to meet the objectives and goals of a recovery strategy and include information regarding habitat, protection measures and evaluations of socio-economic costs and benefits (DFO 2016a). These documents are dynamic and can be modified over time (DFO 2016a). Action plans have been created for four species/populations designated as *endangered* or *threatened* that may occur in the Study Area: (1) North Atlantic right whale (proposed; DFO 2016c); (2) northern bottlenose whales (DFO 2017e); (3) Red Crossbill (ECCC 2012b); and (4) Olive-sided Flycatcher (PCA 2017). DFO planned to develop and post action plans for blue whale (Atlantic population), leatherback sea turtle (Atlantic population), and northern and spotted wolffish during 2016–2017, but these documents are not yet available (DFO 2016b).

Management plans include measures for the conservation of species, and must be posted on the public registry within three years of a species/population being listed as *special concern* on Schedule 1 of *SARA* (DFO 2007). Management plans have been prepared for nine species/populations designated as *special concern* that may occur in the Study Area: (1) Atlantic wolffish (Kulka et al. 2007); (2) banded killifish (Newfoundland population; DFO 2011); (3) fin whale (Atlantic population; DFO 2017a); (4) Sowerby's beaked whale (DFO 2017f); (5) Peregrine Falcon (ECCC 2017b); (6) Rusty Blackbird (ECCC 2015); (7) Short-eared Owl (proposed; ECCC 2016c); (8) Barrow's Goldeneye (Eastern population; ECCC 2013a); and (9) Red Knot (ECCC 2017a).

Grieg NL acknowledges the possibility that species/populations other than those provided in Table 4.14 may receive *endangered*, *threatened*, *special concern* or *vulnerable* status under Schedule 1 of *SARA* or the *ESA* during the course of the Project, that the status of species/populations within Table 4.14 may change, and that updated or new *SARA* recovery strategies, action plans and management plans may be posted. Grieg NL will monitor for updates and comply with relevant regulations pertaining to species at risk and their associated strategies and plans.

#### 4.2.5.2 Profiles of Species/Populations listed as *Endangered, Threatened, Special Concern* or *Vulnerable* under Schedule 1 of *SARA* and/or the *ESA*

Only those species and/or populations listed as *endangered* or *threatened* on Schedule 1 of *SARA* and/or under the *ESA* receive immediate legal protection (GC 2014; LGL 2015), and those *endangered* or *threatened* species/populations which may occur within the Study Area (see Table 4.14) are profiled below. Land birds are not included because Project activities in the terrestrial environment are limited to those in an established Marine Industrial Park. The legal prohibitions protecting *endangered* or *threatened* Schedule 1 or *ESA* species/populations do not apply to those listed as *special concern* on Schedule 1 of *SARA* or as *vulnerable* under the *ESA* (ECCC 2007b; GC 2014). However, provisions related to environmental assessments, including the identification of species at risk, critical habitat and mitigation, monitoring, and notification of appropriate ministers if a project is likely to affect a listed species or its critical habitat, apply to all species listed on Schedule 1, including species of *special concern* (GC 2014). Therefore, species listed as *special concern* on Schedule 1 of *SARA* and/or *vulnerable* under the *ESA* that may occur in the Study Area (see Table 4.14) are also described below. Candidate species do not receive legal protection and are not described further in this subsection.

***Fish***

Six fish species are listed on Schedule 1 of *SARA* and/or under the *ESA* that could occur in the Study Area (see Table 4.14). These species are profiled below.

*White Shark (Atlantic population)*

The Atlantic population of white shark is designated as *endangered* on Schedule 1 of *SARA* and by COSEWIC. Globally, this species is observed and captured most frequently in waters over the continental shelves of the Northwest Atlantic Ocean, Mediterranean Sea, southern Africa, southern Australia, New Zealand, and the eastern North Pacific Ocean (LGL 2015). White shark is relatively rare in Canadian waters, which represents the northern-most portion of its sub-tropical and temperate distribution (COSEWIC 2006a). This species occurs in inshore and offshore waters, including in the breakwaters off sandy beaches, off rocky shores, and within bays, lagoons, harbours and estuaries, from just below the surface to water depths of at least 1,280 m (COSEWIC 2006a). White shark does not typically enter brackish or freshwaters (COSEWIC 2006a). A highly mobile species, white shark individuals in Atlantic Canada are likely seasonal migrants that belong to a widespread Northwest Atlantic population (COSEWIC 2006a). In recent years, numerous white sharks have been tagged by OCEARCH, a non-profit organization devoted to global-scale research on white sharks and other large apex predators, providing open source, near-real time data (including satellite tracks) through the Global Shark Tracker (LGL 2015; OCEARCH 2018). An adult female white shark, "Lydia", originally tagged in March 2013 off Jackson, Florida, was within the Study Area during 26–29 October 2013, including in the vicinity of the proposed sea cage sites in the Rushoon BMA, within the southern portion of the Merasheen BMA, and south of the Red Island BMA (OCEARCH 2018). No abundance trend information is available for the Atlantic population of white shark (COSEWIC 2006a). However, the white shark population has been estimated to have recently declined by ~80% in portions of the Northwest Atlantic Ocean beyond Canadian waters (COSEWIC 2006a).

*Northern Wolffish*

The northern wolffish is designated as *threatened* on Schedule 1 of *SARA* and by COSEWIC. This deepwater species has been captured from boreal and subarctic water depths of 38–1,504 m, with the densest concentrations observed between 500 and 1,000 m in water temperatures of 2–5ºC (COSEWIC 2012a; LGL 2015). In Canadian waters, northern wolffish range from the Canadian portion of the Gulf of Maine to the Labrador Sea as far as the waters off west Greenland, and extend eastwards to the Grand Banks (COSEWIC 2012a). Northern wolffish undertake limited migration, inhabiting a variety of bottom substrate types such as mud, sand, pebbles, small rock and hard bottom, with the highest concentrations observed over sand and shell hash in the fall and coarse sand in the spring (C-NLOPB 2010; COSEWIC 2012a; LGL 2015). Unlike other wolffish species, both juvenile and adult stages of this species have been found a considerable distance above the bottom substrate, as indicated by diet (Kulka et al. 2007; LGL 2015). Northern wolffish have low productivity, and are thought to spawn in the late-fall or early-winter on rocky bottom substrate (Templeman 1985, 1986 *in* C-NLOPB 2010; COSEWIC 2012a; LGL 2015). No northern wolffish were caught in the commercial fishery or DFO Research Vessel (RV) surveys within the Study Area in recent years (see Section 4.4.1, Fisheries), although suitable habitat exists there (COSEWIC 2012a).

*Spotted Wolffish*

Spotted wolffish are designated as *threatened* on Schedule 1 of *SARA* and by COSEWIC. The life history, distribution and habitat use of spotted wolffish are very similar to that of northern wolffish, except that it rarely inhabits the deepest areas used by northern wolffish (COSEWIC 2012b; LGL 2015). Spotted wolffish have been caught at water depths of 56–1,046 m, although they are most frequently observed between 200–750 m depth at water temperatures of 1.5–5ºC (COSEWIC 2012b; LGL 2015). In Newfoundland and Labrador waters, reproduction typically occurs in July and August on stony bottom habitat (LGL 2015). No spotted wolffish were taken in recent commercial fisheries or DFO RV surveys

in the Study Area (see Section 4.4.1, Fisheries), despite the presence of suitable habitat (COSEWIC 2012b).

*Atlantic Wolffish*

Atlantic, or striped, wolffish are designated as *special concern* on Schedule 1 of *SARA* and by COSEWIC. Atlantic wolffish occupy the same general distribution range as northern and spotted wolffish, with juveniles and adults primarily inhabiting rocky or sandy bottom substrates of continental shelf waters (COSEWIC 2012c). Atlantic wolffish tolerate a broader temperature range than other wolffish species, from -1.5–13ºC (COSEWIC 2012c). Similar to other wolffish species, Atlantic wolffish have low productivity. Spawning is thought to occur in the fall, and the eggs are guarded by male Atlantic wolffish until they hatch (COSEWIC 2012c). The total number of Atlantic wolffish in Canadian waters has been estimated at 49 million, including ~5 million mature individuals (COSEWIC 2012c). No Atlantic wolffish were caught in recent commercial fisheries in the Study Area, while at least 21 individuals were caught during DFO RV surveys within the Study Area during 2010–2015, in water depths <200 m (see Section 4.4.1, Fisheries).

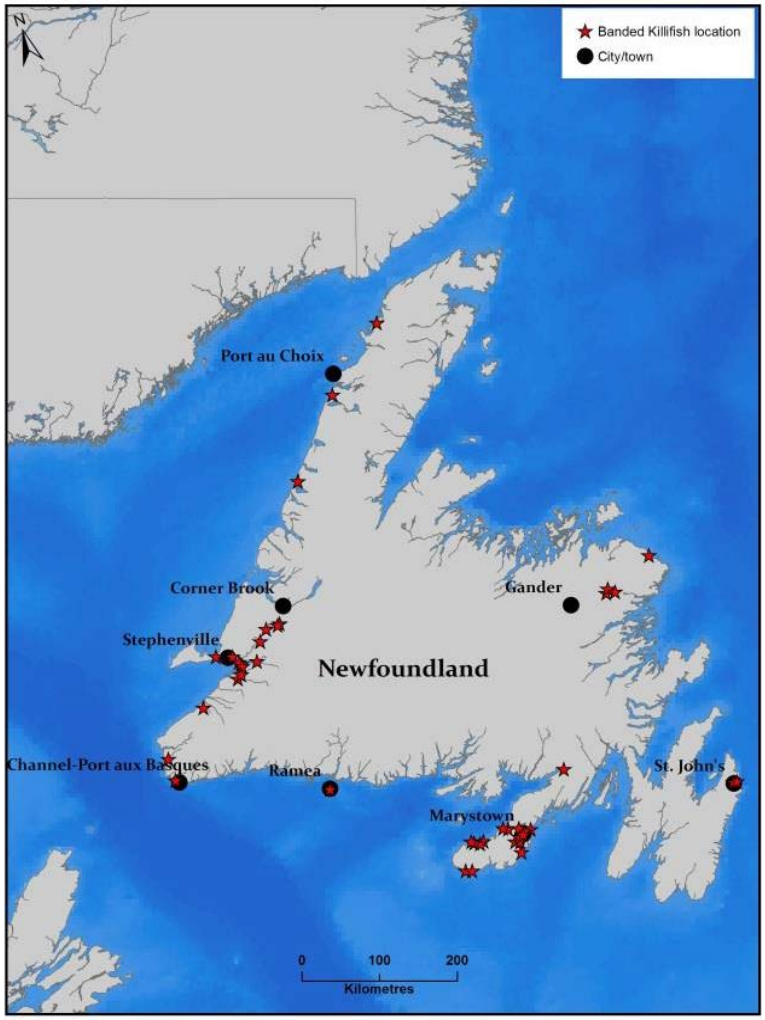
*American Eel*

Although not listed on *SARA*, American eel is designated as *threatened* by COSEWIC and *vulnerable* under the *ESA*. American eel is a highly migratory species that spawns in oceanic waters, migrates to coastal and inland waters to grow, and returns to ocean spawning grounds to reproduce and die (Cairns et al. 2008 *in* C-NLOPB 2010; COSEWIC 2012d). The continental distribution of this species ranges from northern South America to Greenland and Iceland (COSEWIC 2012d). Historically, its Canadian range included all accessible freshwater habitats, estuaries and coastal marine waters connected to the Atlantic Ocean, up to the mid-Labrador coast (COSEWIC 2012d). The distribution and abundance of this species has decreased in freshwater habitats over the past 100 years due to human development (COSEWIC 2012d). Currently, American eel can be found in most coastal areas and adjacent accessible rivers in Newfoundland but are only known as far north as Labrador's English River (FLR 2018). Maturing American eel are primarily benthic, using rocky, sandy or muddy substrate, woody debris and submerged vegetation for protection and cover, particularly eelgrass and interstitial spaces (i.e., spaces between aquatic sediments) (COSEWIC 2012d). American eel spawn once during their lifetimes, with spawning occurring in the Sargasso Sea (C-NLOPB 2010; COSEWIC 2012d). Newfoundland is relatively data-poor with respect to absolute abundance at any life stage (C-NLOPB 2010); however, time series data used to estimate percent change in indices of abundance indicated declines between the 1980s and 2000s (COSEWIC 2012d). American eel were not caught during commercial fisheries or DFO RV surveys within the Study Area in recent years, although the Study Area is within the habitat range of this species (see Section 4.4.1, Fisheries; COSEWIC 2012d).

*Banded Killifish (Newfoundland populations)*

The Newfoundland populations of banded killifish are designated as *special concern* on Schedule 1 of *SARA* and by COSEWIC, and as *vulnerable* under the *ESA*. Banded killifish is distributed throughout much of eastern North America, with the Newfoundland populations exhibiting a scattered distribution, primarily concentrated in clear lakes and ponds with a muddy or sandy bottom along the south and west coasts of the island (Chippet 2003 and SAR 2006 *in* C-NLOPB 2010; COSEWIC 2014). The Newfoundland populations are isolated from the mainland populations, and are now being investigated as a possible subspecies (FLR 2018). Although banded killifish most often inhabit fresh waters, it is euryhaline (i.e., capable of living in habitats with elevated salinity) and occasionally occupies estuaries or marine waters (Fritz and Garside 1974 *in* C-NLOPB 2010; COSEWIC 2014). This species requires

shallow water, slow currents, soft substrates and abundant aquatic vegetation, and does not appear to become active in Newfoundland until water temperatures reach 12ºC (COSEWIC 2014). Spawning has been reported in Newfoundland from late-June through August, contrary to the mainland populations which reproduce during the spring (COSEWIC 2014). Adhesive eggs are attached to aquatic plants, and the young receive no parental care (COSEWIC 2014). Banded killifish are typically abundant within the confined regions in which they are found (GNL 2010). Limited data are currently available with regard to Newfoundland population trends, although there is no indication of decline in the number of populations or abundance within their scattered regions (GNL 2010; COSEWIC 2014). Known populations of banded killifish in freshwater bodies which ultimately drain into Placentia Bay are located in Freshwater Pond (southwest of Marystown), the town of Winterland (west of Marystown), and Garnish Pond (northwest of Marystown) (COSEWIC 2014). Additional banded killifish locations were recently identified near Marystown and the southern portion of the Burin Peninsula, although specific location names were not provided (DFO 2016d; Figure 4.10). Banded killifish were not caught during commercial fisheries or DFO RV surveys within the Study Area in recent years (see Section 4.4.1, Fisheries).




Source: DFO (2016).

**Figure 4.10. Current (2015) known distribution of the Newfoundland population of banded killifish.**

***Marine Mammals***

Five whale species that may occur in the Study Area are listed as *endangered* or *special concern* on Schedule 1 of *SARA* (see Table 4.14). These five species/populations are described below. Other marine mammals that may occur in the Study Area, as well as river otters, are overviewed as part of the Sensitive Areas VEC (Section 4.2.6.2).

*Blue Whale (Atlantic population)*

The Atlantic population of blue whale is designated as *endangered* on Schedule 1 of *SARA* and by COSEWIC. Blue whales became severely depleting during industrial whaling in the Atlantic, with at least 1,500 killed before the 1960s in the waters of eastern Canada (DFO 2017b). Blue whales still occur at relatively low densities in the North Atlantic, with an estimated population size of 400–600 individuals in the western North Atlantic, of which fewer than 250 are thought to be adults (Waring et al. 2011; DFO 2017b). Within Canadian waters, the Atlantic population of blue whale may be found in the northern Gulf of St. Lawrence, off Nova Scotia and Newfoundland, in the Davis Strait and between Baffin Island and Greenland (DFO 2017b). Atlantic blue whales usually migrate south during the winter, although some remain within eastern Canadian waters year-round (DFO 2017b). Blue whales are typically sighted in deep water rather than coastal environments and are typically associated with areas of upwelling or shelf edges where its prey, mainly euphasiids, may concentrate (Jefferson et al. 2008 and COSEWIC 2002a *in* LGL 2015). Blue whales may live up to 70–80 years and reproduce every two to three years, after reaching sexual maturity between six and ten years of age (DFO 2017a). Most sightings of blue whales in Canadian waters include sightings during spring, summer and fall in the Gulf of St. Lawrence or eastern Nova Scotia, and during winter off southern Newfoundland (Waring et al. 2007 *in* C-NLOPB 2010).

In the North Atlantic, seasonal movements and habitat use of blue whales are relatively poorly understood; this includes uncertainty regarding the location of breeding and wintering areas. Lesage et al. (2016) used satellite telemetry to track the seasonal movements of 24 blue whales in eastern Canada. These whales were tagged between August and November off the Gaspé Peninsula in the Gulf of St. Lawrence and at various sites throughout the St. Lawrence Estuary. Three of the tagged blue whales showed movement out of the nearshore waters, with two travelling into the waters around the New England seamounts and one blue whale in 2013 passing through offshore waters of the Grand Banks (well south of the Study Area).

There are two primary database sources for cetaceans in the Study Area: the Ocean Biogeographic Information System (OBIS) and DFO St. John's cetacean database of opportunistic sightings. The OBIS database was adopted as a project under the Intergovernmental Oceanographic Commission (IOC)-United Nations Educational, Scientific and Cultural Organization (UNESCO) International Oceanographic Data and Information program in 2009. OBIS is a provider of open-access data on global marine biodiversity for scientific, conservation and sustainable development purposes, in collaboration with scientific communities from 500 institutions in 56 countries (OBIS 2018). There are a total of 90 recorded sightings of blue whales within Placentia Bay in the OBIS database during 1927–1944 but none included since then coinciding with the decline of blue whales due to whaling. The number of sightings ranged from 10–51 per year during the late-1920s, and thereafter decreased to ≤5 sightings per year, until a single sighting in 1944 (OBIS 2018). Based on DFO St. John's cetacean database for 1975–2017, blue whales are infrequently sighted in the Study Area (two sightings in Figure 4.11). The latest sighting within the Study Area was of four individuals during July 2002. No blue whales were sighted during boat-based surveys for marine mammals in Placentia Bay during August 2006–August 2007 (see Figure 3.80 *in* NLRC 2007). Blue whales are considered rare in the Study Area.

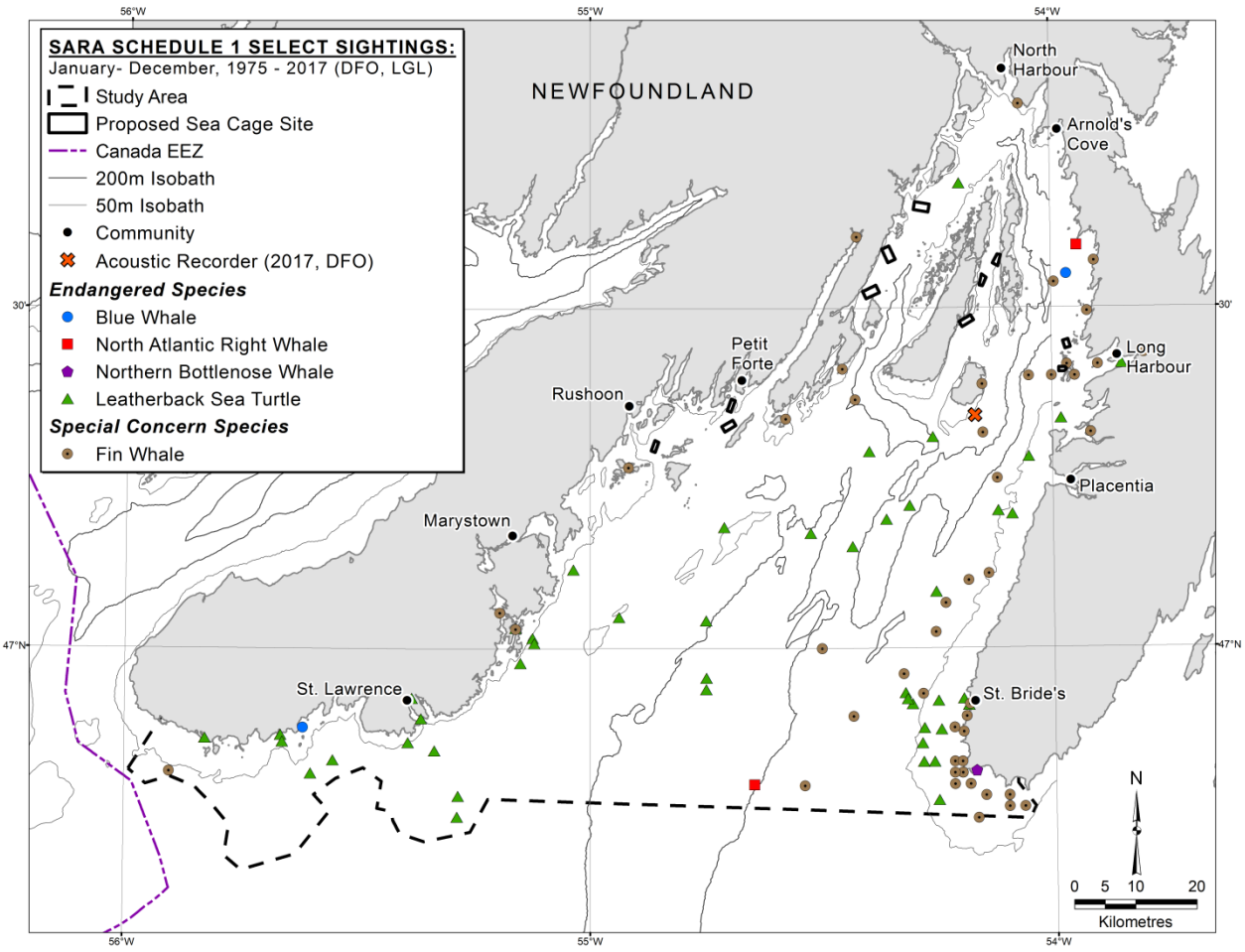



**Figure 4.11. Sightings of marine mammal and sea turtle species listed on Schedule 1 of *SARA*.**

*North Atlantic Right Whale*

North Atlantic right whale is designated as *endangered* under Schedule 1 of *SARA* and by COSEWIC. This long-lived, slowly reproducing species was severely depleted by commercial whaling, and is one of the most critically endangered large whale populations in the world (COSEWIC 2013a). North Atlantic right whales occupy a range of water depths at varying distances from shore, including shallow coastal areas, deep coastal waters and offshore waters, aggregating near dense patches of copepods for feeding (COSEWIC 2013a). Females give birth to a single calf every three to five years after reaching maturity between five and 21 years of age, and males typically mature around 15 years of age (COSEWIC 2013a).

North Atlantic right whales occur in the northwest Atlantic from Florida to Newfoundland and in the Gulf of St. Lawrence (COSEWIC 2013a). They have wintering calving grounds located off the coast of Florida and Georgia. Whales that use the calving ground during the early winter migrate north in the late winter and spring to feed in Cape Cod Bay, the Great South Channel and Massachusetts Bay. Not all individuals occupy these areas during the winter and their whereabouts (especially adult males) is largely unknown (COSEWIC 2013a). A possible breeding ground located in the middle of the Gulf of Maine has recently been discovered (COSEWIC 2013a). During the summer and fall, right whales have historically been

found congregating and feeding in the lower Bay of Fundy and in the Roseway Basin on the western Scotian Shelf. Smaller numbers have also been observed in other areas of the Scotian Shelf and the Gulf of St. Lawrence, and rarely, in the waters off Newfoundland. The main threats facing this species are ship strikes and entanglement in fishing gear (COSEWIC 2013a; Brillant et al. 2017); both have contributed to limited population recovery (COSEWIC 2013a).

The western North Atlantic population is thought to have a minimum of 440 individuals (Hayes et al. 2017), but perhaps as many as 736 individuals (Pettis et al. 2017). The best estimate is 451 individuals (Pettis et al. 2017), but the population size has been declining since 2010 (Pace et al. 2017). It is likely that only ~100 reproductive females remain in the population (Baumgartner et al. 2017; Pennisi 2017). Decreasing calving rates (down 40% since 2010) and increasing rates of human-caused mortality are of great concern (Kraus et al. 2016). Some researchers suggest the right whale population can recover as long as prey availability is favourable and mortality rates are low (Meyer-Gutbrod and Greene 2017). However, in 2017, only five calves were reportedly born and there were three times as many mortalities (Pettis et al. 2017). From 6 June 15–September 2017, 12 dead North Atlantic right whales were reported in the Gulf of St. Lawrence; nine were observed floating in the southern Gulf of St. Lawrence and four came ashore in western Newfoundland (Daoust et al. 2017). Necropsies on seven of the whales determined that the cause of death was blunt trauma in four instances and drowning as a result of entanglement in two instances; the cause of death could not be determined for the seventh whale due to advanced decomposition. An additional five entanglements were reported between 5 July and 28 August 2017; of these entanglements, two were disentangled, one shed the gear on its own and the remaining two entangled whales could not be disentangled; their fate remains unknown (Daoust et al. 2017).

There are no North Atlantic right whale sightings within Placentia Bay in the OBIS database, and none were observed during marine mammal surveys from August 2006–August 2007 (see Figure 3.80 *in* NLRC 2007; OBIS 2018). There are two relatively recent sightings of individual North Atlantic right whales in the DFO sightings database, one during August 2005 in northeast Placentia Bay and the other in September 2017 at the entrance to the bay (see Figure 4.11). Additionally, in summer 2017, right whale calls were detected on multiple occasions on a DFO acoustic recorder located southeast of Red Island (see Figure 4.11; J. Lawson, Research Scientist, DFO, pers. comm., 5 May 2018). Right whales are considered rare in the Study Area but given recent visual and acoustic detections, it is quite possible this species may occur there again.

*Northern Bottlenose Whales*

Northern bottlenose whales are found only in the North Atlantic. In Canada, northern bottlenose whales regularly occur in several locations: along the Scotian Shelf, in Davis Strait, and the Flemish Pass area (DFO 2016e; L.J. Feyer, Ph.D. Candidate, Dalhousie University, Halifax, NS, 5 February 2018). The Scotian Shelf population is listed as *endangered* by both *SARA* (Schedule 1) and COSEWIC. The Davis Strait-Baffin Bay-Labrador Sea population is listed as *special concern* by COSEWIC but is not listed under *SARA*. Critical habitat for the Scotian Shelf population has been defined and includes the Gully, Shortland, and Haldimand submarine canyons, located at the edge of the eastern Scotian Shelf (DFO 2016e). While the Scotian Shelf population does not appear to migrate, the movements of the Davis Strait-Baffin Bay population have not been studied (COSEWIC 2011). Northern bottlenose whales are primarily found in offshore waters deeper than 500 m, often near the 1,000 m isobath (DFO 2016e). They are excellent divers; a tagged whale was recorded diving to 1,453 m; they can remain underwater for up to two hours (DFO 2016e). The species mainly feeds on squid, which typically dwell at or near the bottom (DFO 2016e).

The Scotian Shelf population is estimated at 143 individuals (O'Brien and Whitehead 2013), but there are no estimates of the size of the Davis Strait-Baffin Bay-Labrador Sea population or the total number of northern bottlenose whales in the Northwest Atlantic (COSEWIC 2011). This beaked whale species is considered quite rare in the Study Area. There is only one sighting in the DFO database (see Figure 4.11).

*Fin Whale (Atlantic population)*

The Atlantic population of fin whale is designated as *special concern* on Schedule 1 of *SARA* and by COSEWIC. Fin whales are distributed throughout the world's oceans, but are most commonly found in temperate and polar waters (Jefferson et al. 2008). Although previously heavily targeted during the commercial whaling fishery, fin whales continue to regularly occur around Newfoundland and Labrador, particularly during the summer (LGL 2015). The scientific committee of the International Whaling Commission (IWC) classifies the fin whales off the eastern US, Nova Scotia, and the southeastern coast of Newfoundland as a single stock, the 'western North Atlantic stock' (Hayes et al. 2017). The current abundance estimate for the western North Atlantic fin whale stock is 1,618 individuals (CV = 0.33; Hayes et al. 2017). Fin whales in the western North Atlantic range from close inshore to well beyond the shelf break (COSEWIC 2005). They are typically found near concentrations of their primary prey items, small schooling fish and krill (Borobia et al. 1995), such as along thermal fronts, areas of upwelling, shelf breaks and banks (Woodley and Gaskin 1996; COSEWIC 2005; Doniol-Valcroze et al. 2007). This species reaches sexual maturity at 5–15 years of age, and is thought to reproduce and calve during the winter at low latitudes, possibly up to every two years (COSEWIC 2005).

Fin whales are regularly seen in Placentia Bay albeit in relatively lower numbers than humpback and minke whales (Abgrall and Moulton 2007; see Figure 4.14 later). There were two fin whale sightings within Placentia Bay during Northeast and Southeast Fisheries Service Centre (NEFSC and SEFSC, respectively) shipboard and aerial summer surveys during various years from 1995–2011 and/or DFO's 2007 Trans North Atlantic Sightings Survey (TNASS) survey (see Figure 1 *in* Hayes et al. 2017). There were two sightings of individual fin whales during boat-based surveys from August 2006–August 2007, during August in both survey years (Abgrall and Moulton 2007; see Figure 3.80 *in* NLRC 2007 and Figure 4.11). There are 576 fin whale sightings within the Study Area during 1927–1944 and 2007 in the OBIS database (OBIS 2018). Based on DFO sighting records from 1975–2017, fin whales have been recorded primarily in coastal waters of Placentia Bay including within the Rushoon and Long Harbour BMAs (see Figure 4.11).

*Sowerby's Beaked Whale*

Sowerby's beaked whale is found exclusively in the North Atlantic. The species is listed as a species of *special concern* under *SARA* (Schedule 1) and COSEWIC. In the northwestern Atlantic, they are thought to occur as far north as the Davis Strait, although they are most frequently observed in the waters off Newfoundland, Nova Scotia, and the northeastern US (DFO 2016f). Little is known of this species' habitat preferences and life history requirements. Sowerby's beaked whale is most often observed in deep water (>200 m) along the continental shelf edge and slope (COSEWIC 2007b; DFO 2016f). Submarine canyons appear to be of importance to this species, and they demonstrate a strong affinity for canyon habitats along the Scotian shelf (Whitehead 2013; DFO 2016f). Stomach content and isotope analyses indicate that the diet of Sowerby's beaked whale consists of squid and fish occurring in between 200 and 2,000 m depth (DFO 2016f). There is currently no population estimate for this species in Canada (DFO 2016f). There are no reported sightings of Sowerby's beaked whale in the Study Area and this species is considered rare in coastal waters of Newfoundland.

### *Sea Turtles*

Two sea turtle species considered species at risk under Schedule 1 of *SARA* may occur within the Study Area, the Atlantic population of leatherback sea turtle and loggerhead sea turtle (see Table 4.14), and are summarized below. Additionally, incidences of leatherback sea turtle strandings and entrapments in fishing gear in Newfoundland and Atlantic Canada were summarized by Ledwell and Huntington (2009) and Hamelin et al. (2017), respectively. Proposed critical habitat for leatherback sea turtles is described in Section 4.2.6.3, Estuaries, Rivers and Habitats of Species at Risk.

*Leatherback Sea Turtle (Atlantic population)*

The Atlantic population of leatherback sea turtles is designated as *endangered* on Schedule 1 of *SARA* and by COSEWIC. Leatherback sea turtles are the largest species of sea turtle and the most likely to be observed in the Study Area. They are a pelagic, migratory species that tend to inhabit temperate oceanic and coastal shelf waters, where they forage on jellyfish between April and December (COSEWIC 2012e). Recent efforts in Atlantic Canadian waters have yielded insight into the foraging and movements of leatherback sea turtles using both satellite telemetry and camera tags, providing footage of leatherbacks searching for, capturing and handling their prey. This footage revealed that this species finds its prey by entirely visual means and feeds only during daylight hours, predominantly within the top 30 m of the water column (DFO 2016g).

The leatherback turtle does not nest in Canada, but rather, nesting occurs on tropical and sub-tropical beaches during the spring (COSEWIC 2012e). In Atlantic Canada, leatherback sea turtles occur in both coastal and offshore waters, although most sightings are from the continental shelf (COSEWIC 2012e). Leatherback turtles outfitted with satellite telemetry tags and vessel-based sightings have been reported in the offshore waters of Nova Scotia and Newfoundland (DFO 2012; Stewart et al. 2013; Dodge et al. 2014; Archibald and James 2016; Chambault et al. 2017). The Atlantic population of leatherback sea turtles is currently estimated at 29,000–34,000 mature individuals (SRPR 2018a). While the size of the seasonal foraging population in Atlantic Canada is not known, sightings data suggest that the population in Canadian Atlantic waters numbers is in the thousands (COSEWIC 2012e). Archibald and James (2016) suggested that Canadian waters may have the highest density of foraging leatherbacks anywhere throughout their range. Although critical habitat has not yet been designated for this species in Atlantic Canadian waters (ALTRT 2006), areas previously identified as important foraging habitat have now been identified in the proposed recovery strategy as critical habitat areas for leatherbacks (DFO 2016f). Three proposed critical habitat areas have been identified: the Southwestern Scotian Slope Area, the Gulf of St. Lawrence-Laurentian Channel Area, and the Placentia Bay Area (DFO 2016). The main threat facing leatherback sea turtles in Canadian waters is bycatch in fisheries, although globally, the species is threatened by ship strikes, marine debris, and oil and gas exploration (COSEWIC 2012e).

There are numerous leatherback sea turtle sightings throughout the Study Area in the DFO sightings database (1975–2017), primarily occurring south of the BMAs (see Figure 4.11). Three sightings of individual leatherbacks were made near the central portion of Placentia Bay during boat-based surveys from August 2006–August 2007, with all three sightings during August 2007 (Abgrall and Moulton 2007). Leatherbacks are considered common in the Study Area., albeit in relatively low numbers.

*Loggerhead Sea Turtle*

Loggerhead sea turtle is designated as *endangered* on Schedule 1 of *SARA* and by COSEWIC. Loggerheads are distributed throughout the Atlantic, Pacific and Indian Oceans, preferring water

temperatures of ≤18ºC (DFO 2017d). The Atlantic and Pacific populations of loggerheads are genetically distinct, but there are no recognized subspecies of this sea turtle (SRPR 2018b). In Atlantic Canadian waters, loggerheads seem to prefer sea surface temperatures >20ºC, generally along the shelf break and farther offshore (DFO 2017d). Loggerheads spend the majority of their lives at sea, with adult females coming ashore to lay their eggs on sub-tropical and tropical beaches every two to three years, after reaching maturity between 16–34 years of age (DFO 2017d; SRPR 2018b). Loggerhead sea turtles found in Atlantic Canadian waters likely originate from the same nesting populations as turtles found in northeastern US waters, with the largest regional nesting area located in Peninsular Florida (DFO 2017d). There are no current population estimates for loggerheads in Atlantic Canada (COSEWIC 2010). The adult female population in the western North Atlantic is estimated at 38,334 individuals (Richards et al. 2011). Thousands of mostly immature loggerheads have been caught as bycatch in the Canadian pelagic longline fishery off the east coast since 1999 (Brazner and McMillan 2008; Paul et al. 2010). No loggerhead sea turtles were sighted within the Study Area in the OBIS or DFO sightings databases (OBIS 2018). Loggerhead sea turtles are considered rare in the Study Area.

***Birds***

Twenty-four species and/or populations of birds occurring in Newfoundland and Labrador have been legislated as species at risk by federal and/or provincial governing bodies (see Table 4.14). Thirteen of these species/populations are land birds, which are unlikely to be affected by the presence or activity of the Project, and are therefore, not described further in the EIS. Species descriptions for listed land birds can be found on the *SARA* website (2018). Five aquatic bird species (i.e., live on the water or shoreline) listed as *endangered* or *special concern/vulnerable* on Schedule 1 of *SARA* and/or under the *ESA* are described below. Eskimo Curlew are not profiled, as they are thought to be extinct in the Study Area (see footnote ‘c’ of Table 4.14).

*Ivory Gull*

The Ivory Gull is designated as *endangered* on Schedule 1 of *SARA*, under the *ESA* and by COSEWIC. An 80% decline of the Canadian breeding population during the last 20 years (COSEWIC 2006b) has contributed to a worldwide concern over the global population of Ivory Gull. The global population of this species is thought to be <12,800 pairs, although population values from Russia may be overestimated (Gilchrist and Mallory 2005). The Ivory Gull inhabits the Arctic Ocean, and is usually associated with pack ice. This Gull nests near partially ice-free marine waters in late-May and early-June in the high Canadian Arctic, northern Greenland and Spitsbergen to Novaya Zemlya, with colonies concentrated around Jones and Lancaster Sounds, southeastern Ellesmere Island, eastern Devon Island, and the Brodeur Peninsula of northern Baffin Island in Canada (COSEWIC 2006b). Ivory Gull winters as far south as the reach of pack ice off northeast Newfoundland (Haney and MacDonald 1995). Recent warm winters have led to a reduction in the overall area of pack ice off Newfoundland and a corresponding reduction of Ivory Gull sightings. Few records exist of observations of Ivory Gull off the south coast of Newfoundland, and none for Placentia Bay. One sighting of a single Ivory Gull occurred in Little Bay East, Fortune Bay, during January 2000 and one in St. Joseph’s on the Avalon Peninsula (west of the Avalon Wilderness Reserve) in January 1998 (eBird Canada 2018). There are four records of Ivory Gull for St. Pierre et Miquelon, during February 1979, January 1988, April 1994 and January 2002 (Abraham and Etcheberry 2014). Ivory Gull may be a rare visitor to Placentia Bay during November–April.

*Piping Plover*

The Piping Plover *melodus* subspecies is designated as *endangered* on Schedule 1 of *SARA*, under the *ESA* and by COSEWIC. A 2011 survey of the Canadian population of Piping Plover indicated a total of 1,439 adults, of which 406 were in the Atlantic population and 51 in the Newfoundland breeding population (COSEWIC 2013b). Piping Plover nests and forages on sandy beaches from April–September (C-NLOPB 2010). The Newfoundland breeding range includes the southwest portion of the island, from Flat Bay Island in St. Georges Bay to Grand Barasway near Burgeo. An isolated one to two pairs of Piping Plover nest in Gros Morne National Park. One to two pairs nesting at Miquelon, St. Pierre et Miquelon, are the closest breeding Piping Plover to Placentia Bay (Abraham and Etcheberry 2014). Piping Plover are rarely observed in Newfoundland outside of their breeding sites, and the extensive sandy beaches required by Piping Plover for breeding sites and foraging do not exist in Placentia Bay. A single sighting record of one bird exists for Piping Plover for Placentia Bay, by an observer in Come by Chance during May 2016 (eBird Canada 2018).

*Red Knot*

The Red Knot *rufa* subspecies is designated as *endangered* on Schedule 1 of *SARA*, by COSEWIC and under the *ESA*. This subspecies breeds in the central Canadian Arctic and winters from California and Massachusetts to the southern tip of South America (COSEWIC 2007a). Red Knot nests on barren habitats in the Arctic, and uses coastal areas with extensive sandflats or mudflats in migration and wintering areas, where they feed on bivalves and other invertebrates (COSEWIC 2007a). Red Knot is also known to use peat banks, salt marshes, brackish lagoons, mangrove areas, mussel beds and rocky intertidal platforms rich in invertebrate fauna (COSEWIC 2007a). Population trends of the *rufa* subspecies within Newfoundland are unknown. It is an uncommon fall migrant in coastal Newfoundland, and rarely occurs during spring migration. Its preferred Newfoundland feeding habitat of open, sandy beaches, typically including rotting kelp piles and extensive mud flats, occur sparingly in Placentia Bay. One Red Knot was recorded on the tidal flats at the Arnold's Cove estuary during the Atlantic Canada Shorebird Survey Program during 2000–2007 (ECCC 2009). Red Knots were also observed near Arnold's Cove during January 2003, August 2013, and August 2015 (eBird Canada 2018).Three Red Knots were sighted near Lamaline in August 1986. Additionally, a Red Knot was observed near Come by Chance in September 2015 and August 2017.

*Barrow's Goldeneye (Eastern population)*

The Eastern population of Barrow's Goldeneye is designated as *special concern* on Schedule 1 of *SARA* and by COSEWIC, and as *vulnerable* under the *ESA*. Barrow's Goldeneye winter in eastern Canada (COSEWIC 2000). The Eastern population consists of ~4,500 individual birds, with ~400 individuals thought to winter in coastal Atlantic Canada and Maine (COSEWIC 2000). The core breeding area of Eastern Barrow's Goldeneye includes small lakes at high elevations in drainage systems draining into the north shore of the Gulf of St. Lawrence. At least 90% of the Eastern Barrow's Goldeneye winter in the St. Lawrence Estuary. In Newfoundland, small numbers have been documented wintering at the mouth of the Humber River near Corner Brook, Traytown, Port Blandford, Spaniard's Bay and St. Mary's Bay (Schmelzer 2006). There is a least one sighting of Barrow's Goldeneye in Placentia Bay, of an adult male and female at the Arnold's Cove estuary in November 1993 (B. Mactavish, Technician, LGL Limited, pers. comm., 19 March 2018). It is possible that some Barrow's Goldeneye are wintering undetected among Common Goldeneyes (*Bucephala clangula*) in some parts of Placentia Bay. Summer moulting sites have been identified on the northeastern side of Hudson Bay, Ungava, Frobisher Bay and the coast of Labrador, from Nain northward (Schmelzer 2006).

*Harlequin Duck (Eastern population)*

The Eastern population of Harlequin Duck is designated as *special concern* on Schedule 1 of *SARA* and by COSEWIC, and as *vulnerable* under the *ESA*. The Eastern Harlequin Duck breeds on rivers in northern Quebec (rivers draining into the eastern side of Hudson Bay and Ungava Bay), Labrador (Nachvak Fiord to Hopedale), the western coast of the Great Northern Peninsula of Newfoundland, the Gaspé Peninsula of Quebec, and northern New Brunswick (Robertson and Goudie 1999). This species winters in coastal areas, mainly from Newfoundland to Massachusetts, with over half of the population wintering in Maine (Robertson and Goudie 1999). Cape St. Mary's hosts the largest known wintering population in Newfoundland, with an average of 120 individuals during 1997–2006 (51–200 individuals per year) (Audubon 2018). Boat-based surveys conducted at Cape St. Mary's during 2005–2013 showed an increasing trend in the number of wintering Harlequin Duck, from 242 individuals in 2005 to 636 in 2013 (ECCC 2013b). An additional 24 individuals were within other locations on the Avalon Peninsula in 2013 (ECCC 2013b), and 150 wintered throughout St. Pierre et Miquelon (B. Letournel, pers. comm., 2012 *in* COSEWIC 2013c). There are no known locations for wintering Harlequin Duck on the Burin Peninsula. Relatively low numbers of Harlequin Duck likely occur within suitable habitat in Placentia Bay during migration and winter (i.e., October–April), including coastal areas and the vicinity of small islands and rocky islets, in zones of high wave energy. A Harlequin Duck pair was observed near the Allan's Island lighthouse, south of Lamaline (southwestern portion of the Study Area) in April 2016, one individual was sighted southwest of St. Lawrence in November 2017, two individuals were seen near Saint Bride's in December 1989, and numerous sightings of one to over 100 individuals have occurred near the Cape St. Mary's Peninsula during the past ~40 years (eBird Canada 2018).

### 4.2.6 Sensitive Areas

In accordance with the SEA for southern Newfoundland (C-NLOPB 2010), a 'sensitive area' is defined as the following:

1. an area that is afforded some level of protection under federal or provincial legislation;
2. an area that may be under consideration for such legislative protection; or
3. an area that is known to have particular ecological or cultural importance and is not captured under federal or provincial regulatory framework.

Various regulatory frameworks are either directly or indirectly involved with sensitive areas in Newfoundland and Labrador. DFO administers marine fisheries through the federal *Fisheries Act*, which also includes management of marine mammals under the *Marine Mammals Regulations* of the *Fisheries Act* (LGL 2015). Species at risk and measures to protect them are administered under the *Species at Risk Act* (2002). Marine Protected Areas (MPAs) are established by DFO under the *Oceans Act* (1996) to protect and conserve important fish and marine mammal habitats, endangered marine species, unique features and areas of high biological productivity or diversity (LGL 2015). Depending on the species, migratory birds are solely or jointly managed between Canada and the U.S. through the Canadian Wildlife Service (CWS) branch of Environment and Climate Change Canada (ECCC), via legislation and agreements including the Convention for the Protection of Migratory Birds (1916), *Migratory Birds Convention Act*, and the North American Waterfowl Management Plan (LGL 2015). Waterfowl are managed according to "flyways" denoting wintering and summering habitat connected by international migration corridors (LGL 2015).

Sensitive areas which overlap the Study Area are shown in Figure 4.12, and discussed in the following subsections.

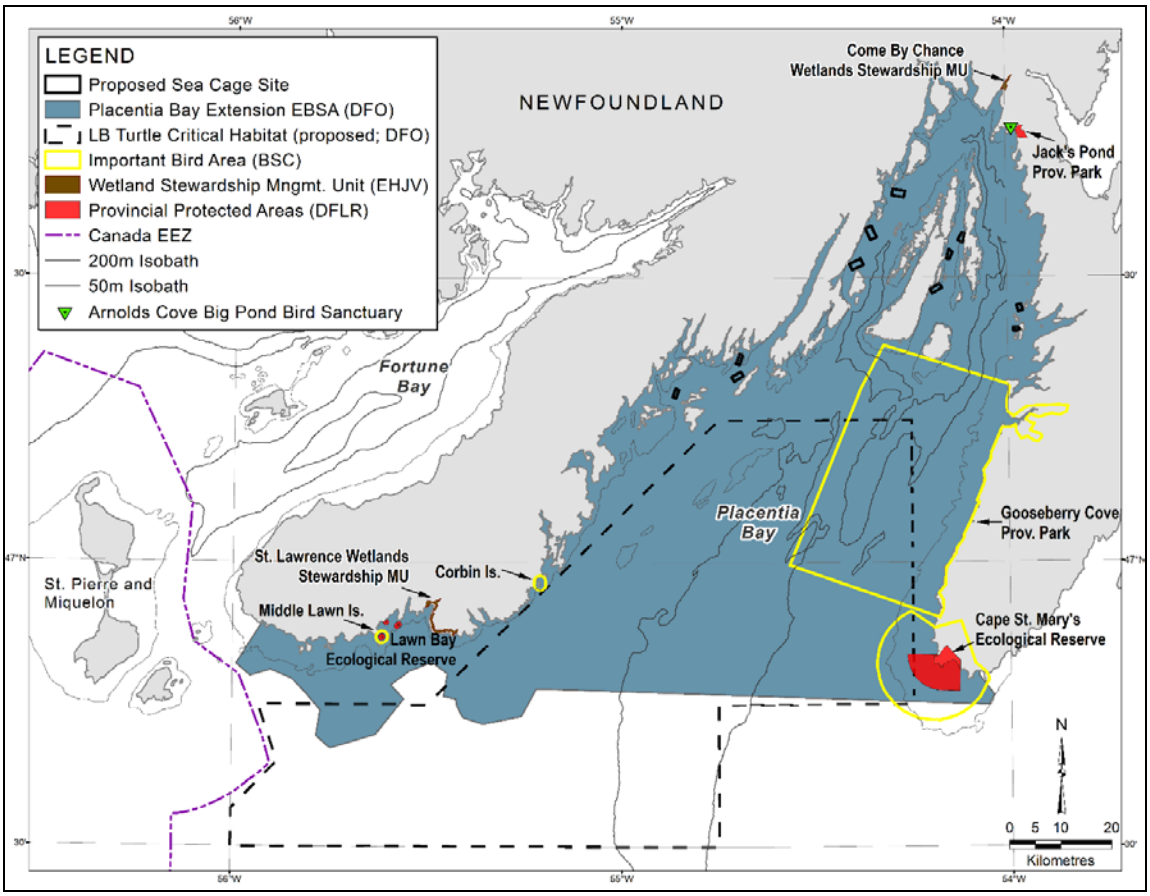



**Figure 4.12. Sensitive areas overlapping or immediately proximate to the Study Area.**

The government of Newfoundland and Labrador designates wilderness and ecological reserves using the *Wilderness and Ecological Reserves* (*WER*) *Act* as guidance, with administration by the Natural Areas Program, Land Management Division within the Department of Fisheries and Land Resources, in cooperation with the Wilderness and Ecological Reserve Advisory Council (DFLR 2017c). Wilderness and ecological reserves are designated to protect the province's natural heritage and are utilized as a tool for the province's conservation strategy, with the goal of preserving wilderness, wildlife and biodiversity and providing outdoor venues for education, research and public enjoyment (DFLR 2017c). Since the establishment of reserves can be a lengthy process, the *WER Act* allows for the creation of "provisional reserves" which receive protection while they are under review for full designation (DFLR 2017c). In situations of immediate threat, the *WER Act* also allows the Minister to establish "emergency reserves" (DFLR 2017c). The Lawn Bay and Cape St. Mary's Ecological Reserves and Jack's Pond and Gooseberry Cove Provincial Parks occur within or immediately adjacent to the Study Area, and there are no provisional or emergency reserves in the region (see Figure 4.12). With the exception of the Cape St. Mary's Ecological Reserve, the province's reserves have few roads and services, and no public buildings or trail markers (DFLR 2017c). The disturbance, removal or introduction of plants, animals, fossils or other foreign objects to or from reserve landscapes is strictly prohibited, as are forestry, mining, hydro or new road/track/building development, agriculture, or driving off-road or all-terrain vehicles (DFLR 2017c).

### 4.2.6.1 National, Provincial and Recreational Parks and Reserves

The Lawn Bay Ecological Reserve encompasses Middle Lawn, Swale and Colombier Islands, located in the southwestern portion of the Study Area near the communities of Lawn and Lord's Cove on the Burin Peninsula (DFLR 2017d). Established as a provisional reserve in 2009 and designated as a full reserve in 2015, the Lawn Bay Ecological Reserve covers ~4 $km^2$, of which ~3.7 $km^2$ is the marine component (DFLR 2017d). The islands are used by thousands of nesting seabirds and the Reserve's primary reason of establishment was to protect North America's only known colony of Manx Shearwater, a nocturnal seabird (DFLR 2017d). The Reserve also provides habitat for at least seven other breeding seabird species, including Leach's Storm-petrel, Great Black-backed Gull, Herring Gull, Black Guillemot, Black-legged Kittiwake, Common Murre and occasionally Arctic and Common Terns (DFLR 2017d). The islands provide important habitat for thousands of feeding and fledging seabirds (DFLR 2017d). During the breeding season (15 March–30 October), all activities other than permitted scientific research are prohibited on the islands in the Reserve (DFLR 2017d). Otherwise, access is unrestricted to Swale and Colombier Islands, and a specific permit is required to access Middle Lawn Island (DFLR 2017d). Although commercial and recreational fisheries are permitted in the Reserve's waters, in accordance with provincial and federal fishing regulations, boaters must take care not to disturb the birds (DFLR 2017d). Fishers are encouraged to fish outside the marine component area in an effort to promote stewardship and protection of the Reserve (DFLR 2017d). Boats, motorized or otherwise, are not permitted within 100 m of the cliffs containing nesting birds during the breeding season. There are currently no licenced commercial boat tour operators registered with the Natural Areas Program that can take the public around the islands (DFLR 2017d). Hunting is prohibited in the reserve at all times. During bird breeding season, aircraft are not permitted to either take off or land within the reserve, or fly lower than 300 m over the reserve (DFLR 2017d).

The Cape St. Mary's Ecological Reserve, established in 1983 and located in the southeastern portion of the Study Area south of St. Bride's, is one of the best and most accessible places in the world to view nesting seabirds (DFLR 2017e). Considered a major seabird colony habitat, this 64 $km^2$ reserve typically hosts 24,000 Northern Gannet, 20,000 Black-legged Kittiwake, 20,000 Common Murre, and 2,000 Thick-billed Murre during breeding season (DFLR 2017e). The Gannet colony within the Reserve is the largest in Atlantic Canada and the third largest in North America (BirdLife International 2002, Lock et al. 1994 and Mercer and Willcott 2005 *in* DFO 2010c). Over 100 pairs of Razorbill, 60 pairs of Black Guillemot, and various numbers of Double-crested and Great Cormorant and Northern Fulmar also nest there (DFLR 2017e). A footpath through open meadows atop steep cliffs, leads to "Bird Rock", the nesting site for the majority of Northern Gannet in the Reserve (DFLR 2017e). The offshore waters of the Reserve (54 $km^2$) are an important wintering site for thousands of sea ducks, including Harlequin, Common Eider and Long-tailed ducks and scoters (DFLR 2017e). As one of the world's most southerly expanses of sub-Arctic tundra, the plateaus of the Cape also host mosses, lichens, alpine wildflowers and low-growing shrubs, and feature ponds, bogs, brooks and sheer sea cliffs (DFLR 2017e). A modern Interpretive Centre is located in the Reserve, near the Coast Guard-operated lighthouse which was originally built in 1860, offering environmental and seabird interpretation by provincial naturalists (DFLR 2017e; IBA Canada n.d.). Thousands visit Cape St. Mary's annually to view the birds and other wildlife, including whales, dolphins, porpoises and seals in the summer, and fall and spring migrating shorebirds and raptors (DFLR 2017e; IBA Canada n.d.). Although commercial and recreational fishing is permitted in the waters of the reserve, boaters are expected to exhibit caution to avoid disturbing the birds (DFLR 2017e). Pets, other than service animals, and hunting are not permitted within the Reserve. Motorized boats must remain >100 m from cliffs during the breeding season (1 April–30 October), and non-motorized boats must remain >20 m from the cliffs during this same time (DFLR 2017e).

Jack's Pond Provincial Park is located on Route 1, 8 km from Arnold's Cove (TCII 2017a). Jack's Pond is a Provincial Park Reserve, an area with significant natural features and landscapes and a component of a provincial initiative to protect representative portions of all of the province's different ecoregions (TCII 2017a). Provincial Park Reserves do not have day use facilities and are not open to camping (TCII 2017a). Jack's Pond Provincial Park preserves some of Newfoundland and Labrador's rare plant species and contains high habitat diversity, such as barren vegetation, wetlands and a forested stream valley (TCII 2017a). Migration routes for the Canada lynx, black bear and coyote are located within the Park (SNC Lavalin 2007).

Gooseberry Cove Provincial Park, located south of Placentia, is a day use sandy beach area with a grassy back shore (TCII 2017b). Gooseberry Cove Provincial Park is considered a Natural and Scenic Attraction, defined as an area protecting and providing access to sites with significant natural features and/or special high quality scenic attributes (TCII 2017b). Natural and Scenic Attractions are located near or adjacent to highways and/or scenic routes, providing rest stops for the travelling public. Camping is not permitted and high wave action restricts swimming at the Park (TCII 2017b).

#### 4.2.6.2 Placentia Bay Extension Ecologically and Biologically Significant Area (EBSA)

Large Ocean Management Areas (LOMAs) are marine regions established for planning purposes, forming the basis for the implementation of integrated management plans intended to address the socio-economic needs of humans while preserving the health of the marine ecosystem (C-NLOPB 2010). The Study Area occurs within the Placentia Bay/Grand Banks (PB/GB) LOMA (see Figure 4.12), one of five priority LOMAs in Canada. It has an area >500,000 $km^2$, and includes nearshore and offshore components of the Grand Banks portion of the Newfoundland and Labrador continental shelf (C-NLOPB 2010; DFO 2012a). The vision statement for the PB/GB LOMA is "safe and sustainable use of healthy oceans through collaborative and effective governance", involving federal and provincial government departments and agencies, indigenous groups, industry organizations, environmental and community groups, and academia (C-NLOPB 2010; DFO 2012a). There are two Coastal Management Areas (CMAs) within the coastal portion of the PG/GB LOMA, Placentia Bay and Coast of Bays (C-NLOPB 2010). The PBIMPC is a multi-stakeholder group formed in 2005 to assist in addressing issues/concerns resulting from multiple ocean users within the Placentia Bay CMA. The PBIMPC uses a collaborative approach to consider all ocean users and maintain the health of the marine environment (C-NLOPB 2010). It develops and implements integrated management plans, and monitors and evaluates functions during plan implementation phases (DFO 2007, 2012a; ICOM NL n.d.).

Canada has agreed to the Convention on Biological Diversity (CBD) Aichi Target 11, which includes the conservation of 10% of its coastal and marine waters by 2020 (DFO 2016e). The 'Newfoundland and Labrador Shelves' has been identified as one of five biogeographic units for MPA Network development in Canada (DFO 2016e). EBSAs are a primary feature in consideration for MPA network development (DFO 2016e). Twenty-five EBSAs have been identified in the Newfoundland and Labrador Shelves Bioregion since 2007, eleven of which are associated with the PB/GB LOMA. The EBSAs are based primarily on uniqueness (i.e., rarity), aggregation (density/concentration) and fitness consequences (importance to reproduction/survival), and secondarily on resilience (sensitivity to disturbance) and naturalness (undisturbed state of habitat) (Templeman 2007; DFO 2016e). Delineation of the Study Area is equivalent to that of the Placentia Bay Extension EBSA. The features that led to the designation of this EBSA are summarized in Table 4.15.

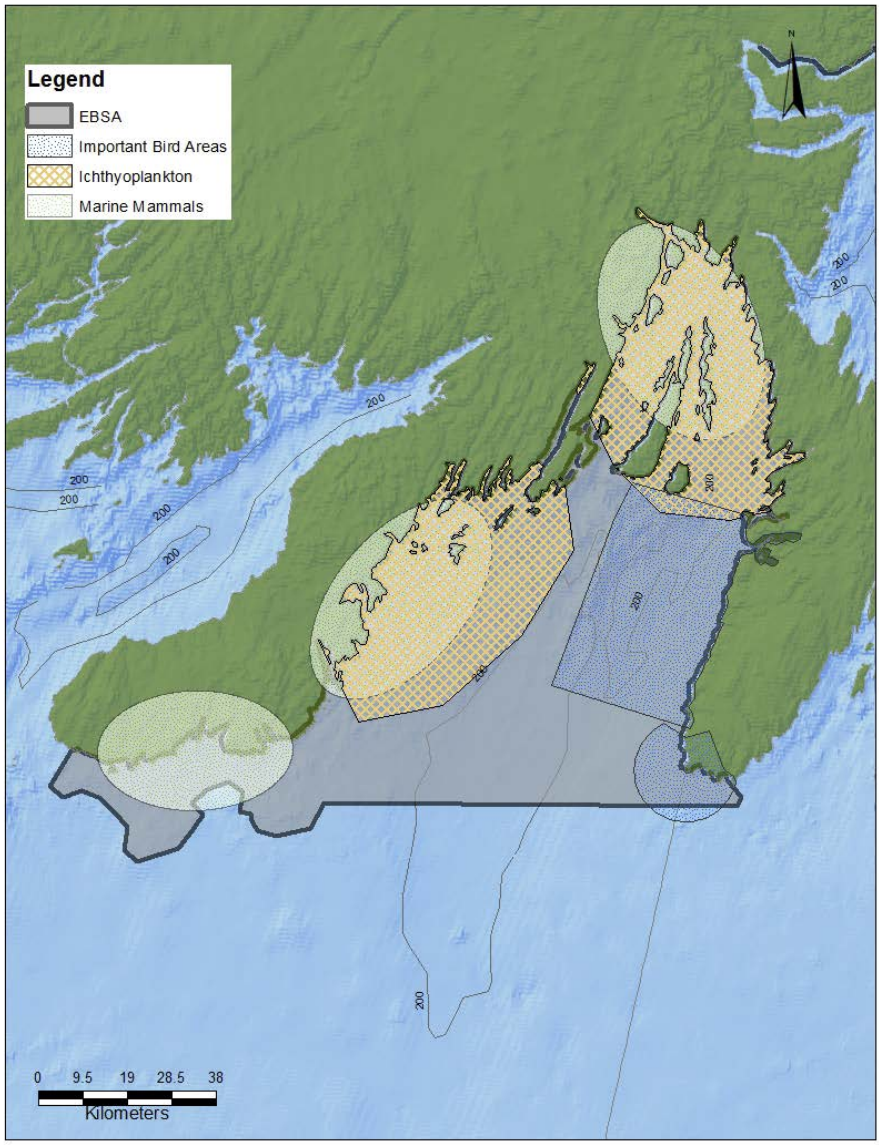
**Table 4.15. Principal features of the Placentia Bay Extension EBSA.**

| Feature | Rating | | | | |
|---|---|---|---|---|---|
| | **Uniqueness** | **Aggregation** | **Fitness Consequences** | **Resilience** | **Naturalness** |
| Ichthyoplankton | | **High:** High ichthyoplankton concentrations (e.g., Atlantic cod, cunner, American plaice, capelin) | **High:** Important for survival & dispersal of high concentrations of ichthyoplankton | | |
| Marine Mammals and Sea Turtles | **High:** Numerous cetaceans & leatherback sea turtles aggregate during spring & summer; harbour seals & otters utilize the area year-round; high biomass of terrestrial mammals in river & estuarine habitats | **High:** Important area for feeding, reproduction & migration of marine mammals & sea turtles | **High:** Important feeding area (especially harbour porpoises & humpback whales); important nursing/rearing area (e.g., three important pupping areas for harbour seals; otter reproduction; female cetaceans with young during critical feeding periods) **Moderate:** Important feeding area for migrating leatherbacks | | |
| Fish | **High:** High pelagic & demersal species diversity; contains NW Atlantic Ocean's largest Atlantic cod spawning stock | **High:** contains NW Atlantic Ocean's largest Atlantic cod spawning stock | **High:** contains NW Atlantic Ocean's largest Atlantic cod spawning stock | | |
| Birds | **High:** Supports high biomass of birds associated with river and estuarine habitats; contains four Important Bird Areas for nesting, feeding & overwintering | **High:** Supports high biomass of birds associated with river and estuarine habitats; contains four Important Bird Areas for nesting, feeding & overwintering | **High:** Supports high biomass of birds associated with river and estuarine habitats; contains four Important Bird Areas for nesting, feeding & overwintering | | |
| Other Features | **High:** counter-clockwise gyre (offshoot of Labrador Current, enters in east & exits in west); localized upwelling (where currents meet at Burin Peninsula south & Cape St. Mary's headlands); stable temperature & salinity compared to other embayments | **High:** high primary & secondary production (at headlands & within the Bay) | | **High:** important spawning/nursing & coastal bird breeding areas highly sensitive to disturbance | **Moderate:** some contamination or disturbance (due to high levels of commercial & industrial activity within/near Placentia Bay over time) |

Source: Templeman (2007).

### *Ichthyoplankton*

Western and northern Placentia Bay have the highest concentrations of early-stage eggs of Atlantic cod, American plaice and cunner in the Study Area (Figure 4.13; DFO 2016e). Based on several ichthyoplankton surveys in Placentia Bay during the spring and summer in 1997 and 1998, Bradbury et al. (2003) found that while the pelagic eggs and early larvae were distributed in accordance with passive drifting, the distributions of older larvae were congruent with the areas of high biological production denoted in Figure 4.13. Bradbury et al. (2003) concluded that the spatial distribution of pelagic larvae is increasingly determined by their behaviour and ability to swim as they develop.




Source: DFO (2016e).

**Figure 4.13. Important area for ichthyoplankton, marine mammals and seabirds within the Placentia Bay Extension EBSA.**

### *Marine Mammals and Sea Turtles*

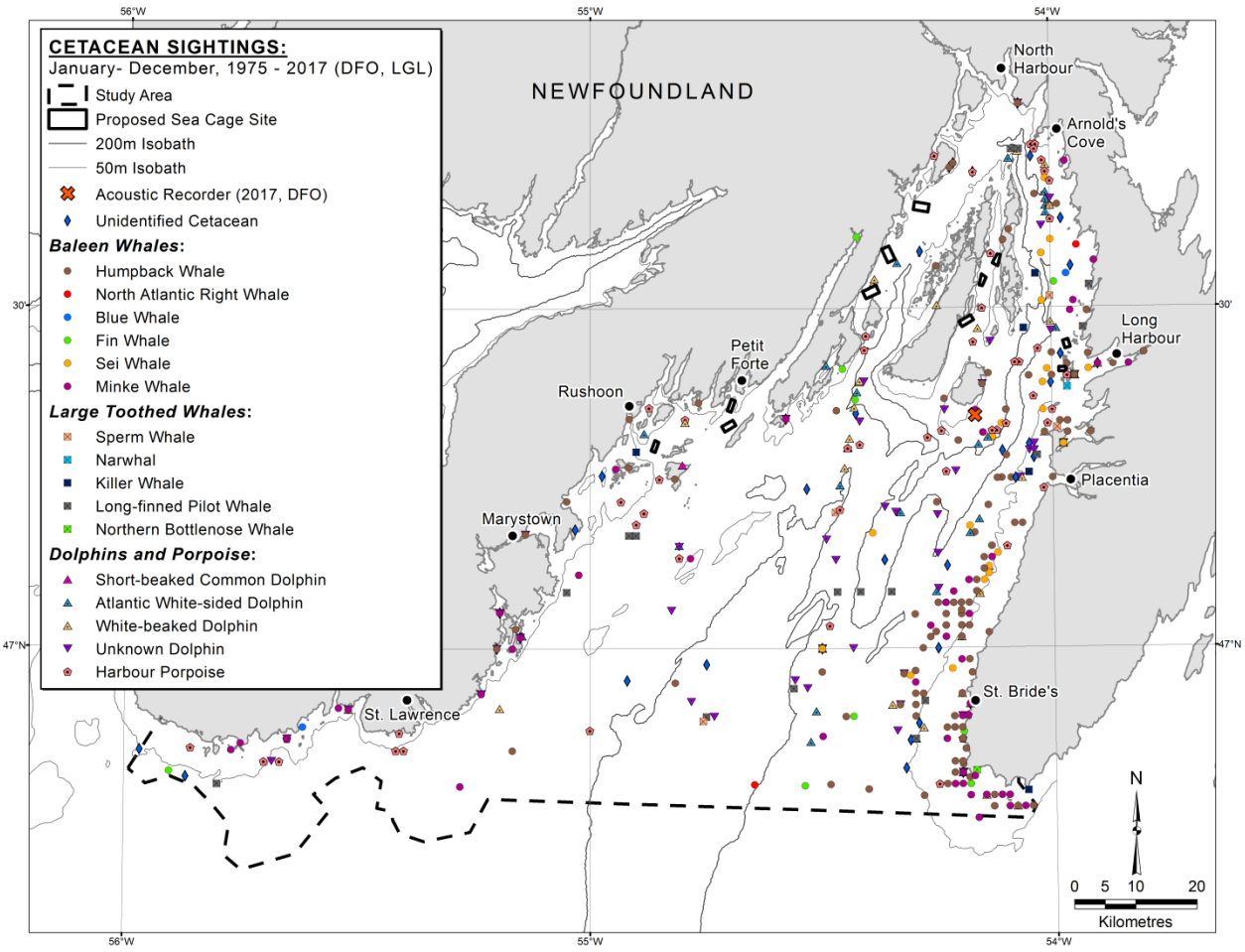
Numerous cetaceans and seal species are known to occur in the Study Area including three species of baleen whales (blue, North Atlantic right, and fin whales) which are listed on Schedule 1 of *SARA* (see Section 4.2.5.2). While numerous cetaceans and leatherback sea turtles aggregate in Placentia Bay during summer through early fall to feed, harbour seals, river otters (*Lontra canadensis*) and some cetaceans feed in the area year-round (Templeman 2007). The inner reaches of Placentia Bay, particularly around Merasheen Island and Long Island, support one of the highest densities of river otter in the province (Goudie and Jones 2007; Coté et al. 2008). There, some river otters have adopted a primarily marine lifestyle inhabiting coastal waters. Point May and its surrounding area, located near the southwestern-most portion of the Study Area, is considered an historic harbour seal haulout and pupping site (Templeman 2007). Placentia Bay is also considered important foraging habitat for leatherback sea turtles as described in Section 4.2.5.2. The southern portion of Placentia Bay is proposed as one of three critical habitat areas for leatherbacks (see Section 4.2.6 and Figure 4.12). Sjare et al. (2003 *in* DFO 2016e) utilized Local Ecological Knowledge (LEK) to identify areas of high pelagic fish and marine mammal productivity and occurrence. Three notable areas of high biodiversity of marine mammals (and pelagic fish) were identified in Placentia Bay: (1) St. Lawrence; (2) Marystown; and (3) Swift Current (see Figure 4.12). Baleen whales commonly found in Placentia Bay in summer include humpback whales (*Megaptera novaeangliae*) and minke whales (*B. acutorostrata*), and to a lesser extent fin whales (Figure 4.14; Abgrall and Moulton 2007). Blue whales, North Atlantic right whales, and sei whales (*B. borealis*) are considered rare. Other marine mammals found in Placentia Bay include grey seals (*Halichoerus grypus*), harp seals, white-beaked dolphins (*Lagenorhynchus albirostris*), Atlantic white-sided dolphins (*L. acutus*), short-beaked common dolphins (*Delphinus delphis*), long-finned pilot whales (*Globicephala melas*), killer whales (*Orcinus orca*), and harbour porpoises (*Phocoena phocoena*). There have also been reported sightings of a northern bottlenose whale, sperm whale, and narwhal (*Monodon monoceros*; Figure 4.14). The narwhal sighting is considered extralimital.

### *Fish*

At least 14 species of groundfish and nine pelagic fish species inhabit Placentia Bay (CPAWS-NL 2009). In addition to Atlantic cod, species include lumpfish, flounders, Greenland halibut, skates, sculpins, Atlantic haddock, pollock, sand lance, wolffishes, American plaice, sturgeon, mackerel, sharks, capelin, herring, sunfish, eels, Atlantic salmon and brook trout (CPAWS-NL 2009). Shellfish species within the Bay include snow and rock crab, mussels, clams, American lobster, sea, Icelandic and giant scallops, whelk and squid (CPAWS-NL 2009).

### *Birds – Important Bird Areas*

The four Important Bird Areas (IBAs) within the Placentia Bay Extension EBSA are: (1) Cape St. Mary's (NF001); (2) Placentia Bay (NF028); (3) Corbin Island (NF030); and (4) Middle Lawn Island (NF031) (see Figure 4.12; Templeman 2007; IBA Canada n.d.). These IBAs are described below.




Source: DFO database; Abgrall and Moulton 2007.

**Figure 4.14. Recorded sightings of cetaceans in the Study Area.**

The Cape St. Mary's IBA is located in the southeastern portion of the Study Area, at the eastern headland of Placentia Bay. The IBA habitats include marine waters, rocky shores and flats, and cliffs which rise to ~130 m above sea level featuring grassy barrens on their tops. An isolated offshore sea stack, 'Bird Rock', is also a component of the Cape St. Mary's IBA. A site where seabird studies and surveys are conducted by researchers from MUN and the CWS, the ~329 km$^2$ IBA extends beyond the Cape St. Mary's Ecological Reserve to encompass Bull Island Point, Bull, Cow and Calf islets, St. Mary's Keys (Cays), and Lance Point. Cape St. Mary's supports over 30,000 breeding pairs of seabirds, with Common Murre and Black-legged Kittiwake among the most abundant species, estimated at ~10,000 pairs each (as of the late-1980s). Approximately 2% and 4–5% of the eastern North America population of Common Murre and the western Atlantic breeding population of Black-legged Kittiwake, respectively, inhabit this IBA. An estimated 2% of the global population and ~12% of the North American population of Northern Gannet are located in the Cape St. Mary's IBA, with 5,485 pairs estimated during the late 1980s. Other nesting species at the Cape include Thick-billed Murre, Razorbill, Black Guillemot, Herring Gull, Great Black-backed Gull, Great Cormorant and Double-crested Cormorant. Cape St. Mary's also supports migrant sea ducks, including Oldsquaw, scoters, eiders, and possibly >1% of the eastern North American population of Harlequin Duck. Other species which have been noted in the IBA include Black-headed Gull, Dovekie, Manx Shearwater and Piping Plover. Disturbance, fisheries and pollution, e.g., oil slicks

or spills, are of concern for the Cape St. Mary's IBA, as it is situated near a major shipping route between the Hibernia oilfields and refinery/oil storage facilities in Placentia Bay. The area also experiences a high volume of shipping traffic, particularly during the winter (IBA Canada n.d.).

The Placentia Bay IBA encompasses a ~1,398 $km^2$ area and occupies the majority of the southeastern portion of the Study Area, ranging from Argentia to Cape St. Mary's and extending out to ~25 km from shore. The IBA habitats include marine waters and inlets/coasts, including low, non-vegetated rocky islets and the Virgin Rocks. Capelin spawn in the shallow waters of Placentia Bay sometime during June and July, attracting large numbers of seabirds close to shore. Greater Shearwater is the most abundant of the shearwater species regularly occurring in the IBA, with a globally-significant concentration of >100,000 individuals recorded. Sooty Shearwater is also common in the IBA, while Manx Shearwater is uncommon. Local breeding seabirds from Cape St. Mary's feed on capelin in the Placentia Bay IBA, including Northern Gannet, Black-legged Kittiwakes and Common Murre. Large numbers of sub-adult Black-legged Kittiwake also feed in the Bay, likely from various breeding colonies in the North Atlantic. Numerous jaegers attempt to steal capelin from the juvenile kittiwakes in the area, particularly Parasitic and Pomarine jaegers. Long-tailed Jaeger is rare in Placentia Bay. Approximately 1,000–2,000 Common Eider congregate to winter around the Virgin Rocks, entering Placentia Bay from various points from Great Barasway to Gooseberry Cove. Other species noted in the IBA include Dovekie and Red Crossbill. Due to year-round oil tanker vessel traffic, there is potential for oil spills in the Placentia Bay IBA. There are also additional freighter vessels and the Argentia-North Sydney ferry transiting in the area during the summer and fall (IBA Canada n.d.).

The Corbin Island IBA is located in the southwestern portion of the Study Area ~1 km from the mainland, with an area of ~5 $km^2$, including the ~0.2 $km^2$ Corbin Island area, with an elevation from 0–70 m above sea level. The IBA habitats include the rocky cliffs/shores and grassy and low-shrub covered surface of Corbin Island, and the surrounding marine waters. The most recent surveys available for the Corbin Island IBA were completed during 1974. These surveys indicated that the IBA likely supports a globally-significant colony of Leach's Storm-petrels (~2% of the Western Atlantic population), with an estimated 100,000 pairs noted at the site during the survey. A large Herring Gull colony was also found in the IBA during the 1974 survey, comprised of ~5,000 pairs, representing ~3.5% of the estimated North American population. Other nesting species in the IBA include Black-legged Kittiwake, Great Black-backed Gull and Black Guillemot. Although little research has been completed at this IBA, as with all seabird colonies, the potential for oil spills in adjacent marine areas is a concern (IBA Canada n.d.).

The Middle Lawn Island IBA includes a ~4 $km^2$ area encompassing Middle Lawn Island and the surrounding marine waters, located in the southwestern portion of the Study Area near Lord's Cove on the Burin Peninsula. The Island habitat is comprised of meadows vegetated with grasses and ferns, coastal cliffs and rocky shores. Ocean ice rarely forms on the southern side of the Island, due to its exposure to the Atlantic Ocean. North America's largest concentration of nesting Manx Shearwater occurs on Middle Lawn Island. During the 1980s, ~100 pairs and 300 non-breeding Manx Shearwater were recorded on the Island, along with >26,000 pairs of Leach's Storm-petrel (13,879 pairs were recorded by Cairns et al. 1989), 20 pairs of Herring Gull, six pairs of Greater Black-backed Gull, and eight pairs of Black Guillemot (IBA Canada n.d.). Seven pairs of Manx Shearwater were recently recorded on Middle Lawn Island (Fraser et al. 2013**)**. Due to the nearby heavily used shipping routes of the Gulf of St. Lawrence, oil pollution is a threat to seabirds and other wildlife inhabiting the Middle Lawn Island IBA. As Middle Lawn Island is not utilized by humans and is considered a natural area, the threat of introduced species, such as rats, could have a significant and negative impact on the nesting seabirds there (IBA Canada n.d.).

The Placentia Bay Extension EBSA is also an important area for nesting, feeding and/or overwintering for Atlantic Puffin and Northern Fulmar (Templeman 2007). Other seabirds that inhabit Placentia Bay include Ring-billed, Glaucous and Iceland gulls, Great and South Polar skuas, and Arctic Tern (CPAWS-NL 2009). Waterfowl include Common Loon, Red-necked Grebe, Canada Goose, Black Duck, Green-winged Teal, Common Goldeneye, Common and Red-breasted mergansers, and Greater Scaup (CPAWS-NL 2009). Additional shorebird species include Greater Yellowlegs, Spotted, Purple, Least and Semipalmated sandpipers, Wilson's, Northern and Red phalaropes, Whimbrel, Semipalmated Plover, Ruddy Turnstone, and Sanderling (CPAWS-NL 2009).

#### 4.2.6.3 Estuaries, Rivers and Habitats of Species at Risk

A recovery strategy was recently proposed for leatherback sea turtle in Atlantic Canada, describing proposed critical habitat for this species within Placentia Bay (DFO 2016f). Critical habitat is necessary for the survival or recovery of a species, which may include habitat for reproduction, nursery, rearing, feeding, migration or any other aspects necessary for aquatic species to complete their life processes, or areas where aquatic species formerly occurred and may be reintroduced (DFO 2016f). Researchers used satellite tagging data to help determine habitat use and seasonal movements of leatherback sea turtles in Atlantic Canada, and inferred that residency behaviour is positively correlated with good foraging habitat (DFO 2016f). Within the Study Area, the recovery strategy identified proposed critical habitat for the Atlantic population of leatherbacks within southern Placentia Bay, and south and east of the Burin Peninsula (DFO 2016f). The proposed critical habitat is south of the proposed sea cage sites, with the northernmost portion of the critical habitat in the vicinity of the proposed sea cage sites within the Rushoon BMA (see Figure 4.12).

Features which led to the proposed designation of critical habitat for leatherback sea turtles within Placentia Bay focus on the quantity/quality of prey items, the acoustic environment, and water quality (DFO 2016f). It was determined that the area's environmental, oceanographic and bathymetric conditions support and aggregate sufficient concentrations and quality of gelatinous prey, e.g., jellyfish, salps and siphonophores, to support the leatherback population's survival, migration and reproduction (DFO 2016f). The region's anthropogenic noise levels are considered sufficiently low to allow for uninterrupted feeding and foraging, and the water within the area is of sufficient quality so as to not result in adverse health effects for the leatherbacks (DFO 2016f).

Mature and large sub-adult leatherback sea turtles of the western Atlantic nesting populations occur within Atlantic Canadian waters during late-spring and fall (James et al. 2005, 2007 *in* DFO 2016f), with peak use of critical habitat areas occurring during summer and fall (DFO 2012b *in* DFO 2016f). Residency within and migration through critical habitat areas is thought to correspond to the distribution and abundance of suitable gelatinous prey species, which is poorly understood (DFO 2016f).

Activities which may damage or destroy Atlantic Canadian leatherback sea turtle critical habitat include: 1) a reduction in their food supply, such as by the direct or indirect harvest of gelatinous prey species; 2) increased acoustic disturbance, including vessel noise, sonar, and large scale industrial development and operations (e.g., pile driving, dredging, construction); and 3) marine pollution, such as from ocean dumping, industrial developments or persistent vessel discharges (DFO 2016f).

### 4.2.6.4 Other Sensitive Areas

***Marine Protected Areas***

An MPA is a "part of the ocean that is legally protected and managed to achieve the long-term conservation of nature" (DFO 2017m). There are no MPAs or other 'effective area-based conservations measures' designated by DFO within or proximate to the Study Area (DFO 2017n).

***Deep-sea Corals and Sponges***

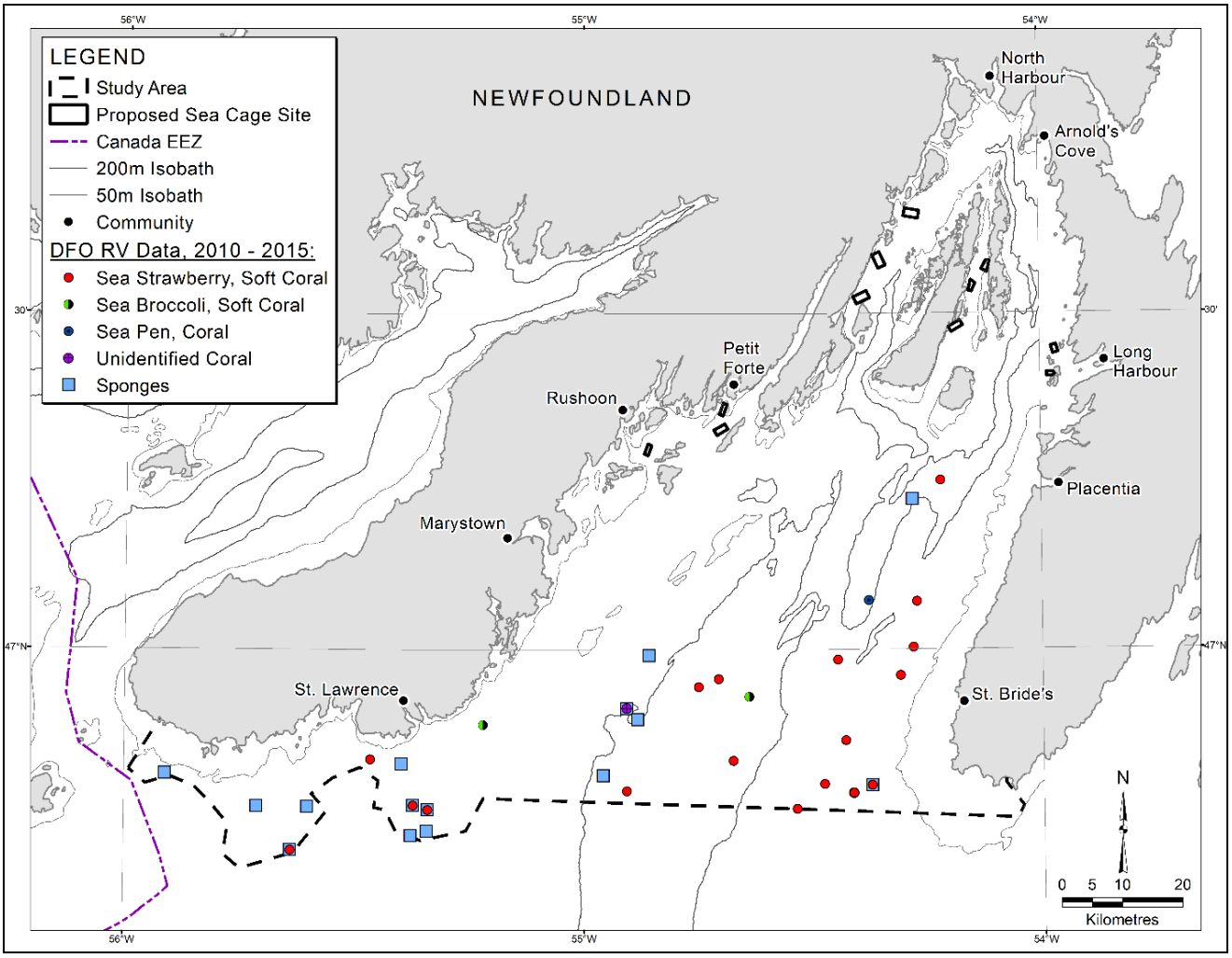
Deep-sea corals and sponges provide structural habitat for marine organisms (e.g., for resting, feeding, spawning and predator avoidance), including marine species of commercial importance to Canadians (DFO 2012b, 2015b). Coral and sponge communities also contribute to species richness and biodiversity (DFO 2015b). They are sessile, typically long-lived and slow-growing, making them particularly vulnerable to direct human activities (e.g., bottom contact fishing gear) and indirect activities, such as smothering by sedimentation, climate change and ocean acidification (DFO 2012b, 2015b). Given these factors, deep-sea corals and sponges have been identified as a primary conservation priority in the PB/GB LOMA (DFO 2012b). DFO has developed a Coral and Sponge Conservation Strategy for Eastern Canada to "facilitate the conservation and protection of cold water coral and sponge species, communities, and their habitats in the Atlantic and Arctic Oceans of Eastern Canada" (DFO 2015b).

During recent years, deep-sea coral and sponge research in Newfoundland and Labrador waters, conducted collaboratively between DFO Science, MUN, and industry, has increased (DFO 2012b). Edinger et al. (2009, *in* Gilkinson and Edinger 2009) found a significant correlation between coral biomass and fish biodiversity, perhaps indicating that soft corals, sea pens and small gorgonian corals are important to groundfish and invertebrate species in the region. Data collected during DFO (RV) multi-species surveys within the Newfoundland and Labrador Shelves Bioregion during 2000–2007, and data collected by Fisheries Observers aboard commercial fishing vessels during 2004–2007 included several catch locations of soft corals in Placentia Bay (Gilkinson and Edinger 2009). Sea strawberry corals (*Gersemia rubiformis*) were caught in the southwestern, south-central and northeastern portions of the Study Area, and *Nephtheid* spp. corals in the south-central and southeastern portions of the Study Area (Gilkinson and Edinger 2009). The following coral and sponge catches were reported during DFO RV multi-species surveys within the Study Area during 2010–2015 (Figure 4.15):

- an unidentified coral was caught in the southern portion of the Study Area at ~200 m water depth;
- sea pens (soft coral) were found in the southeastern portion of the Study Area in water depths ~200 m;
- sea strawberry corals (soft coral) were caught throughout the southern portion of the Study Area in water depths between 50 and 200 m;
- sea broccoli corals (*Capnella florida*; soft coral) were found in the southwestern and south-central portions of the Study Area in water depths of 100 m and 200 m; and
- sponges were found in the southwestern and northeastern portions of the Study Area in water depths of 50–200 m.

Closure areas are a management tool used for the purpose of protecting sensitive benthic areas, including coral and sponge communities (DFO 2015b). Within the marine waters of Eastern Canada, closure areas include NAFO Coral, Sponge and Seamount Closures, DFO Coral/Sponge Conservation Areas and

MPAs, National Marine Conservation Areas (NMCAs), and voluntary closures driven by the fishing industry (DFO 2015b). No such closure areas are identified within the Study Area.




Source: DFO RV Survey Database (2010–2015).

**Figure 4.15. Distribution of DFO RV multi-species survey catch locations of corals and sponges in the Study Area, 2010–2015.**

### *Natural Areas*

The Stewardship Association of Municipalities (SAM) works in partnership with the Eastern Habitat Joint Venture (EHJV) in Newfoundland and Labrador to "secure, enhance, and restore important wildlife habitat, namely wetlands, uplands, coastal areas and species at risk habitat generally found within municipal planning boundaries" (DFLR 2017f). The SAM utilizes Management Units and Stewardship Zones to promote the protection of natural resources. Within a Management Unit, all development is reviewed by the Wildlife Division of the Department of Fisheries and Land Resources, and only low-impact developments, such as trails and benches, are permitted in terrestrial components (L. King, SAM, Conservation Biologist, pers. comm., 26 February 2018). Management Units are formalized provincially as a Crown land interest, and legalized municipally by being zoned for conservation or

environmental protection (L. King, SAM, Conservation Biologist, pers. comm., 26 February 2018). A Stewardship Zone is a broader concept, whereby participant communities commit to the "wise use" of resources, and developments are not necessary referred to the Wildlife Division for approval (L. King, SAM, Conservation Biologist, pers. comm., 26 February 2018). A Stewardship Zone encompasses important bird habitat, especially waterfowl, and encompasses a larger area than a Management Unit (L. King, SAM, Conservation Biologist, pers. comm., 26 February 2018). As a Stewardship Zone is intended to describe the area that a town manages through its planning process rather than sensitive habitat, only Management Units are shown on Figure 4.13 (J. Sharpe, Department of Fisheries and Land Resources, Wildlife Division, pers. comm., 26 February 2018).

The Wetland Stewardship Area in the northern Placentia Bay community of Come by Chance was introduced in 1995, followed by the development of a Habitat Management Plan to protect the region's wetland habitat, and bird and fish species (SNC Lavalin 2007). The Come by Chance Wetland Stewardship Zone encompasses >40 $km^2$, including a ~2 $km^2$ Estuary Management Unit located west of the town (SNC Lavalin 2007; SAM 2017a). Wetlands in the region are important staging habitats for various waterfowl species, including American Black Duck, Green-winged Teal and Canada Goose (SAM 2017a). At least 65 other species of birds and waterfowl have been observed in the area of Come by Chance, including Red Knot (CLO 2018a). Out of concern for all-terrain vehicle-induced damage to the Stewardship Area's wetlands, barriers were installed at trailheads to reduce traffic (EHJV 2003 *in* SNC Lavalin 2007).

The St. Lawrence Wetland Stewardship Management Unit was established in October 2013 (SAM 2017b). The ~6 $km^2$ Management Unit encompasses the coastline from the outflow of Three Stick Pond to Cape Chapeau Rouge, and extends ~400 m inland (SAM 2017b). Habitat in the St. Lawrence region includes balsam fir tuckamore, extensive open barrens and bogs (SAM 2017b). At least 51 species of shorebirds, waterfowl and seabirds inhabit the St. Lawrence Management Unit, including birds from the nearby nesting colonies at the Lawn Islands Ecological Reserve (SAM 2017b; CLO 2018b).

Arnold's Cove developed the Big Pond Bird Sanctuary within its town limits to provide protection for numerous species of birds and an easy means of viewing them (SNC Lavalin 2007; NL Tourism 2018a). The Sanctuary, located 50 m from shore, is an important migratory stop for birds year-round (TAC 2010b). Species using the Sanctuary include Canada Goose, Pie Duck, Mallard Duck, Ruddy Turnstone, Spoked Sandpiper, Greater Yellowlegs, mergansers, plomers, gulls, and eastern Canada's highest concentration of American Black Duck (TAC 2010b). Other species that have been observed in the Sanctuary include ptarmigans, cormorants, osprey, Bald Eagle and occasionally some endangered bird species (TAC 2010b). Hunting, trapping or snaring of birds is strictly prohibited within the Bird Sanctuary's limits (SNL Lavalin 2007).

### 4.2.6.5 Habitat Enhancement Projects

***Coastal Restoration Project – Eelgrass in Placentia Bay***

Among the world's most productive environments for primary productivity, eelgrass beds "form extensive underwater networks providing a crucial habitat that reduces local currents, provides protection from predation, stabilize the sediment, filter water, and increase habitat complexity" in sheltered photic environments (DFO 2012b). In addition to various non-obligate algal species that are associated with eelgrass, there are at least 20 obligate algal species that are dependent on eelgrass for the completion of their life cycles (DFO 2012b). Eelgrass has been shown to support increased fish species diversity and density compared to unvegetated seabed areas, serving as important nursery grounds for some benthic species in Newfoundland, including Atlantic cod (DFO 2012b). Within eelgrass beds, predation rates for

some fish species are reduced, and growth rates for some fish species, including Atlantic cod, have been shown to be higher than those in unvegetated seabed areas (DFO 2012b). Fluctuations in eelgrass structure occur in association with climactic events (e.g., temperature change and sea-ice cover). The relatively recent arrival of the invasive species green crab (*Carcinus maenas*) appears to be impacting eelgrass habitats through its burrowing behaviour among the eelgrass root system (DFO 2012b). The Coastal Restoration Project, managed by the MI in collaboration with FFAW, plans to restore eelgrass sites within Placentia Bay through the utilization of globally-established eelgrass transplantation methodology, and is described in Section 4.2.3.1, above.

## 4.3 Terrestrial Environment

The terrestrial components of the Project include the RAS Hatchery, which is located in the Marystown Marine Industrial Park. No roads will be constructed to access sea cage sites.

The Marystown Industrial Park was subject to the provincial environmental assessment process. The Town of Marystown registered the Marystown Marine Industrial Park Development (Registration No. 1387) with the NL Department of Municipal Affairs and Environment on 27 June 2008. A registration document was submitted, which overviewed the existing biophysical environment of the proposed development including terrestrial fauna, flora, species at risk, and ecological land classification[14]. The Marystown Marine Industrial Park Development was released from the provincial environmental assessment process on 14 August 2008. The Town of Marystown was required to adhere to relevant permits, approvals, and legislation during development of the Marine Industrial Park as stipulated in the EA release.

As described in Sections 2.4.2.1 and 2.4.3.1, site clearing for the RAS Hatchery was completed on behalf of Grieg NL during late summer and fall 2016 and grubbing of the site was undertaken during summer 2017.[15] Appropriate mitigation measures were in place for managing erosion and sedimentation and for site clearance for breeding birds (see Section 2.5.1.1). Some grubbing and leveling of the site is still required and will commence upon Project approval. Existing conditions at the RAS Hatchery site are not considered suitable habitat for terrestrial fauna given that vegetation has been cleared. Interactions between Project activities and terrestrial wildlife are not expected. However, it is possible that some terrestrial fauna, namely birds, may occur there periodically. Species at risk (birds) that may occur at the RAS Hatchery site are listed in Section 4.2.5 and where relevant are considered in the environmental assessment.

## 4.4 Land and Resource Use

### 4.4.1 Fisheries

Fisheries in Placentia Bay were previously described in Volume 4 of the Newfoundland and Labrador Refining Corporation Refinery Project EIS (NLRC 2007), and Volume 3 of the Vale Inco Long Harbour Nickel Processing Plant EIS (Vale 2008). An overview of fisheries within the Study Area, based on information in NLRC (2007), Vale (2008) and new information, is provided below. This subsection describes the commercial fishery in the Study Area during 2010–2015 using the DFO Database and 2010–2016 using the NAFO STATLANT21A database, historical commercial fisheries, aquaculture activity, recreational and indigenous fisheries, industry and scientific surveys, and seabird hunting.

[14] Available at: http://www.mae.gov.nl.ca/env_assessment/projects/Y2008/1387/index.html
[15] Site clearing activities occurred after the Project was initially released from the EA process.

## 4.4.2 Commercial, Recreational, and Indigenous Fisheries

### 4.4.2.1 Information Sources

The primary fisheries data analyses use all DFO Atlantic Region's georeferenced landings data for 2010, as well as gridded cell landings for 2011–2015 (Table 4.16). These DFO datasets record domestic harvest landed in Canada. The 2010 data are georeferenced in two ways: (1) by latitude and longitude (degrees and minutes) of the gear set location; and (2) by NAFO Unit Area (UA) in which the catch was harvested. Georeferencing by latitude and longitude allows the mapping of specific harvesting locations. Areas farther from shore, generally fished by larger vessels, tend to have a greater proportion of their catches georeferenced than those closer to shore. Certain inshore species (e.g., lobster) are not georeferenced. While approximately 60% of the 2010 data have associated latitude and longitude information, virtually all of the data have a UA designation. The UA designation allows all the harvesting data to be tabulated according to these fisheries management areas. The data for 2011 and later are provided by DFO as annual ranges of catch weight and catch value quartiles within 6'x6' cells (latitude x longitude) (LGL 2015).

**Table 4.16. Summary of information sources for commercial fisheries data.**

| Data Source | Domestic/Foreign Fisheries | Temporal Period | Geographic Area | Spatial Resolution |
|---|---|---|---|---|
| DFO | Domestic | 2010–2015 | Study Area | Geo-referenced/3PSc (2010)<br>Gridded 6'x6' cells (2011+) |
| NAFO | Domestic/Foreign | 2010–2016<br>(1986–2016 for historical overview) | NAFO Div. 3Ps | NAFO Divisions |

NAFO catch weight data are used to describe domestic and foreign commercial fisheries within NAFO Division (Div.) 3Ps, within which the Study Area is located (Figure 4.16). The NAFO data were obtained from the STATLANT21A dataset for 2010–2016 (see Table 4.16). The STATLANT reporting system of questionnaires data is a long-standing standardized statistical inquiry for submission of national catch data to international fisheries agencies by national reporting offices. Rather than being georeferenced, these STATLANT data are geographically resolved at the NAFO Division level only (LGL 2015).

The maps in this subsection show harvesting locations as points within the Study Area for 2010, based on the latitude and longitude DFO data. Since the data coordinates provided are those recorded in the vessel's fishing log and are reported in the DFO dataset by degree and minute of latitude/longitude, the position should be accurate to within approximately 925 m (0.5 nm) of the reported coordinates. The points are not "weighted" by quantity of harvest, but show where fishing effort was recorded. Such location data have proven to be particularly useful in understanding the likely location of gear concentrations and timing of fisheries in order to minimize potential conflict between the fishers and other marine users. DFO catch data for 2011 onwards, based on 6'x6' cells, are displayed as uniformly-coloured grid cells representing cells within which any level of harvesting was reported (LGL 2015).

The data primarily used to characterize the fisheries within this subsection are harvest catch weights (or catch weight quartile range codes for DFO data for 2011+). Catch value is used to demonstrate that some species have lower ranked catch weights but are highly ranked in terms of value.

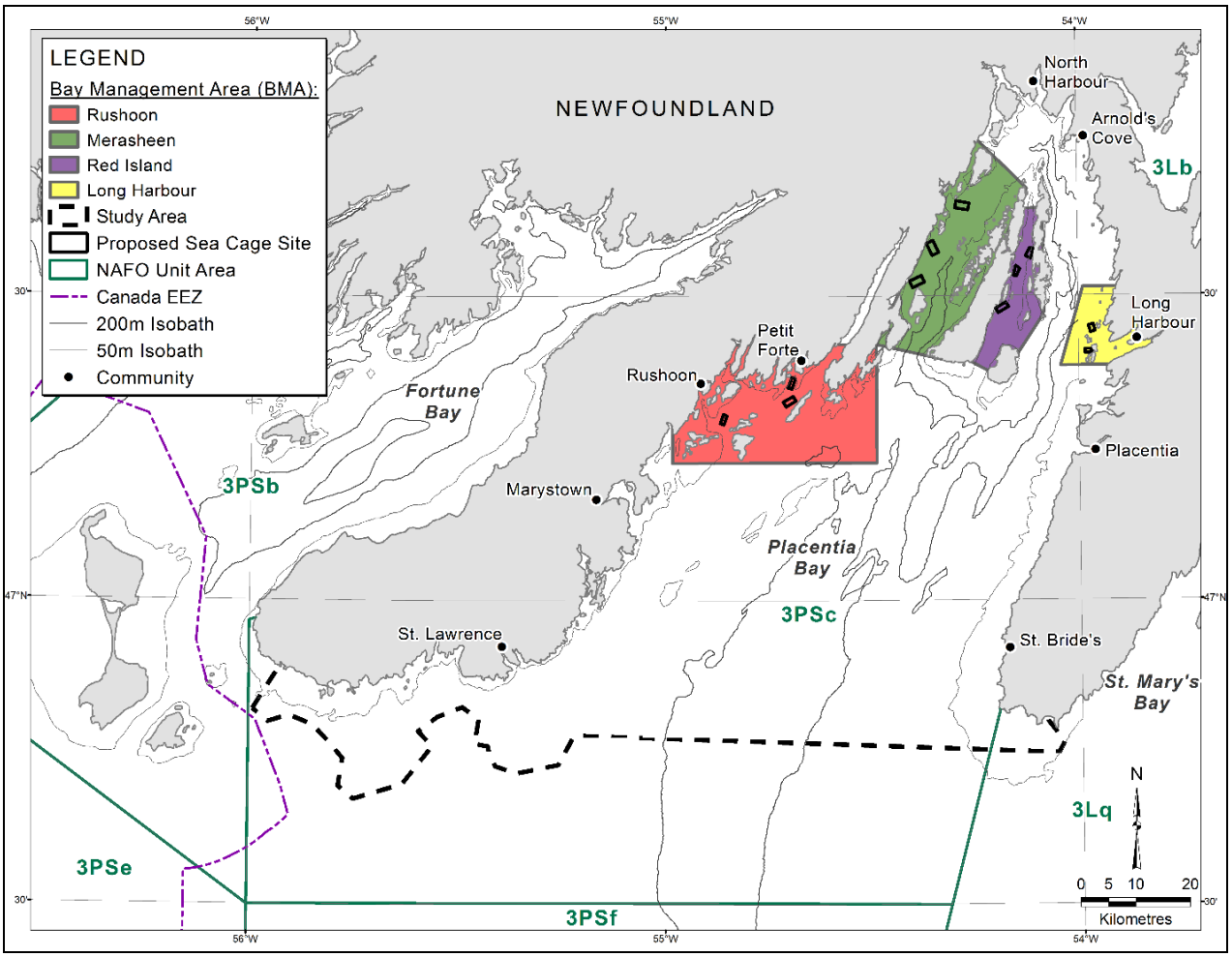



**Figure 4.16. Study Area in relation to regional fisheries management areas (NAFO Divisions and Unit Areas).**

Various stakeholder groups/individuals were involved in Project consultations related to fisheries. One purpose of the consultations was to gather both spatial and temporal information about fisheries and to determine any issues or concerns to be considered for the Project (Appendix A). Other sources used for this subsection include DFO species management plans and decisions, DFO stock status reports and other internal DFO documents, a previous EIS report for Placentia Bay (Vale 2008), and grey literature (e.g., FFAW|UNIFOR reports).

### 4.4.2.2 NAFO Fisheries in Division 3Ps, 2010–2016

During the 2010–2016 period, commercial harvest catch weight within NAFO Div. 3Ps was dominated by Atlantic cod (*Gadus morhua*; 26% of total catch weight), snow crab (*Chionoecetes opilio*; 21%) and whelks (Buccinidae; 15%), followed by Atlantic herring (*Clupea harengus*; 7%), unidentified marine invertebrates (5%), American lobster (*Homarus americanus*) and sea scallop (*Placeopecten magellanicus*; 4% each), and Atlantic redfishes (*Sebastes fasciatus*; 3%). Canadian vessels accounted for 92% of the commercial catch weight reported for Div. 3Ps during 2010–2016, including harvesters from

Newfoundland (87%), Nova Scotia/Bay of Fundy (3%) and the Maritimes (2%). Foreign vessels from St. Pierre et Miquelon accounted for the remaining 8% of the harvest.

### 4.4.2.3 Domestic Fisheries in the Study Area

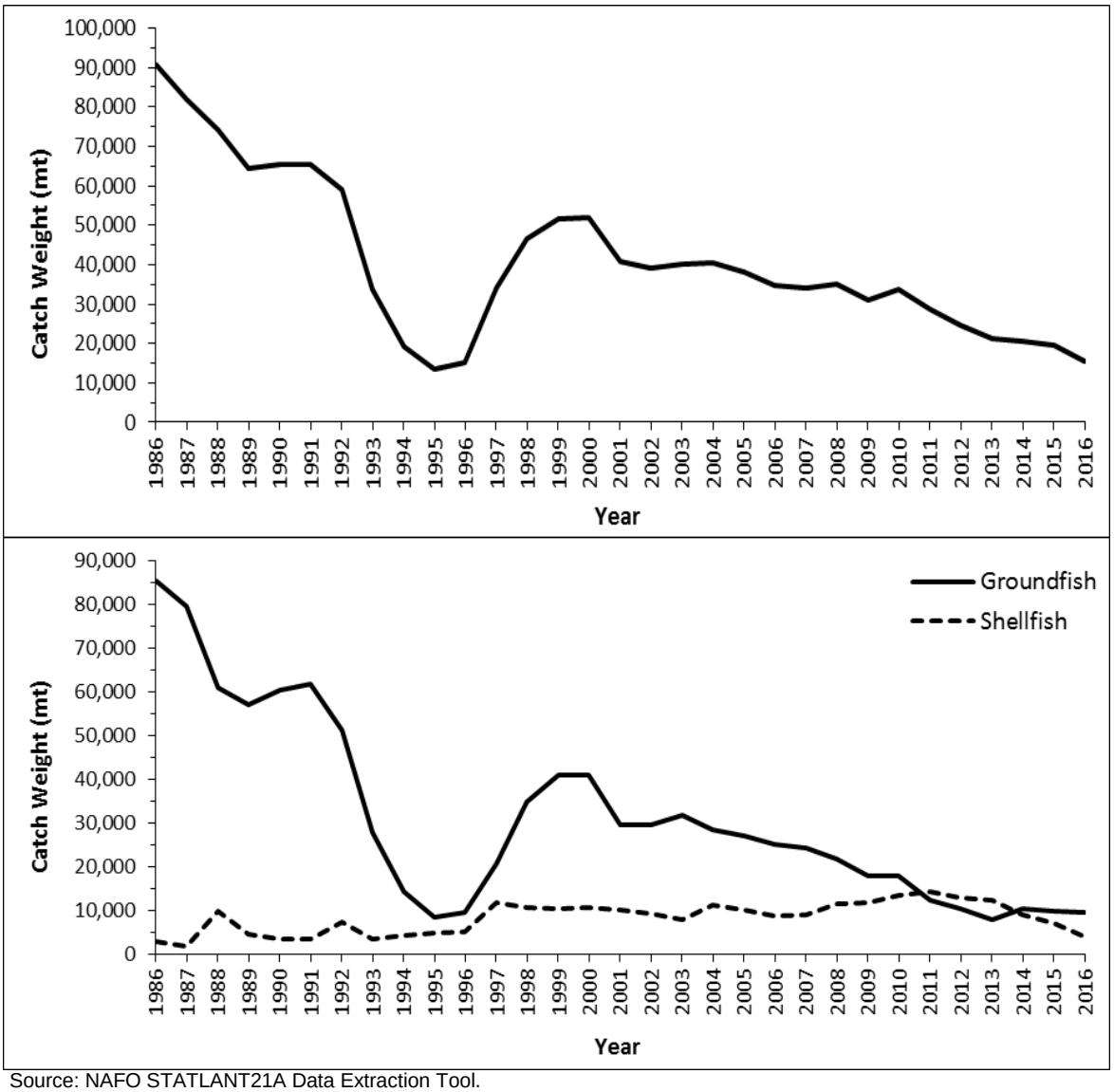
The following subsection describes the commercial fisheries in the Study Area. Historical fishing activity in the Study Area during 1986–2016, including abundance data for historically principal species, are presented. Statistical summaries of the commercial catch data specific to the Study Area, including species' harvest, harvest locations, fishing gear types and harvest seasonality, based on the georeferenced latitude/longitude data for 2010 and annual gridded cell (6'x6') data for 2011–2015 are also provided. Harvest information within this subsection includes wild (i.e., non-aquaculture) captures within the Placentia Bay area only. Information relating to aquaculture fisheries is presented in a separate subsection below.

***Historical Fisheries, 1986–2016***

Commercial fisheries in many parts of Newfoundland and Labrador fisheries have undergone considerable changes over the last three decades, shifting in many locations from a groundfish-based to a shellfish-based industry (LGL 2015). Currently there is a shift back to a groundfish-based fishery (Figure 4.17). In the early 1990s, a harvesting moratorium was declared due to the collapse of several groundfish (i.e., demersal) stocks, resulting in the prohibition of directed fisheries for Atlantic cod and other groundfish species in most areas (Vale 2008; LGL 2015). The cod stock in NAFO Div. 3Ps was subject to a moratorium on all fishing from August 1993 to the end of 1996 (Rideout et al. 2017). Atlantic cod comprised ~50–70% of the annual catch weight within Div. 3Ps during 1986–1993, with other groundfish species such as Atlantic redfishes, American plaice (*Hippoglossoides platessoides*), pollock (*Pollachius virens*) and haddock (*Melanogrammus aeglefinus*) accounting for ~20% of the remaining total annual catch weight and snow crab for ≤1%. Immediately after the moratorium was declared, Atlantic cod harvests comprised only 5% of the annual catch weight, while the proportion of snow crab harvests increased to ~10–23%. During this time, catch weights of Atlantic redfishes increased by ~30%. In 1997, a limited cod fishery was reinstated in NAFO UA 3PSc (i.e., Placentia Bay) under a strict management regime (Vale 2008). Since then, Atlantic cod and snow crab have been the principal species harvested in Div. 3Ps, accounting for approximately 50–75% of the total annual catch weight per year. Atlantic redfish catches have decreased since 1997 (Figure 4.18). During 2011–2013, shellfish (primarily snow crab and whelks) accounted for a greater proportion of the total harvest in Div. 3Ps than did groundfish. However, since 2014, this trend has reversed (primarily Atlantic cod) (Figures 4.17–4.18). During 2016, the commercial fishery harvest in Div. 3Ps was dominated by Atlantic cod (34% of total catch weight), followed by unidentified marine invertebrates (11%), snow crab (8%), Atlantic herring (7%) and American lobster (7%).

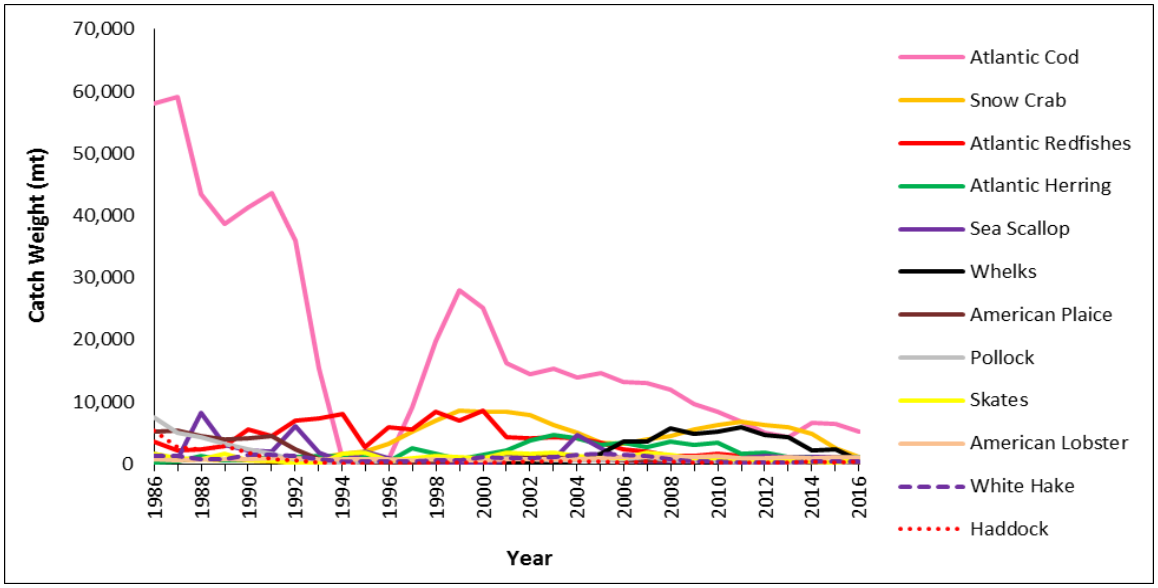
During 1986–1995, harvest catch weight in Placentia Bay (NAFO UA 3PSc) declined by ~90%, from over 17,000 mt to ~2,000 mt. However, the landed value of the Placentia Bay commercial harvesting did not undergo a similar decline during this period due to the altered catch composition (predominantly high value species such as lobster, snow crab and lumpfish roe [*Cyclopterus lumpus*]) (Vale 2008). Despite a considerable decrease in total catch weight, the value of the fishery in Placentia Bay was only 8% less in 1995 (~$9,740,000) than in 1986 (~$10,634,000) (Vale 2008). Harvest value continued to increase in Placentia Bay, rising to over $18 million by 2002 (Vale 2008). The impact of the decline in the cod fishery was partially mitigated by a strong crab fishery and high crab prices prior to 2014, whereby "an active enterprise in Placentia Bay earned ~$53,000 from the crab fishery compared with just ~$10,000 from the cod" (between 2011 and 2014; FFAW 2016). Since 2014, the crab fishery has declined (see

Figure 4.18), with the average inshore under 40' enterprise crab revenue of ~$35,000 during 2015 anticipated to decline to ~$10,000 (FFAW 2016).




Source: NAFO STATLANT21A Data Extraction Tool.

**Figure 4.17. Historical catch weights for all species (top), and all groundfish and shellfish (bottom) in the commercial fisheries in NAFO Division 3Ps, all countries, 1986–2016.**

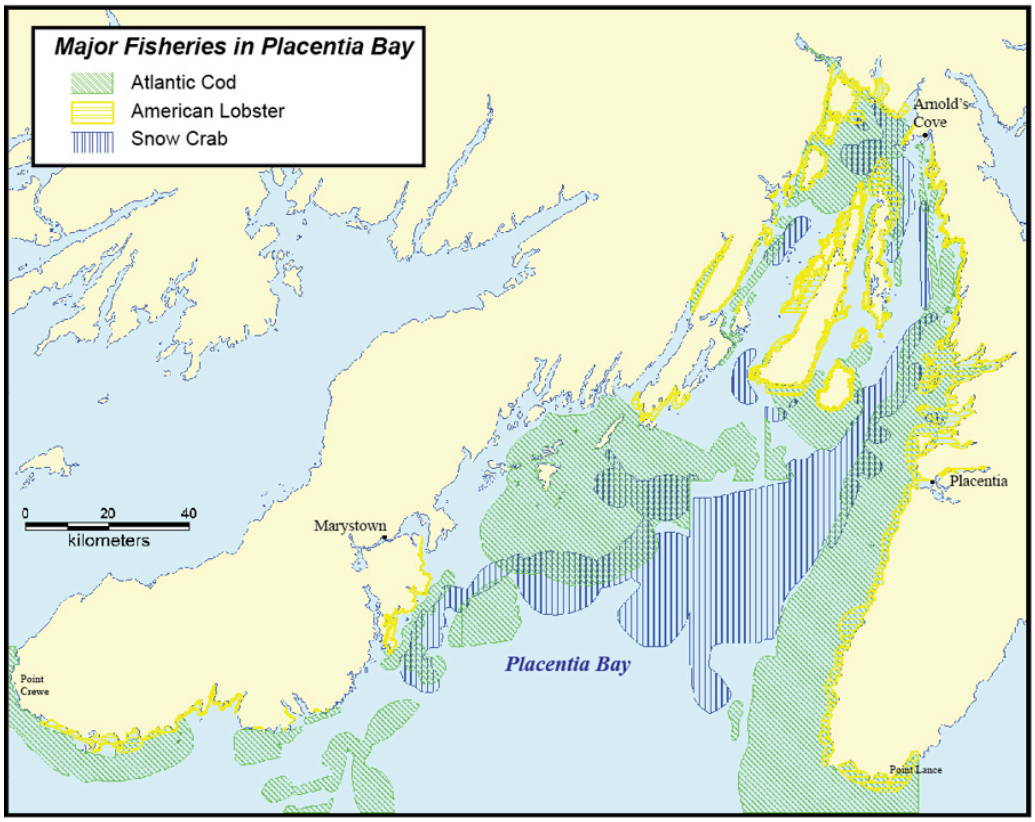



Source: NAFO STATLANT21A Data Extraction Tool.

**Figure 4.18. Historical catch weights for predominant species in the commercial fisheries in NAFO Division 3Ps, all countries, 1986–2016.**

Since 1996, DFO has been working with community groups to document coastal fisheries resources. This information has been collected through direct contact with individuals and stakeholders in coastal communities around the province, including Placentia Bay (DFO 2008). Knowledgeable people in communities in the Placentia Bay area were interviewed to identify areas where specific resources were known to occur. As a result, DFO was able to produce Community-Based Coastal Resource Inventories (CCRIs) and maps such as Figure 4.19, demonstrating the locations of major fisheries in Placentia Bay (DFO 2008).

The fisheries, fisheries management and licencing regimes have evolved since the mid-1990s, particularly with respect to a fish harvesting rationalization strategy that reduced the number of participants in the harvesting sector, and a professionalization process which prescribes specific levels of experience and training required to be a professional fish harvester (Vale 2008). DFO also introduced the "core" harvesting enterprise designation, with restrictions placed on harvesters who are not part of such an enterprise (Vale 2008). An enterprise combining policy was developed in 2007 and implemented in 2008, allowing individual Independent Core (IC) enterprise holders to buy other IC licence holders (or Core licence holders) (DFO 2013). Any enterprise combining transaction must result in the removal of one IC (or Core) enterprise, a vessel registration and any duplicate species licences (DFO 2013). A buddy-up system was implemented for the <40' sector in the early 2000s, where two enterprise heads could be on board a vessel (DFO 2013). New entrants (as Core enterprise heads) to the <40' sector were permitted to either combine enterprises or buddy-up, but not both, for a five year period following the acquisition of a Core enterprise (DFO 2013). As of 2017, a combining policy for NAFO Div. 3Ps permits three to one enterprise combining for the entire fleet, and combined enterprises in the 3Ps <40' fleet are permitted to buddy-up (DFO 2017a). In order to assist the inshore northern shrimp fleet in 3Ps deal with the impact of recent quota reductions, DFO considered temporary flexible harvest arrangements between enterprises for 2017 as a short-term option, and is working towards longer-term measures to increase opportunities for the remaining enterprises (DFO 2017a).




Source: DFO (2008).

**Figure 4.19. Locations of major fisheries in Placentia Bay, based on Community-Based Coastal Resource Inventories (CCRIs).**

On 28 April 2017, the FFAW held meetings with representatives for the fishing fleet in Placentia Bay and the 3Ps supplementary fleet to discuss the resource and economic difficulties affecting harvesters in that region during recent years (FFAW|Unifor 2017a). During these meetings, a variety of short- and long-term measures were discussed to ensure stable and sustainable futures for the region's harvesters and communities, including increasing the number of sea cucumber licences, securing a reasonable share of the valuable halibut stock, providing greater opportunities for the whelk fishery, and ensuring that the inshore fleet has exclusive access to the 3Ps cod quota once that quota decreases below 10,000 mt (FFAW|Unifor 2017a). DFO hosted a meeting for NAFO Div. 3Ps fishers in Placentia on 20 November 2017 to provide inshore harvesters and other interested stakeholders an opportunity to discuss concerns regarding the current inshore fisheries and to develop feasible solutions for these concerns (DFO 2017b).

### *Study Area Catch Analysis, 2010–2015*

Information on Study Area domestic harvests during 2010 are shown in Table 4.17, and during 2011–2015 in Tables 4.18–4.22. The total catch weight of commercial fisheries within the Study Area (NAFO UA 3PSc; see footnote in Table 4.17) during 2010 was 6,716 mt (Figure 4.20). In descending order of reported catch weight, the principal fisheries in 2010 were Atlantic cod (40% of the total catch weight) and snow crab (28%), followed by Atlantic herring (14%) and sea cucumber (13%). Snow crab and Atlantic cod also accounted for the majority of commercial harvest catch weight in the Study Area during 2011–2015. Other notable species harvested during 2010–2015 in the Study Area include lobster,

sea scallop, American plaice and Atlantic herring. Aside from a slight increase in 2013, the sum of quartile catch ranges in the Study Area has steadily decreased since 2011 (Figure 4.20).

**Table 4.17. Study Area[a] annual catch weight and value by species, 2010.**

| Species | Quantity | | Value | |
|---|---|---|---|---|
| | mt | % of Total | $CAD | % of Total |
| Atlantic Cod | 2,674 | 40 | 2,652,313 | 27 |
| Snow Crab | 1,908 | 28 | 5,677,598 | 58 |
| Atlantic Herring | 917 | 14 | 180,561 | 2 |
| Sea Cucumber | 843 | 13 | 557,465 | 6 |
| Mackerel | 83 | 1 | 36,451 | 0.4 |
| Winter Flounder | 78 | 1 | 39,965 | 0.4 |
| Lobster | 60 | 1 | 437,663 | 4 |
| Whelk | 49 | 1 | 42,197 | 0.4 |
| American Plaice | 42 | 1 | 28,908 | 0.3 |
| Sea Scallop | 30 | 0.4 | 53,066 | 1 |
| Pollock | 19 | 0.3 | 10,027 | 0.1 |
| Skates | 5 | 0.1 | 1,393 | <0.1 |
| Redfish | 3 | <0.1 | 1,792 | <0.1 |
| Lumpfish Roe | 1 | <0.1 | 13,139 | 0.1 |
| White Hake | 1 | <0.1 | 1,363 | <0.1 |
| Yellowtail Flounder | 1 | <0.1 | 691 | <0.1 |
| Atlantic Halibut | 1 | <0.1 | 7,563 | 0.1 |
| Atlantic Haddock | 0.5 | <0.1 | 361 | <0.1 |
| Atlantic Rock Crab | 0.4 | <0.1 | 335 | <0.1 |
| Monkfish | 0.2 | <0.1 | 163 | <0.1 |
| Greenland Halibut | 0.1 | <0.1 | 199 | <0.1 |
| Witch Flounder | <0.1 | <0.1 | 20 | <0.1 |
| Sturgeon | <0.1 | <0.1 | 20 | <0.1 |
| Porbeagle Shark | <0.1 | <0.1 | 19 | <0.1 |
| **Total** | **6,716** | **100** | **9,743,271** | **100** |

Source: DFO Commercial Landings Database, All Atlantic Regions (2010).

[a] Georeferenced (latitude/longitude) data were not available within the DFO 2010 database for all or virtually all of the recorded harvest for Atlantic haddock, pollock, redfish, monkfish, Atlantic halibut, Greenland halibut, winter flounder, yellowtail flounder, witch flounder, skates, white hake, lobster, Atlantic rock crab, whelk, lumpfish roe, mackerel, porbeagle shark, sea cucumber and sturgeon; and for ~25–50% of records for Atlantic cod, snow crab, American plaice and mackerel. Therefore, catch quantity and value data are presented for NAFO UA 3PSc, which includes the Study Area and a relatively small area immediately south of the Study Area (see Figure 4.16).

**Table 4.18. Commercial catch weights and values in the Study Area, 2011 (values indicate the frequency of catch weight and value quartile codes [i.e., 1–4] attributed to each species).**

| Species | Catch Weight Quartile Code Counts[a] | | | | Catch Value Quartile Code Counts[b] | | | | Total Counts[c] |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| Snow Crab | 75 | 121 | 103 | 6 | 50 | 99 | 111 | 45 | 305 |
| Atlantic Cod | 61 | 52 | 14 | 0 | 91 | 32 | 4 | 0 | 127 |
| American Plaice | 6 | 24 | 3 | 0 | 16 | 15 | 2 | 0 | 33 |
| Sea Scallop | 22 | 1 | 0 | 0 | 22 | 1 | 0 | 0 | 23 |
| Redfish | 0 | 7 | 1 | 0 | 4 | 4 | 0 | 0 | 8 |
| Atlantic Halibut | 1 | 2 | 2 | 0 | 2 | 3 | 0 | 0 | 5 |
| Greenland Halibut | 2 | 1 | 1 | 0 | 3 | 1 | 0 | 0 | 4 |
| Winter Flounder | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 2 |
| Mackerel | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 2 |
| Monkfish | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| Pollock | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Atlantic Herring | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Skates | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| **Total – Counts** | **167** | **214** | **127** | **6** | **194** | **157** | **118** | **45** | **514** |
| **Total – Sum** | **167** | **428** | **381** | **24** | **194** | **314** | **354** | **180** | **-** |

| Species | Catch Weight Quartile Code Counts[a] | | | | Catch Value Quartile Code Counts[b] | | | | Total Counts[c] |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| **(Weight=1,000; Value=1,042)** | | | | | | | | | |
| Lobster[d] | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 5 |
| **Total – Sum (Weight=20; Value=20)** | **0** | **0** | **0** | **20** | **0** | **0** | **0** | **20** | **-** |

Source: DFO Commercial Landings Database, All Regions (2011).

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2011 quartile ranges: 1 = 0 – 2,377 kg, 2 = 2,378 – 11,045 kg, 3 = 11,046 – 45,183 kg, 4 = ≥ 45,184 kg.

[b] Quartile ranges provided by DFO (Quartile ranges calculated annually by DFO based on total catch values in a given year, all species combined). 2011 quartile ranges: 1 = $0 – $7,281, 2 = $7,282 – $32,789, 3 = $32,790 – $126,294, 4 = ≥ $126,295.

[c] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

[d] Lobster harvests in the DFO Database are categorized by NAFO UA and are not georeferenced; quartile code counts are presented for UA 3PSc, which includes the Study Area and a relatively small area immediately south of the Study Area (see Figure 4.16).

**Table 4.19. Commercial catch weights and values in the Study Area, 2012 (values indicate the frequency of catch weight and value quartile codes [i.e., 1–4] attributed to each species).**

| Species | Catch Weight Quartile Code Counts[a] | | | | Catch Value Quartile Code Counts[b] | | | | Total Counts[c] |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| Snow Crab | 59 | 137 | 100 | 13 | 43 | 125 | 96 | 45 | 309 |
| Atlantic Cod | 85 | 41 | 5 | 0 | 114 | 17 | 0 | 0 | 131 |
| American Plaice | 9 | 11 | 0 | 0 | 17 | 3 | 0 | 0 | 20 |
| Sea Scallop | 11 | 1 | 0 | 0 | 12 | 0 | 0 | 0 | 12 |
| Redfish | 5 | 6 | 0 | 0 | 10 | 1 | 0 | 0 | 11 |
| Winter Flounder | 5 | 4 | 0 | 0 | 8 | 1 | 0 | 0 | 9 |
| Greenland Halibut | 4 | 5 | 0 | 0 | 7 | 2 | 0 | 0 | 9 |
| Pollock | 1 | 2 | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| Iceland Scallop | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| Atlantic Halibut | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| Skates | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Mackerel | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| **Total – Count** | **182** | **209** | **106** | **13** | **218** | **151** | **96** | **45** | **510** |
| **Total – Sum (Weight=970; Value=988)** | **182** | **418** | **318** | **52** | **218** | **302** | **288** | **180** | **-** |
| Lobster[d] | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 4 | 4 |
| **Total – Sum (Weight=16; Value=16)** | **0** | **0** | **0** | **16** | **0** | **0** | **0** | **16** | **-** |

Source: DFO Commercial Landings Database, All Regions (2012).

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2012 quartile ranges: 1 = 0 – 2,618 kg, 2 = 2,619 – 12,233 kg, 3 = 12,234 – 47,739 kg, 4 = ≥ 47,740 kg.

[b] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch values in a given year, all species combined). 2012 quartile ranges: 1 = $0 – $8,240, 2 = $8,241 – $35,022, 3 = $35,023 – $130,732, 4 = ≥ $130,733.

[c] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

[d] Lobster harvests in the DFO Database are categorized by NAFO UA and are not georeferenced; quartile code counts are presented for UA 3PSc, which includes the Study Area and a relatively small area immediately south of the Study Area (see Figure 4.16).

**Table 4.20. Commercial catch weights and values in the Study Area, 2013 (values indicate the frequency of catch weight and value quartile codes [i.e., 1–4] attributed to each species).**

| Species | Catch Weight Quartile Code Counts[a] | | | | Catch Value Quartile Code Counts[b] | | | | Total Counts[c] |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| Snow Crab | 94 | 148 | 119 | 12 | 79 | 120 | 145 | 29 | 373 |
| Atlantic Cod | 93 | 59 | 2 | 0 | 123 | 30 | 1 | 0 | 154 |

| Species | Catch Weight Quartile Code Counts[a] | | | | Catch Value Quartile Code Counts[b] | | | | Total Counts[c] |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| Sea Scallop | 18 | 3 | 0 | 0 | 21 | 0 | 0 | 0 | 21 |
| American Plaice | 1 | 13 | 1 | 0 | 9 | 5 | 1 | 0 | 15 |
| Pollock | 1 | 4 | 0 | 0 | 5 | 0 | 0 | 0 | 5 |
| Winter Flounder | 0 | 5 | 0 | 0 | 3 | 2 | 0 | 0 | 5 |
| Atlantic Herring | 2 | 0 | 0 | 2 | 2 | 2 | 0 | 0 | 4 |
| Redfish | 0 | 4 | 0 | 0 | 3 | 1 | 0 | 0 | 4 |
| Whelk | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| Greenland Halibut | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 2 |
| Skates | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| Atlantic Halibut | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Capelin | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| **Total – Count** | **211** | **240** | **124** | **14** | **250** | **162** | **148** | **29** | **589** |
| **Total – Sum (Weight=1,119; Value=1,134)** | **211** | **480** | **372** | **56** | **250** | **324** | **444** | **116** | **-** |
| Lobster[d] | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 5 |
| **Total – Sum (Weight=20; Value=20)** | **0** | **0** | **0** | **20** | **0** | **0** | **0** | **20** | **-** |

Source: DFO Commercial Landings Database, All Regions (2013).

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2013 quartile ranges: 1 = 0 – 2,565 kg, 2 = 2,566 – 11,872 kg, 3 = 11,873 – 48,585 kg, 4 = ≥ 48,586 kg.

[b] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch values in a given year, all species combined). 2013 quartile ranges: 1 = $0 – $8,934, 2 = $8,395 – $35,699, 3 = $35,700 – $125,728, 4 = ≥ $125,729.

[c] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

[d] Lobster harvests in the DFO Database are categorized by NAFO UA and are not georeferenced; quartile code counts are presented for UA 3PSc, which includes the Study Area and a relatively small area immediately south of the Study Area (see Figure 4.16).

**Table 4.21. Commercial catch weights and values in the Study Area, 2014 (values indicate the frequency of catch weight and value quartile codes [i.e., 1–4] attributed to each species).**

| Species | Catch Weight Quartile Code Counts[a] | | | | Catch Value Quartile Code Counts[b] | | | | Total Counts[c] |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| Snow Crab | 116 | 107 | 75 | 8 | 87 | 116 | 82 | 21 | 306 |
| Atlantic Cod | 67 | 45 | 28 | 1 | 100 | 38 | 3 | 0 | 141 |
| Sea Scallop | 14 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 14 |
| American Plaice | 2 | 3 | 3 | 0 | 4 | 4 | 0 | 0 | 8 |
| Greenland Halibut | 1 | 2 | 3 | 0 | 3 | 3 | 0 | 0 | 6 |
| Atlantic Herring | 0 | 0 | 1 | 4 | 1 | 2 | 2 | 0 | 5 |
| Redfish | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 2 |
| Pollock | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 2 |
| Atlantic Halibut | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Yellowtail Flounder | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| **Total – Count** | **201** | **157** | **114** | **14** | **210** | **167** | **88** | **21** | **486** |
| **Total – Sum (Weight=913; Value=892)** | **201** | **314** | **342** | **56** | **210** | **334** | **264** | **84** | **-** |
| Lobster[d] | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 3 |
| **Total – Sum (Weight=12; Value=12)** | **0** | **0** | **0** | **12** | **0** | **0** | **0** | **12** | **-** |

Source: DFO Commercial Landings Database, All Regions (2014).

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2014 quartile ranges: 1 = 0 – 2,421 kg, 2 = 2,422 – 10,786 kg, 3 = 10,787 – 42,872 kg, 4 = ≥ 42,873 kg.

[b] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch values in a given year, all species combined). 2014 quartile ranges: 1 = $0 – $8,851, 2 = $8,852 – $38,076, 3 = $38,077 – $140,695, 4 = ≥ $140,696.

[c] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

[d] Lobster harvests in the DFO Database are categorized by NAFO UA and are not georeferenced; quartile code counts are presented for UA 3PSc, which includes the Study Area and a relatively small area immediately south of the Study Area (see Figure 4.16).

**Table 4.22. Commercial catch weights and values in the Study Area, 2015 (values indicate the frequency of catch weight and value quartile codes [i.e., 1–4] attributed to each species).**

| Species | Catch Weight Quartile Code Counts[a] | | | | Catch Value Quartile Code Counts[b] | | | | Total Counts[c] |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| Snow Crab | 186 | 140 | 25 | 0 | 156 | 137 | 58 | 0 | 351 |
| Atlantic Cod | 77 | 52 | 12 | 1 | 114 | 27 | 1 | 0 | 142 |
| Sea Scallop | 23 | 6 | 0 | 1 | 27 | 3 | 0 | 0 | 30 |
| American Plaice | 4 | 8 | 1 | 0 | 11 | 2 | 0 | 0 | 13 |
| Greenland Halibut | 5 | 8 | 0 | 0 | 9 | 4 | 0 | 0 | 13 |
| Atlantic Herring | 0 | 0 | 3 | 6 | 3 | 6 | 0 | 0 | 9 |
| Iceland Scallop | 1 | 3 | 1 | 0 | 4 | 1 | 0 | 0 | 5 |
| Redfish | 1 | 3 | 0 | 0 | 4 | 0 | 0 | 0 | 4 |
| Winter Flounder | 2 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| Atlantic Rock Crab | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Atlantic Halibut | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Bluefin Tuna | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| **Total – Count** | **300** | **222** | **43** | **8** | **332** | **182** | **59** | **0** | **573** |
| **Total – Sum (Weight=905; Value=873)** | **300** | **444** | **129** | **32** | **332** | **364** | **177** | **873** | **-** |
| Lobster[d] | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 5 |
| **Total – Sum (Weight=20; Value=20)** | **0** | **0** | **0** | **20** | **0** | **0** | **0** | **20** | **-** |

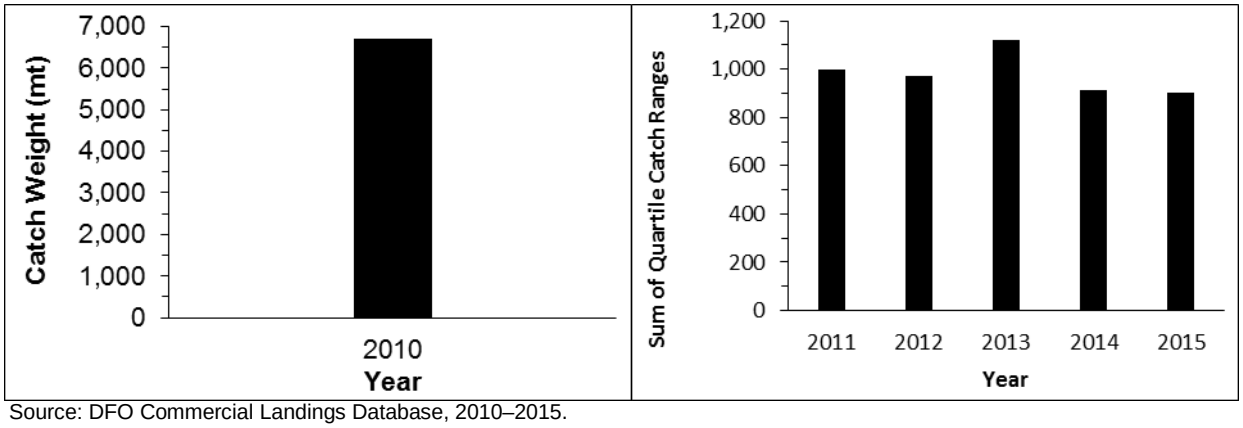
Source: DFO Commercial Landings Database, All Regions (2015).

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2015 quartile ranges: 1 = 0 – 2,253 kg, 2 = 2,254 – 9,535 kg, 3 = 9,536 – 40,703 kg, 4 = ≥ 40,704 kg.

[b] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch values in a given year, all species combined). 2015 quartile ranges: 1 = $0 – $9,539, 2 = $9,540 – $37,526, 3 = $37,527 – $134,094, 4 = ≥ $134,095.

[c] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

[d] Lobster harvests in the DFO Database are categorized by NAFO UA and are not georeferenced; quartile code counts are presented for UA 3PSc, which includes the Study Area and a relatively small area immediately south of the Study Area (see Figure 4.16).



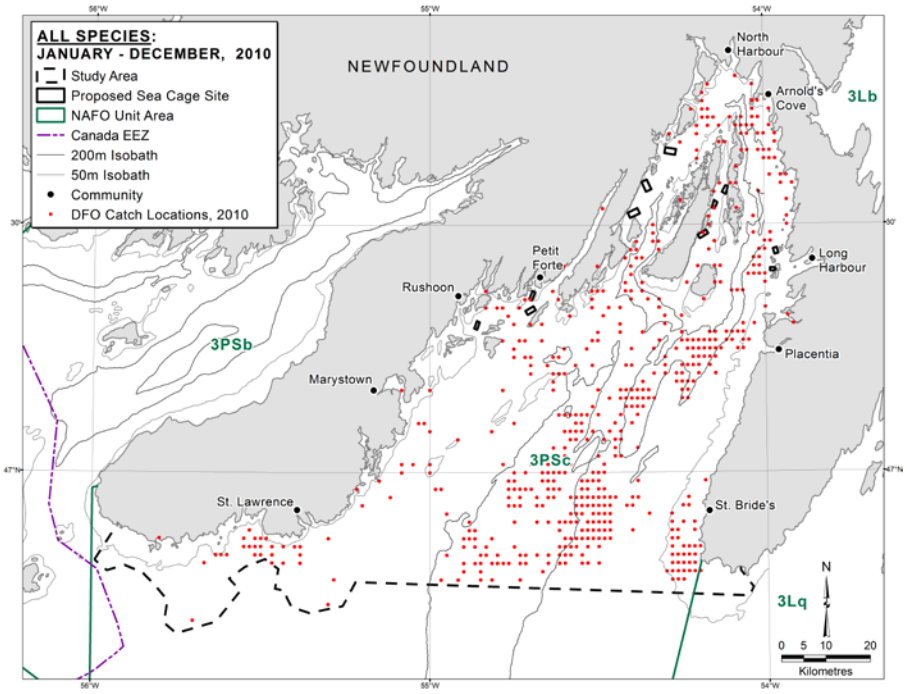

Source: DFO Commercial Landings Database, 2010–2015.

Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all catch records for all species; the greater the sum of quartile catch range counts, the greater the catch weight for a given year.

**Figure 4.20. Total catch weight, 2010 (left), and annual total sum of catch weight quartile codes, 2011–2015 (right) (all species within the Study Area; all species within NAFO UA 3PSc for 2010).**

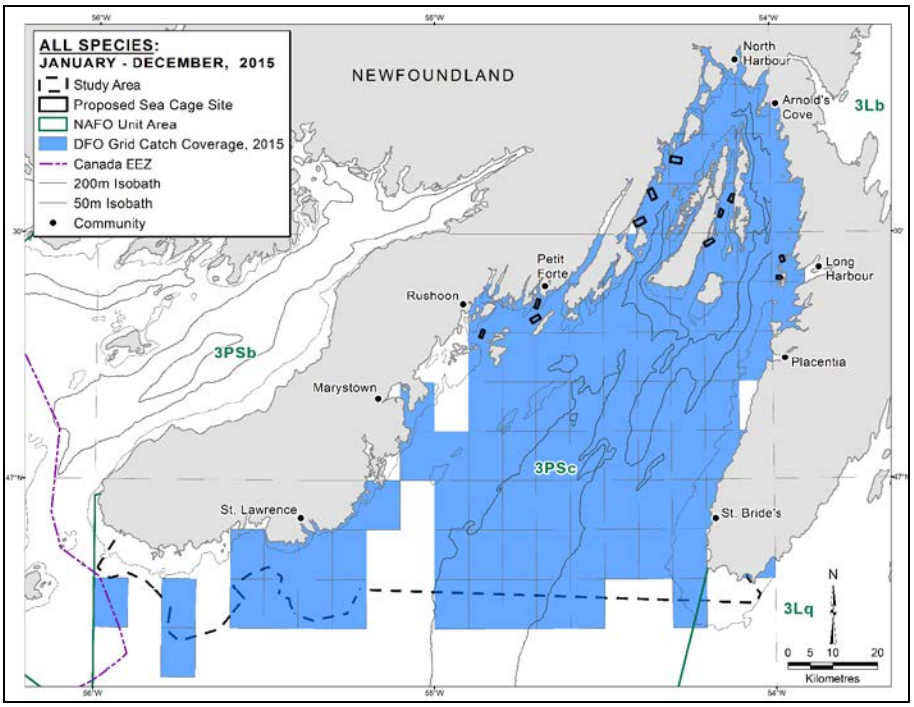
*Harvest Locations*

Georeferenced commercial fisheries harvest locations for all species during 2010 and gridded harvest locations (6'x6'x cells) during 2015 are shown in Figures 4.21–4.22. The harvest locations within Placentia Bay of Atlantic cod, snow crab and lobster, based on data collected by DFO for CCRIs, are also presented in Figure 4.19. Fishers consulted during meetings in various communities within Placentia Bay during February 2018 (Appendix A *in* Grattan et al. 2018, Volume 3) indicated areas in which they fish within the Rushoon and Merasheen BMAs. These areas were amalgamated for each BMA and are shown in Figures 4.23–4.24. Harvests occur throughout Placentia Bay, particularly in the central, eastern and northern portions of the Bay, including for Atlantic cod within and near the Valen Island proposed sea cage site in the Merasheen BMA. Lobster fishing locations are not georeferenced within the DFO Commercial Landings Database. Lobster is harvested nearshore, typically close to the community where the fisher lives (Vale 2008), along the southwestern, western, northern and eastern coasts of Placentia Bay, including within and/or in the vicinity of the Long Island and Gallows Harbour proposed sea cage sites in the Rushoon BMA (Figures 4.19 and 4.23–4.24).



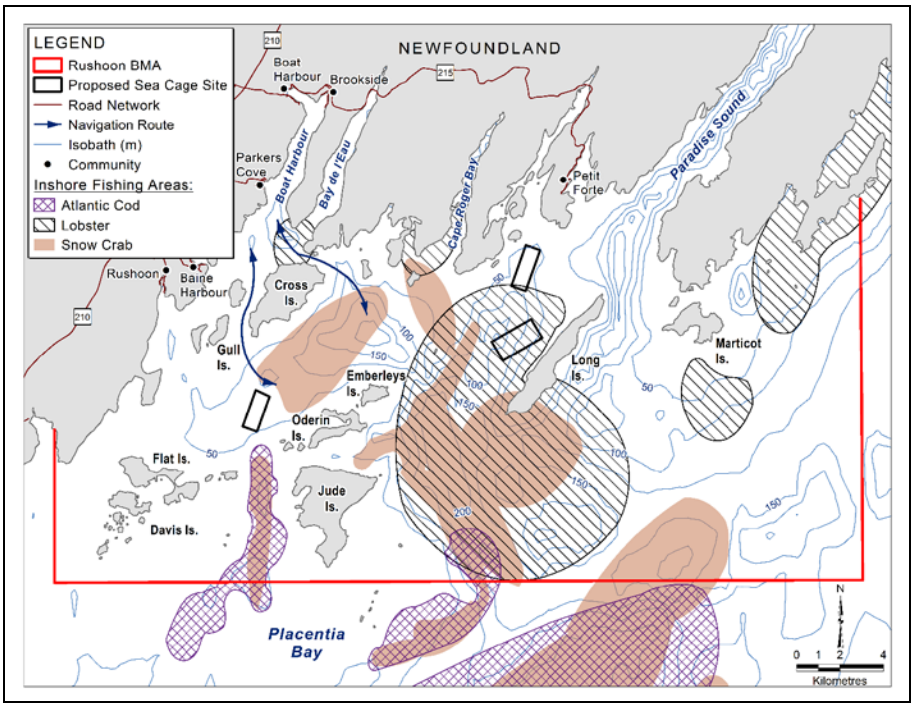

Source: DFO Commercial Landings Database, 2010–2015.

**Figure 4.21. Distribution of commercial harvest locations, all species, 2010.**



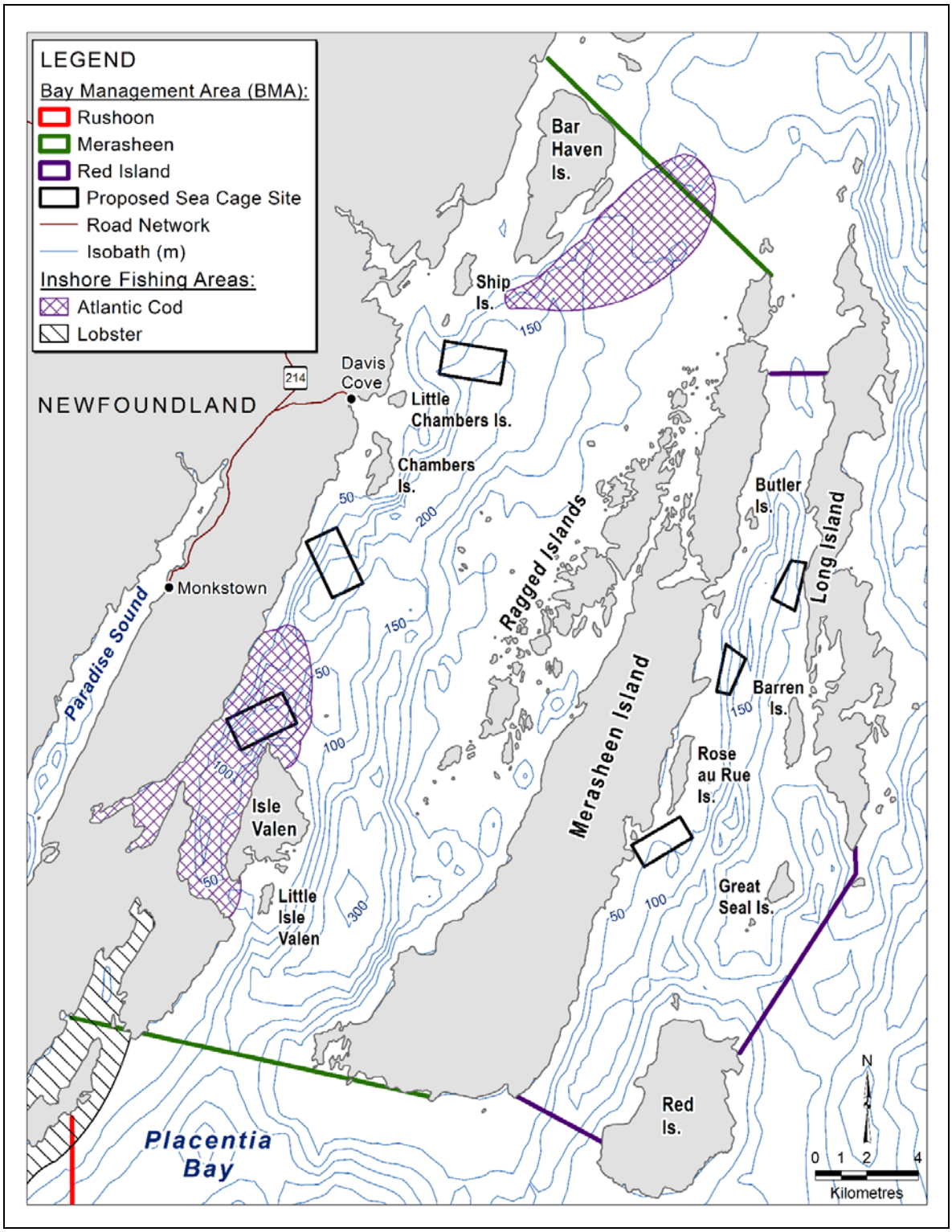

Source: DFO Commercial Landings Database, 2010–2015.

**Figure 4.22. Distribution of commercial harvest locations, all species, 2015.**




Source: Consultations with fishers, February 2018 (see Grattan et al. 2018).

**Figure 4.23. Composite chart showing fishers' sketch of main fishing grounds and travel routes in the Rushoon BMA.**




Source: Consultations with fishers, February 2018 (see Grattan et al. 2018).

**Figure 4.24. Composite chart showing fishers' sketch of main fishing grounds in the Merasheen BMA and Red Island BMA.**

*Fishing Gear*

A variety of fishing gear types was used in the Study Area during 2010–2015. Snow crab, lobster, whelk and Atlantic rock crab were harvested using pots which also incidentally caught several species, including redfish (Tables 4.23 and 4.24). Longlines were used to harvest Atlantic cod, with incidental catches of several other species including American plaice, redfish, Greenland halibut (*Reinhardtius hippoglossoides*) and flounders. Atlantic cod, Atlantic herring and mackerel (*Scomber scombrus*) were harvested using trap nets. Many species in Table 4.24 were harvested using gillnets, either as targeted or incidental catch. Seine nets were used to harvest small pelagic species, such as Atlantic herring and capelin (*Mallotus villosus*). Various demersal species were harvested using baited hand line, including Atlantic cod, American plaice, winter flounder (*Pseudopleuronectes americanus*), skates, redfish and Atlantic halibut (*Hippoglossus hippoglossus*). Bivalves were harvested using dredges, and bluefin tuna (*Thunnus thynnus*) were caught with electric harpoon. The sea cucumber drag was used to harvest sea cucumbers. Gillnets and pots (fixed gears) accounted for about 35% and 30%, respectively, of the total catch weight of all species in NAFO UA 3PSc during 2010. Sea cucumber drags and seines (mobile gears) each accounted for ~13% of the total catch weight during this same period. Overall, fixed and mobile gears accounted for ~71% and 29% of the total catch weight, respectively (see Table 4.23).

**Table 4.23. Total Study Area[a] catch weight by gear type, 2010.**

| Species | Fixed Gear | | Mobile Gear | |
|---|---|---|---|---|
| | mt | % of Total | mt | % of Total |
| Atlantic Cod | 2,463 | 52 | 212 | 11 |
| Snow Crab | 1,908 | 40 | 0 | 0 |
| Atlantic Herring | 49 | 1 | 868 | 44 |
| Sea Cucumber | 0 | 0 | 843 | 43 |
| Mackerel | 83 | 2 | 0 | 0 |
| Winter Flounder | 77 | 2 | 0.3 | <0.1 |
| Lobster | 60 | 1 | 0 | 0 |
| Whelk | 49 | 1 | 0 | 0 |
| American Plaice | 42 | 1 | 0.2 | <0.1 |
| Sea Scallop | 0 | 0 | 30 | 2 |
| Pollock | 19 | 0.4 | 0 | 0 |
| Skates | 5 | 0.1 | <0.1 | <0.1 |
| Redfish | 3 | 0.1 | <0.1 | <0.1 |
| Lumpfish Roe | 1 | <0.1 | 0 | 0 |
| White Hake | 1 | <0.1 | 0 | 0 |
| Yellowtail Flounder | 1 | <0.1 | 0 | 0 |
| Atlantic Halibut | 1 | <0.1 | <0.1 | <0.1 |
| Atlantic Haddock | 0.5 | <0.1 | 0 | 0 |
| Atlantic Rock Crab | 0.4 | <0.1 | 0 | 0 |
| Monkfish | 0.2 | <0.1 | 0 | 0 |
| Greenland Halibut | 0.1 | <0.1 | 0 | 0 |
| Witch Flounder | <0.1 | <0.1 | 0 | 0 |
| Sturgeon | <0.1 | <0.1 | 0 | 0 |
| Porbeagle Shark | <0.1 | <0.1 | 0 | 0 |
| **Subtotal** | **4,762** | **100** | **1,953** | **100** |
| **Grand Total (mt)** | **6,716** | | | |

Source: DFO Commercial Landings Database, All Atlantic Regions (2010).

[a] Georeferenced (latitude/longitude) data were not available within the DFO 2010 database for all or virtually all of the recorded harvest for Atlantic haddock, pollock, redfish, monkfish, Atlantic halibut, Greenland halibut, winter flounder, yellowtail flounder, witch flounder, skates, white hake, lobster, Atlantic rock crab, whelk, lumpfish roe, mackerel, porbeagle shark, sea cucumber and sturgeon; and for ~25–50% of records for Atlantic cod, snow crab, American plaice and mackerel. Therefore, catch quantity and value data are presented for NAFO UA 3PSc, which includes the Study Area and a relatively small area immediately south of the Study Area (see Figure 4.16).

**Table 4.24. Summary of gear type used and timing of the commercial fishery in the Study Area[a], 2010–2015.**

| Species | Month Caught | | | | | | Gear Type | |
|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | Fixed | Mobile |
| Atlantic Cod | Jan-Feb; May-Dec | Jan-Mar; May-Dec | Jan-Feb; May-Dec | Jan-Feb; May-Dec | Jan-Mar; May-Dec | Jan-Mar; May-Dec | Gillnet; Longline; Trap Net; Pot | Hand Line (baited) |
| Snow Crab | Apr-Jul | Apr-Jul | Apr-Jul | Apr-Jul | Apr-Jul | Apr-Jul | Pot | - |
| Atlantic Herring | Apr; Nov-Dec | Dec | - | Jan; Mar; Dec | Mar-Apr | Mar-Apr | Gillnet; Trap Net | Seine |
| Sea Cucumber | Jul-Nov | - | - | - | - | - | - | Sea Cucumber Drag |
| Mackerel | Aug-Oct | Aug-Sep | Aug | - | - | - | Gillnet; Trap Net | - |
| Winter Flounder | Jan-Feb; May-Dec | Jun-Jul | Jun-Jul; Nov-Dec | Jun-Jul; Nov-Dec | - | Jun; Aug; Nov | Gillnet; Longline | Hand Line (baited) |
| Lobster[b] | Apr-Jul | Apr-Jun | Apr-Jul | Apr-Jul | May-Jul | Apr-Jul | Pot | - |
| Whelk | Jun-Aug | - | - | Aug | - | - | Pot | - |
| American Plaice | Jan-Feb; May-Dec | May-Aug; Oct-Dec | May-Jul; Oct-Dec | Jan; Jun-Jul; Nov | Jun-Aug; Dec | Jan; Jul-Aug; Oct-Dec | Gillnet; Longline | Hand Line (baited) |
| Sea Scallop | Feb-Mar; Sep-Dec | Jan; Mar; Oct-Dec | Feb; Oct-Nov | Jun; Sep-Dec | Feb-Mar; Sep-Dec | Feb-Mar; Sep-Dec | - | Dredge |
| Pollock | Jan; Jul; Sep-Nov | Nov | Oct; Dec | Jan; Nov-Dec | Feb-Mar | - | Gillnet; Longline | - |
| Skates | May-Jul; Sep-Dec | Jun | Sep | Jul | - | - | Gillnet; Longline | Hand Line (baited) |
| Redfish | Jan-Feb; Jun-Dec | Oct-Dec | May-Jun; Oct-Dec | Jan; Nov | Jun; Sep | Oct-Dec | Gillnet; Longline; Pot | Hand Line (baited) |
| Lumpfish Roe | May-Jun | - | - | - | - | - | Gillnet | - |
| White Hake | Sep-Oct | - | - | - | - | - | Gillnet | - |
| Yellowtail Flounder | Jan; Jun-Oct | - | - | - | Jun | - | Gillnet; Longline | - |
| Atlantic Halibut | May-Dec | Jun-Jul | Jun-Jul | Jun | Jun | Jun | Gillnet; Longline | Hand Line (baited) |
| Atlantic Haddock | Jul; Sep-Dec | - | - | - | - | - | Gillnet; Longline | - |
| Atlantic Rock Crab | Sep | - | - | - | - | Aug | Pot | - |
| Monkfish | Jul; Sep-Oct | Sep | - | - | - | - | Gillnet | - |
| Greenland Halibut | Jun-Aug; Oct-Dec | May-Aug | May-Jul; Oct-Nov | Jun-Jul | Jun-Sep | Jan-Feb; Jun-Aug; Nov-Dec | Gillnet; Longline | - |
| Witch Flounder | May-Jul; Nov | - | - | - | - | - | Gillnet | - |
| Sturgeon | Nov | - | - | - | - | - | Gillnet | - |
| Porbeagle Shark | Sep | - | - | - | - | - | Gillnet | - |
| Iceland Scallop | - | - | Aug | - | - | Jun-Jul | - | Dredge |
| Bluefin Tuna | - | - | - | - | - | Nov | - | Electric Harpoon |
| Capelin | - | - | - | Jul | - | - | - | Seine |

Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

[a] Georeferenced (latitude/longitude) data were not available within the DFO 2010 database for all or virtually all of the recorded harvest for Atlantic haddock, pollock, redfish, monkfish, Atlantic halibut, Greenland halibut, winter flounder, yellowtail flounder, witch flounder, skates, white hake, lobster, Atlantic rock crab, whelk, lumpfish roe, mackerel, porbeagle shark, sea cucumber and sturgeon; and for ~25–50% of records for Atlantic cod, snow crab, American plaice and mackerel. Therefore, catch data for 2010 are presented for NAFO UA 3PSc, which includes the Study Area and a relatively small area immediately south of the Study Area (see Figure 4.16).

[b] Lobster catches are assigned to NAFO UAs, but not to 6'x6' grid cells within the DFO 2011–2015 database; therefore, harvest months for lobster are presented for NAFO UA 3PSc.

Mobile gear is typically towed by a fishing vessel while fixed gear is deployed and left by the fisher, typically anchored in place (Vale 2008). Fixed gears are typically deployed at a location for several days, sometimes set out over long distances (LGL 2016). Fixed gear fisheries, such as those utilizing gillnets or pots, are usually more site-specific than mobile fisheries, with fewer alternate fishing grounds available (Vale 2008). Fixed and mobile gear harvest locations in the Study Area during 2015 are shown in Figure 4.25.

Since April 2013, DFO provides gear tags for the Atlantic bluefin tuna fishery, and the fishing industry has the responsibility to obtain and pay for any gear tags required for use in other commercial fisheries (DFO 2017c). As per licence conditions, licence holders must attach a tag to their gear that has been obtained from a DFO-approved tag supplier (DFO 2017c). Multi-year tags may be metal or traditional polyurethane-type tags, and must be natural or white in colour (DFO 2017c). Single-year tags require a different colour each year. Within the Newfoundland and Labrador region, the 2018, 2019 and 2020 single-year tag colours will be yellow, purple and green, respectively (DFO 2017c).

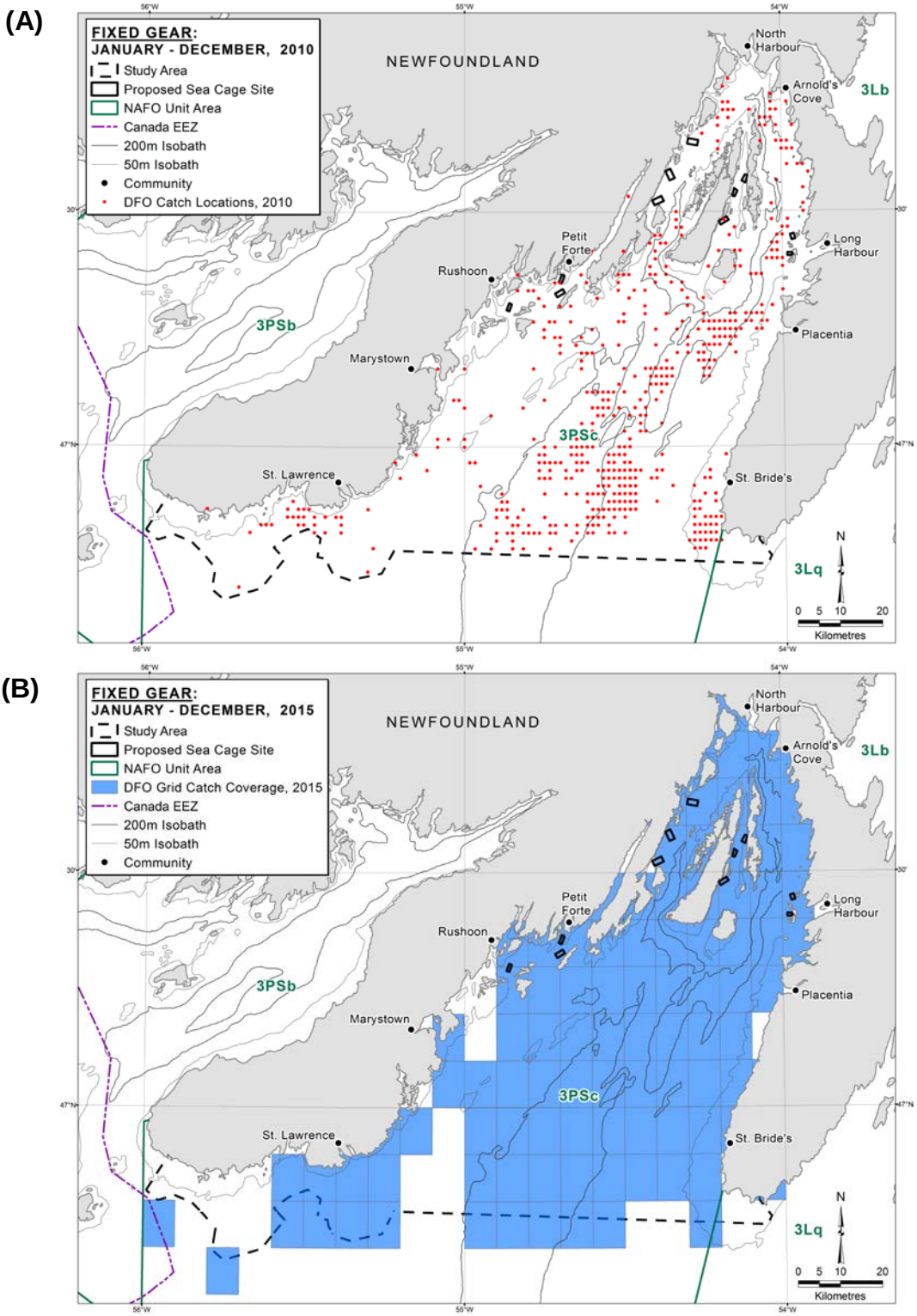
*Harvest Seasons*

Total monthly catch weights during 2010 and the total sum of monthly catch weight quartile codes for 2011–2015 for all species within the Study Area are indicated in Figure 4.26 (within NAFO UA 3PSc for 2010; see footnote a of Figure 4.26). Harvests occur year-round in the Study Area, with the greatest catch weights during April–July, coinciding with the seasons for Atlantic cod, snow crab and lobster (see Table 4.24). Further details regarding the timing of the fisheries for key species in the Study Area are provided in the *Principal Species* and *Other Notable Species* subsections below. For management purposes, the seasons for harvesting species in the Placentia Bay region are provided in Table 4.25.

There is an annual closure of a cod spawning area for all vessel classes in northwestern Placentia Bay, north of Ship Island (DFO 2018b). During 2018, the cod spawning closure began on 1 January and will remain in effect until the fishery re-opens in May (DFO 2018b). In addition, a seasonal closure of the fishery for the 3Ps Atlantic cod stock occurs annually, typically from March to mid-May, to protect spawning aggregations (DFO 2018c).

A mandatory annual closure of the snow crab fishery occurs during August and September in Newfoundland and Labrador to protect soft-shell crabs. Outside of this two-month closure period, areas with a high incidence of soft-shell are closed to harvesting as required. A grid-based soft shell protocol was initiated in 2004 in Newfoundland and Labrador, in which localized areas are closed when the percentage of soft-shelled legal-sized snow crab catch exceeds 20% (DFO 2018d). Areas closed due to soft shell remain closed for the remainder of the fishing season (DFO 2018d).

The Study Area is within the northernmost portion of Lobster Fishing Area (LFA) 10 (see Figure 4.27 for map LFAs). Within LFA 10, harvesters are not permitted to retrieve fishing gear or possess lobsters during the initial 48-hour gear-setting period following the announced opening date (DFO 2017d).




Source: DFO Commercial Landings Database, All Atlantic Regions (2010, 2015).

**Figure 4.25. Distribution of fixed gear [(A) in 2010 and (B) 2015] and mobile gear [(C) in 2010 and (D) in 2015] commercial harvest locations, all species.**

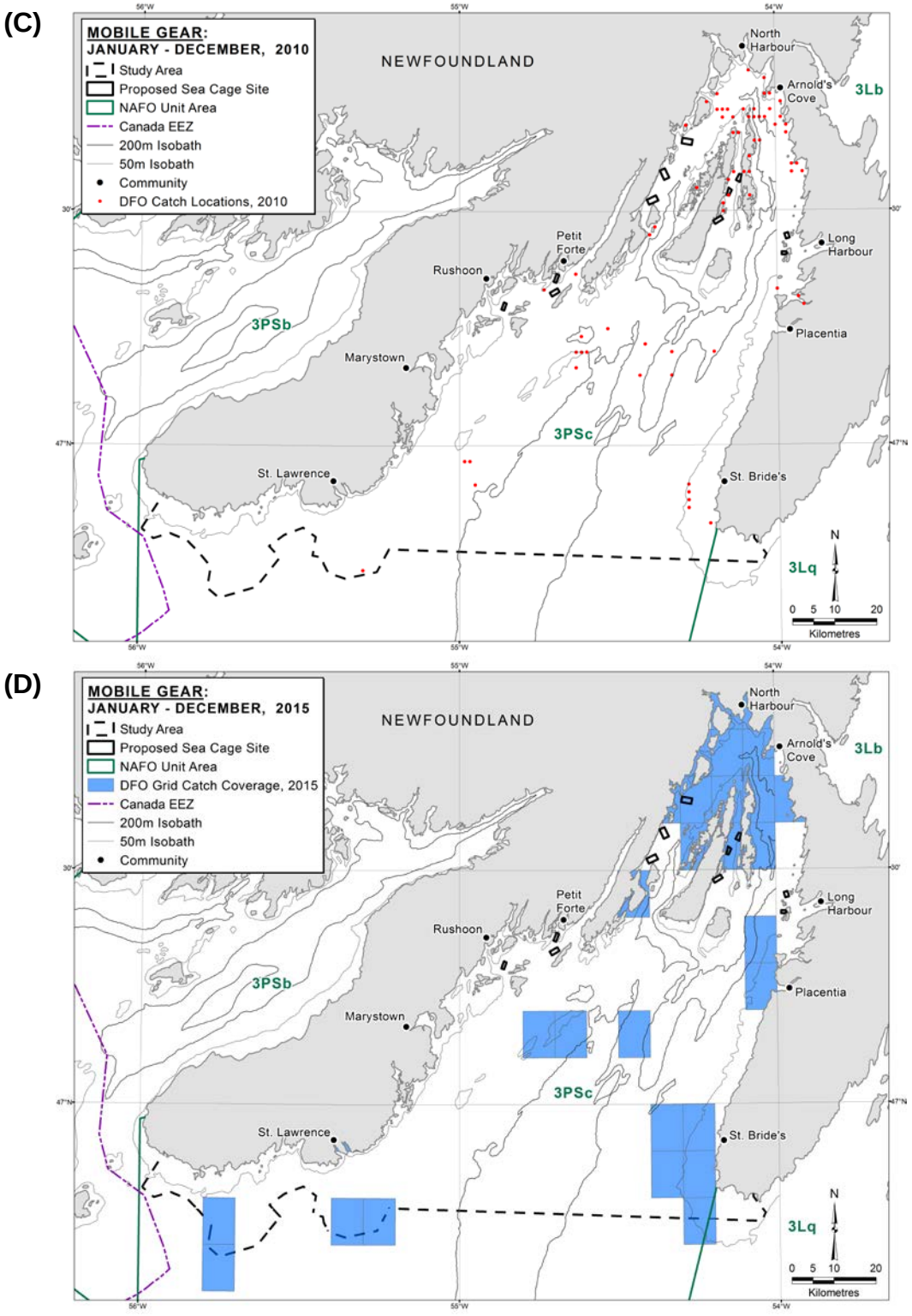
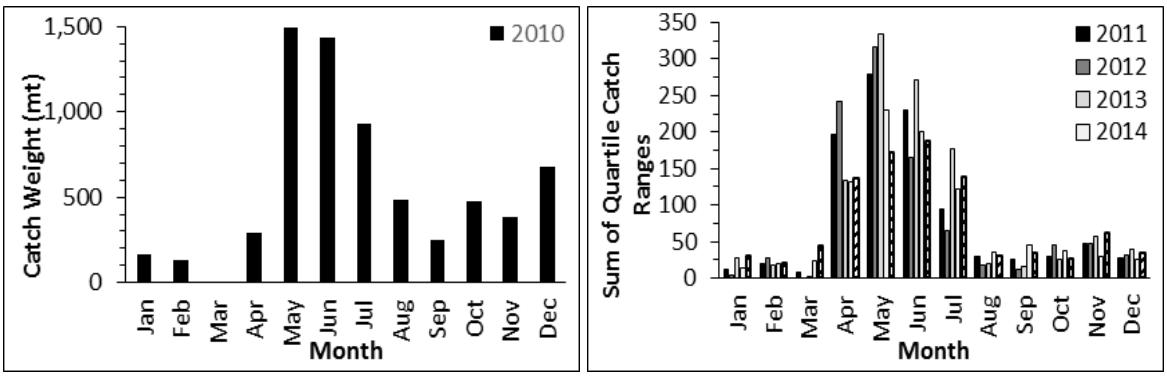



**Figure 4.25 (Continued). Distribution of fixed gear [(A) in 2010 and (B) 2015] and mobile gear [(C) in 2010 and (D) in 2015] commercial harvest locations, all species.**




Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

[a] Georeferenced (latitude/longitude) data were not available within the DFO 2010 database for all or virtually all of the recorded harvest for Atlantic haddock, pollock, redfish, monkfish, Atlantic halibut, Greenland halibut, winter flounder, yellowtail flounder, witch flounder, skates, white hake, lobster, Atlantic rock crab, whelk, lumpfish roe, mackerel, porbeagle shark, sea cucumber and sturgeon; and for ~25–50% of records for Atlantic cod, snow crab, American plaice and mackerel. Therefore, catch data for 2010 are presented for NAFO UA 3PSc, which includes the Study Area and a relatively small area immediately south of the Study Area (see Figure 4.16).

**Figure 4.26. Total monthly catch weight during 2010 (left) and total monthly sum of catch weight quartile codes, 2011–2015 (right) (all species within the Study Area[a]).**

*Principal Species: Atlantic Cod and Snow Crab*

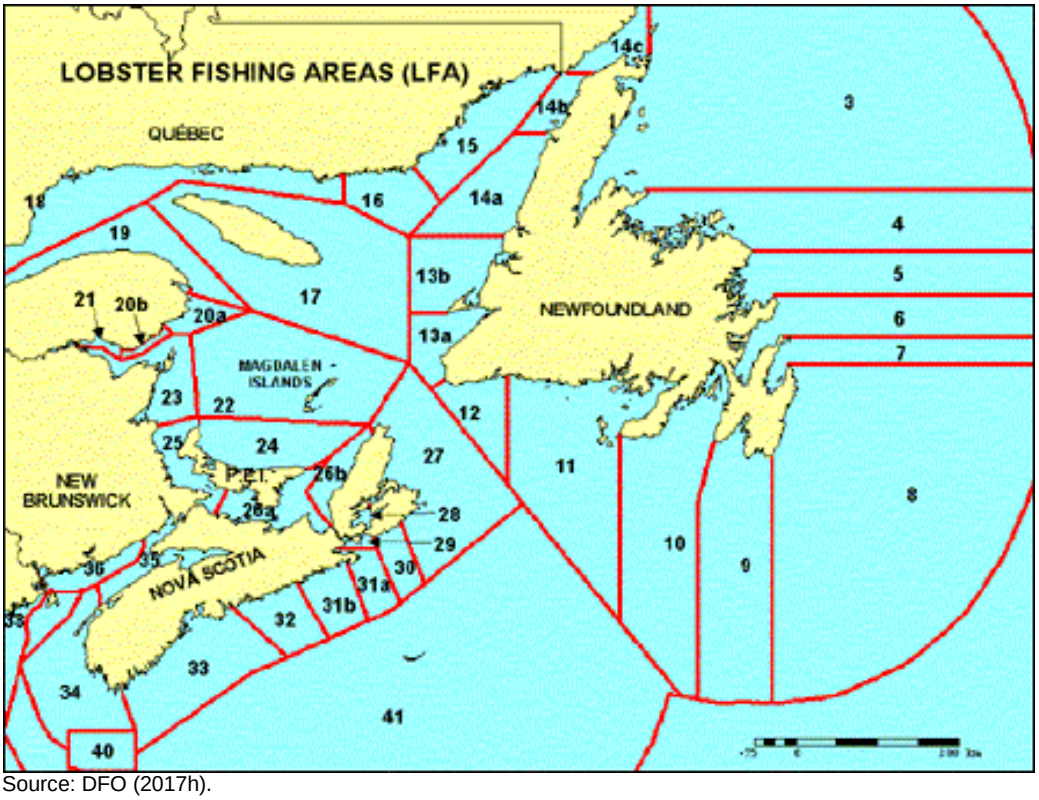
Atlantic cod catches comprised ~40% of the total catch weight and 27% of the total catch value within NAFO UA 3PSc in 2010 (see Table 4.17), and ~25% of the total quartile catch code counts in the Study Area in 2015 (see Table 4.22). Atlantic cod catches in the Study Area increased during 2012–2014, and decreased slightly in 2015 (Figure 4.28). Atlantic cod were primarily harvested during June and July in NAFO UA 3PSc in 2010 and during the summer and fall in 2011–2015 (Figure 4.29). After a DFO-advised delay in opening, the directed cod fishery for inshore and mid-shore fixed gear fleets in NAFO Div. 3Ps opened on 23 May 2017, followed by the >100' mobile gear fleet on 11 November 2017 (DFO 2017g). Based on the previous season's harvest and the management season for this species (Table 4.25), the 3Ps directed cod fishery will likely close by March 2018. The georeferenced harvest locations for Atlantic cod in the Study Area during 2010 and 6'x6' grid cell locations during 2015 are shown in Figure 4.30. Figure 4.19 indicates Atlantic cod harvesting locations based on DFO's qualitative CCRI data. Atlantic cod were harvested throughout Placentia Bay during 2010 and 2015, typically within ~20 km of shore in water depths <200 m. The same general harvest locations were indicated by the CCRI data (DFO 2008). Two Atlantic cod harvest locations occurred adjacent to the Long Island proposed sea cage site in 2010. Otherwise, 2010 Atlantic cod catches occurred in the vicinity of the proposed sea cage sites within the Rushoon, Merasheen and Long Harbour BMAs. No Atlantic cod catch locations were reported near the proposed sea cage sites within the Red Island BMA during 2010. During 2015, Atlantic cod harvest grid cells overlapped with the Long Island, Gallows Harbour, Ship Island, Brine Islands and Iona Islands proposed sea cage sites.

**Table 4.25. Management harvest seasons for species in commercial fisheries in the Placentia Bay region. Note that seasons may close at any time if the season's Total Allowable Catch (TAC) has either been reached or nearly reached.**

| Species | Management Area | Management Harvest Season |
|---|---|---|
| Groundfish<br>• Atlantic Cod<br>• American Plaice<br>• Witch Flounder<br>• Redfish (Unit II)<br>• Skates | 3Ps | • Atlantic Cod: April-March (closure ~April–May to protect spawning aggregations)<br>• American Plaice: under moratorium since 1993 (caught as bycatch)<br>• Witch Flounder: April–March<br>• Redfish (Unit II): April–March<br>• Skates: [likely] April–March |
| Snow Crab | 3Ps | April–July/August (closure August–September to protect soft shell crabs) |
| Lobster | Lobster Fishing Area 10 (Placentia Bay) | May–July |
| Sea Scallop | Scallop Fishing Area 10 (Placentia Bay), north of 47ºN | January–December |
| Iceland Scallop | 3Ps | January–December |
| Whelk | 3Ps | March–December |
| Atlantic Herring | Herring Fishing Area 10 (Placentia Bay) | January–December |
| Capelin | 3Ps | Determined annually based on industry recommendations to DFO; varies by area and fleet; season remains open provided there are commercial quantities of capelin available and quota remaining |
| Mackerel | 3Ps | August–December |
| Bluefin Tuna | 3P | July–November |
| Lumpfish | 3Ps | May–June/July |
| Redfish | Unit II, 3Ps | August–April |
| Winter Flounder | 3Ps | June–August |
| Greenland Halibut | 3Ps | May–March |
| Atlantic Halibut | 3Ps | Direct fishery not permitted; caught as bycatch; occasional retention temporarily permitted |
| Squid | 3Ps | July–December |
| Sea Cucumber | 3Ps | June–December |

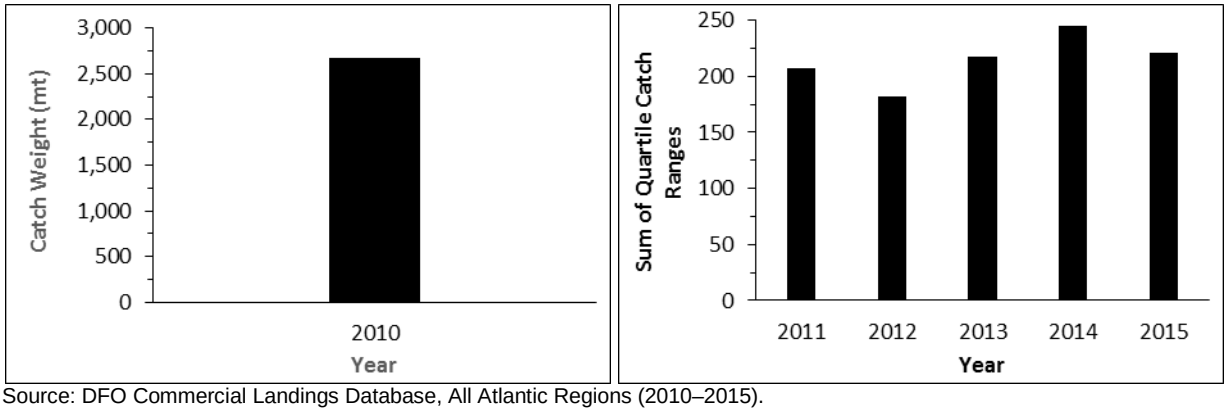
Sources: DFO (2014, 2016a, 2017e,f,g, 2018b); Rideout et al. (2017).

The Atlantic cod stock in NAFO Div. 3PS is managed by NAFO, although the distribution of 3Ps cod does not conform well to management boundaries and is considered a complex mixture of inshore and offshore sub-components, with seasonal migration between them (DFO 2018c). Total landings for the 2015–2016 management season (i.e., April–March) were 6,427 mt in 3Ps, 48% of the TAC (Rideout et al. 2017). The TAC for Atlantic cod in 3Ps for 2017–2018 is 6,500 mt, a decrease from 13,490 mt for 2015–2016 (DFO 2017e). The 2017–2018 TAC allots 1,505 mt and 571 mt for the fixed gear <35' and 35–64' fleets, respectively, in Placentia Bay (DFO 2018e). As of 15 February 2018, both Placentia Bay TACs have been exceeded for the season, with 2,172 mt and 875 mt harvested by the <35' and 35–64' fleets, respectively (DFO 2018e). If the current high mortality levels within Div. 3Ps persist, the biomass of the stock is likely to decline sharply in the coming years (Rideout et al. 2017). In addition to seasonal closures to protect the cod stock, bycatch restrictions are in place and it is mandatory for fish harvesters to submit their completed logbooks to DFO for all commercial groundfish (DFO 2018d).



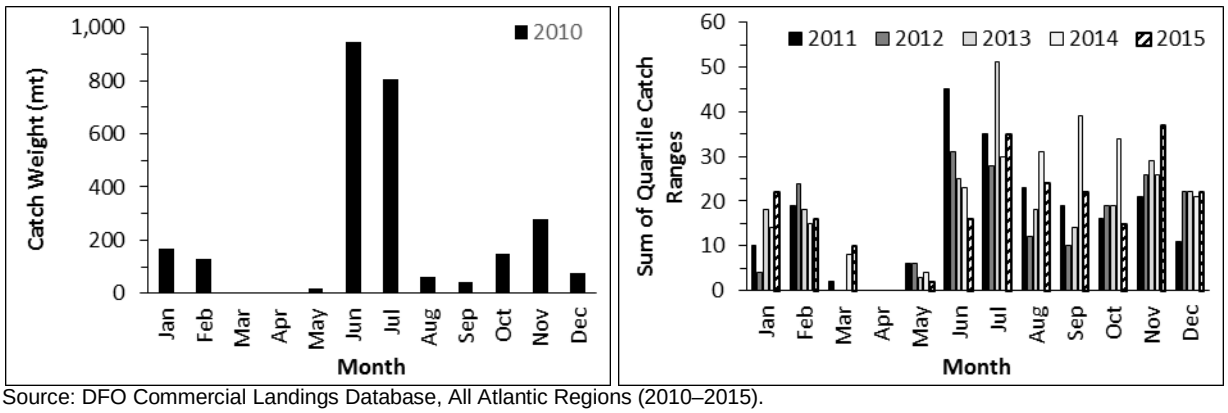

Source: DFO (2017h).

**Figure 4.27. DFO Lobster Fishing Areas (LFAs).**




Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.28. Total catch weight, 2010 (left), and annual total sum of catch weight quartile codes, 2011–2015 (right) for Atlantic cod within the Study Area (within NAFO UA 3PSc for 2010).**



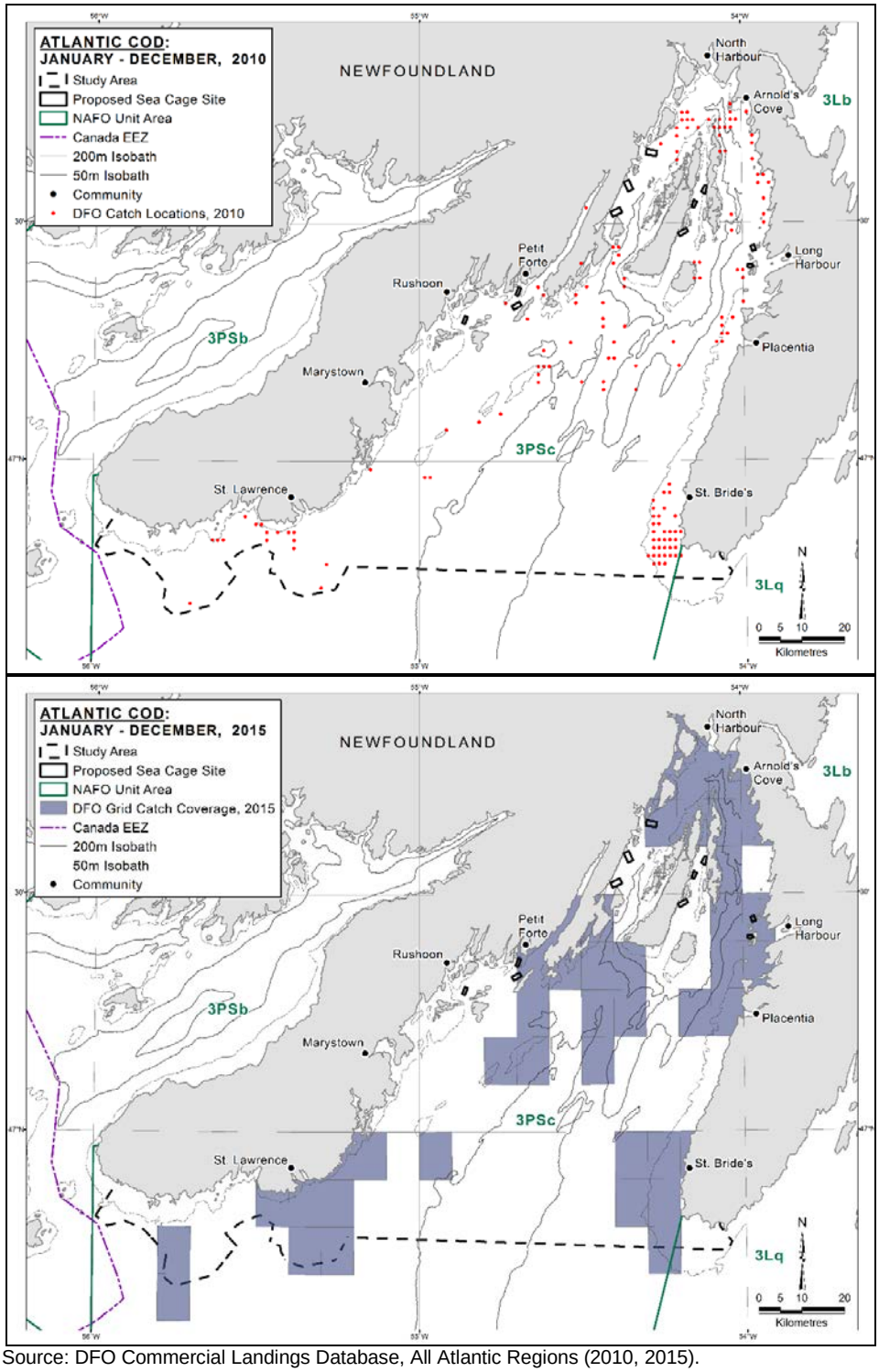

Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.29. Total monthly catch weight, 2010 (left), and monthly total sum of catch weight quartile codes, 2011–2015 (right) for Atlantic cod within the Study Area (within NAFO UA 3PSc for 2010).**

Snow crab harvests comprised ~28% and 58% of the 2010 total catch weight and value, respectively, in Div. 3PSc (within which the Study Area occurs) (see Table 4.17), and ~61% of the total quartile catch code counts in the Study Area in 2015 (see Table 4.22). Snow crab harvests in the Study Area increased during 2011–2013, but they have decreased each year since then (Figure 4.31). The majority of snow crab were harvested in May during 2010–2015 (Figure 4.32). Snow crab were harvested throughout the Placentia Bay area during 2010 and 2015, typically in water depths >50 m (Figures 4.19 and 4.33). While two snow crab harvest locations occurred within the Darby Harbour proposed sea cage site in 2010, other 2010 snow crab catches occurred southeast of the Valen Island and Darby Harbour proposed sea cage sites, and in the vicinity of the proposed sea cage sites within the Rushoon and Long Harbour BMAs. Snow crab grid cell harvest locations overlapped with all of the proposed sea cage sites during 2015.

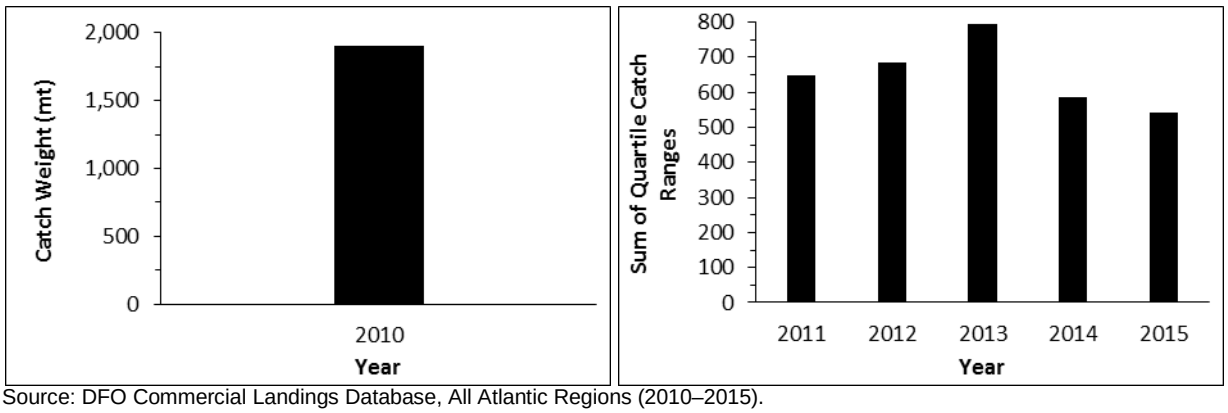
The stock status of Newfoundland and Labrador snow crab is assessed annually within each NAFO Div. (DFO 2017i). The TAC for snow crab for 2017–2018 in Placentia Bay (north of 46º30'N) is 560 mt, a decrease of 50% from the previous year (DFO 2017e). This TAC is divided evenly for harvesters north of 46º30'N and those north of 46º30'N outside of 12 miles. During the 2017 season, 74% (206 mt) and 58% (163 mt) of the TAC portions were harvested in these two areas, respectively, before the fishery closed on 22 June 2017 (DFO 2018e). Snow crab landings within Div. 3Ps declined from a recent peak of 6,700 mt in 2011 to a low of 1,200 mt in 2016 (DFO 2017i). Within Div. 3Ps, fishing effort has decreased by half since the historically-high effort during 2014, with only 40–60% of the TAC taken during 2015 and 2016 (Mullowney et al. 2018). Since 2009, catch per unit effort (CPUE) steadily declined in 3Ps to a record low in 2016, reflecting declines in exploitable biomass and recruitment in recent years (DFO 2017i). Overall, the snow crab fishery in 3Ps performed poorly in 2016, with declines in CPUE within Placentia Bay from ~15–16 kg/trap in 2009/2010 to 3 kg/trap in 2016 (Mullowney et al. 2018). The sharp reduction in CPUE and abundance of legal-sized crab in 3Ps population distributions during recent years suggests that the stock is heavily exploited and/or severely depleted (Mullowney et al. 2018). Considering that discards (i.e., of sub-legal-sized crabs) comprised half of the 3Ps snow crab catch in 2016, the stock's reproductive capacity may be impaired if fishing continues under elevated mortality levels for sub-legal-sized crab (DFO 2017i). The minimum legal size for retention in Newfoundland and Labrador is a 95-mm carapace width, which excludes females and a large proportion of adult males from the fishery in order to promote the protection of the stock's reproductive capacity (DFO 2017i). Other management measures include early and shortened fishing seasons, mandatory sorting of sub-legal-sized crab on deck, improved soft-shell protocols with effective monitoring, at-sea

observer coverage, and quota adjustments in areas that show a flux in population demographics (DFO 2018d).



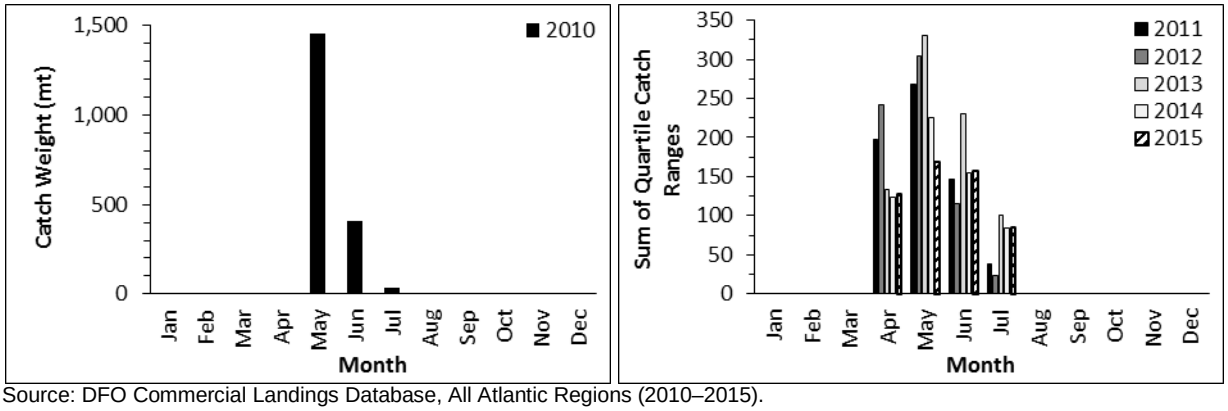

Source: DFO Commercial Landings Database, All Atlantic Regions (2010, 2015).

**Figure 4.30. Distribution of commercial harvest locations for Atlantic cod in the Study Area, 2010 (top) and 2015 (bottom).**




Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.31. Total catch weight, 2010 (left), and annual total sum of catch weight quartile codes, 2011–2015 (right) for snow crab within the Study Area (within NAFO UA 3PSc for 2010).**



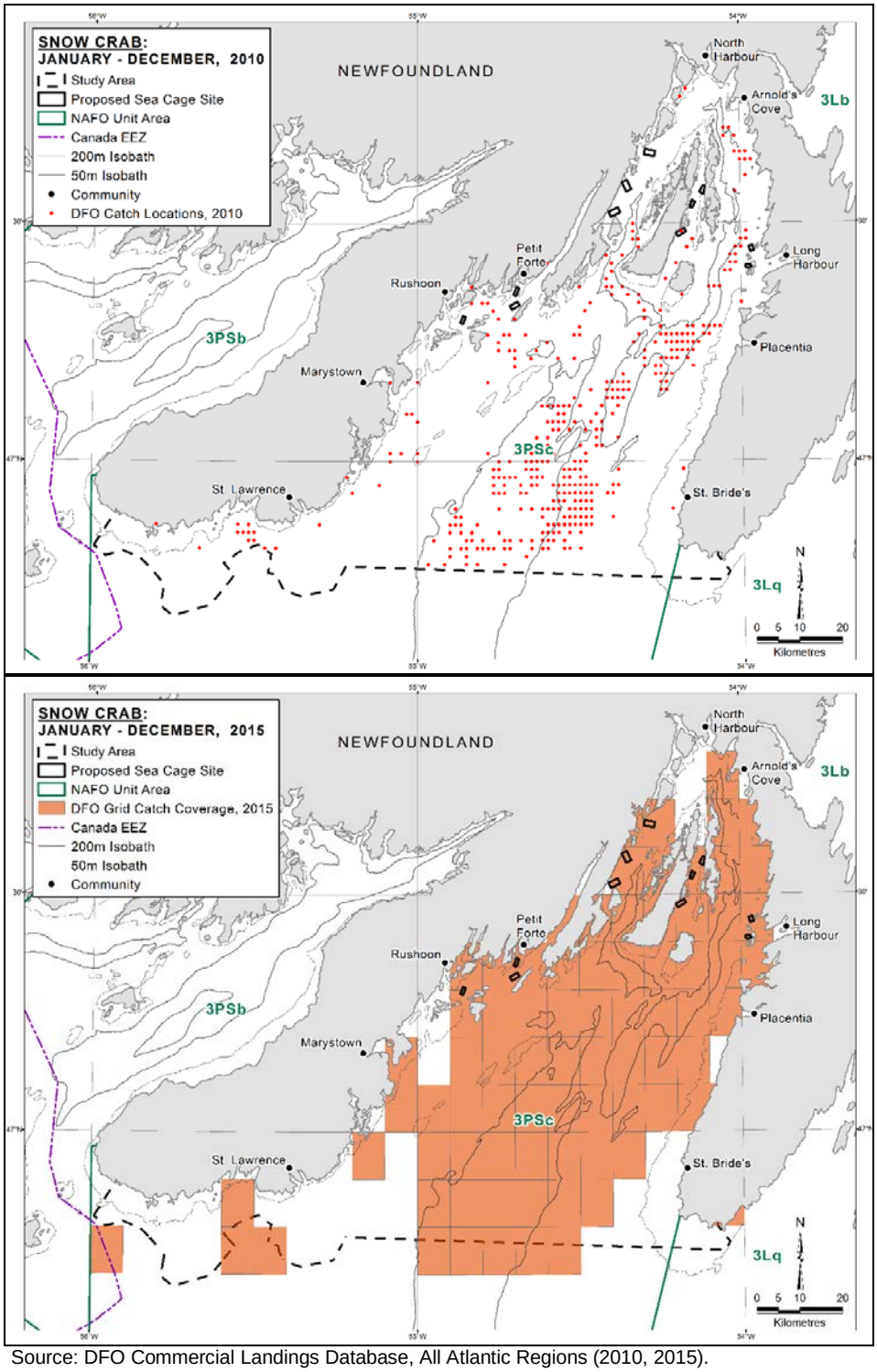

Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.32. Total monthly catch weight, 2010 (left), and monthly total sum of catch weight quartile codes, 2011–2015 (right) for snow crab within the Study Area (within NAFO UA 3PSc for 2010).**

*Other Notable Species: American Lobster, Sea Scallop, American Plaice and Atlantic Herring*

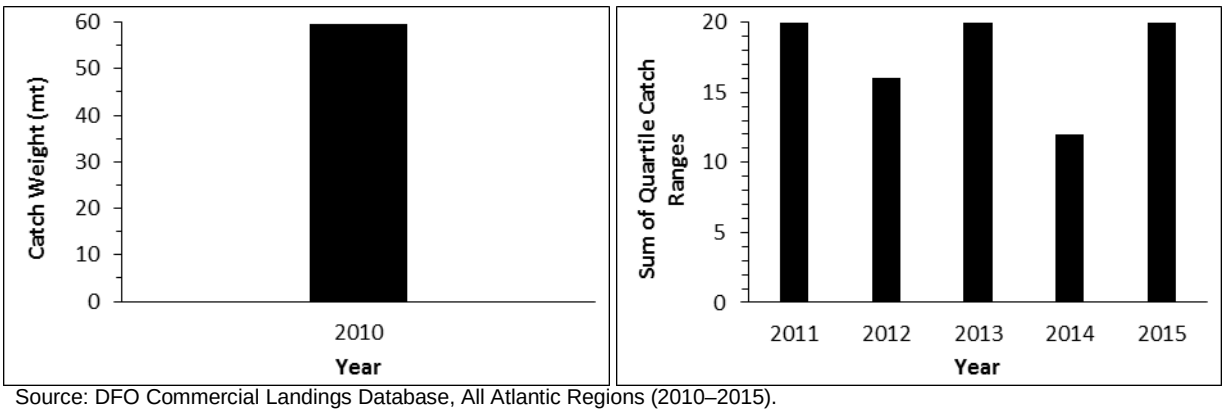
During 2010, the lobster fishery comprised ~1% and 4% of the 3PSc commercial harvest catch weight and value, respectively (see Table 4.17). Lobster harvests were variable within 3PSc during 2011–2015 (Figure 4.34). Most lobster were harvested during June (Figure 4.35). In 2017, the lobster fishery in LFA 10 was open for 10 weeks (1 May–9 July) (DFO 2017d). The fishery is managed by DFO through annual fisheries management decisions (DFO 2017e), and participants are restricted to fishing within the LFA in which they reside or have historically fished (Vale 2008). Traps are set nearshore, generally at depths <20 m (see Figure 4.19), and the fishery is prosecuted using small open boats (DFO 2016b). Throughout Newfoundland, trap limits vary from 100–300 per licenced fisher, depending on the LFA (DFO 2016b). The minimum carapace length to buy, sell or possess lobster for all LFAs in Newfoundland and Labrador is 82.5 mm (DFO 2017j). Other management measures to sustain the lobster resource include a voluntary v-notching program for ovigerous (egg-bearing) females (it is prohibited to harvest ovigerous females or retain v-notched females) (Coughlan et al. 2015), mandatory logbooks, closed areas for conservation, trap

limits, and established season duration (DFO 2017e). Traps must possess vents which allow undersized lobsters to escape (DFO 2016b).



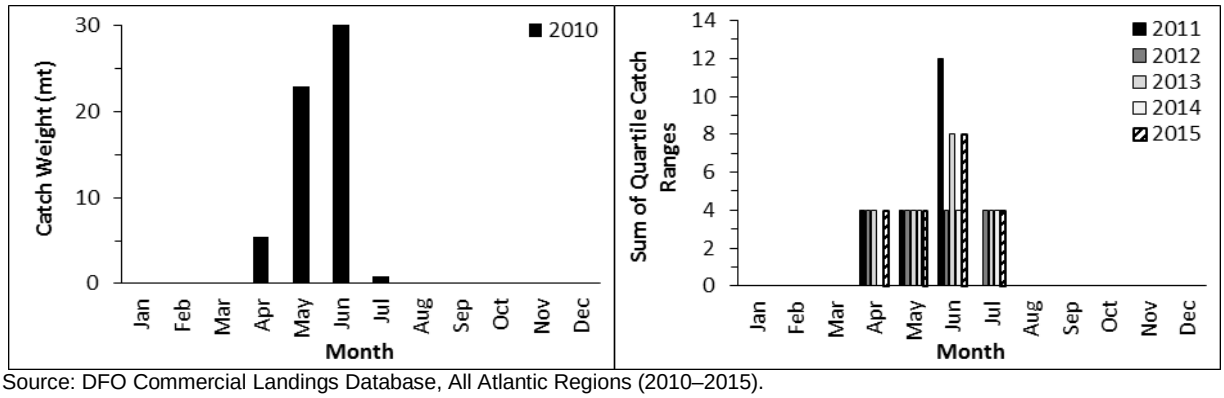

Source: DFO Commercial Landings Database, All Atlantic Regions (2010, 2015).

**Figure 4.33. Distribution of commercial harvest locations for snow crab in the Study Area, 2010 (top) and 2015 (bottom).**




Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.34. Total catch weight, 2010 (left), and annual total sum of catch weight quartile codes, 2011–2015 (right) for lobster within the Study Area* (*within NAFO UA 3PSc; lobster catches are not georeferenced or designated within 6'x6' grid cells).**

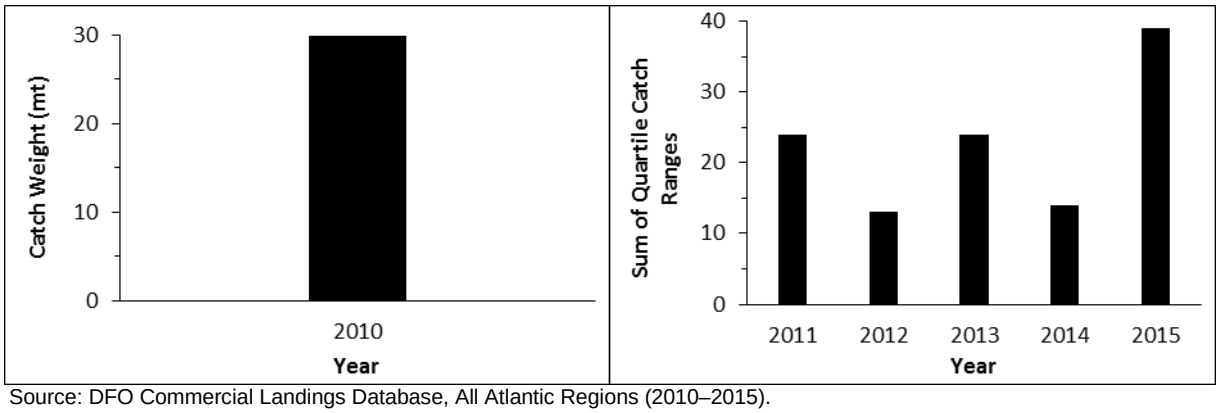



Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.35. Total monthly catch weight, 2010 (left), and monthly total sum of catch weight quartile codes, 2011–2015 (right) for lobster within the Study Area* (*within NAFO UA 3PSc; lobster catches are not georeferenced or designated within 6'x6' grid cells).**

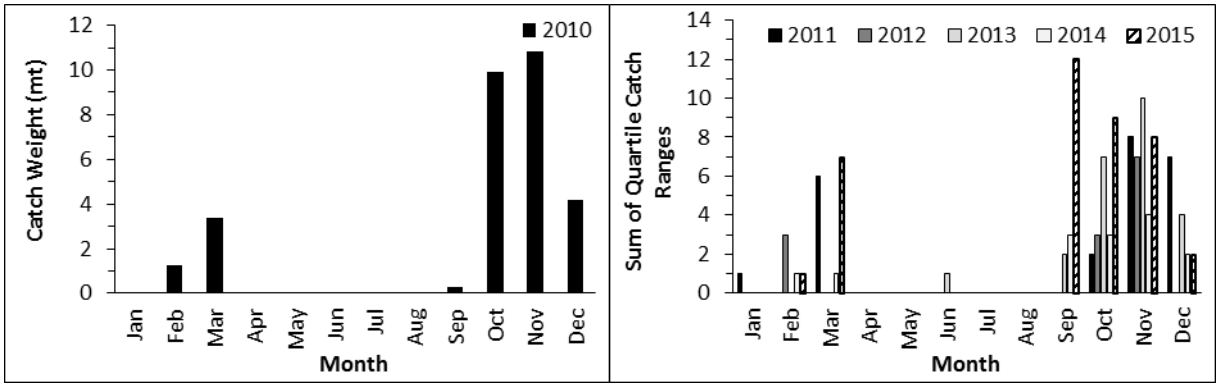
Sea scallops accounted for ~0.4% and 1% of the 2010 3PSc commercial harvest weight and value, respectively (see Table 4.17), and ~5% of the total quartile code counts in the Study Area during 2015 (see Table 4.22). During 2011–2015, sea scallop harvests were variable, with the largest harvest occurring in 2015 (Figure 4.36). Sea scallops are primarily harvested during the fall in the Study Area, followed by a late-winter harvest (March) (Figure 4.37). The Placentia Bay 3Ps commercial scallop fishery in Scallop Fishing Area 10 (Figure 4.38) opened for all fish harvesters on 11 January 2018 (DFO 2018f). The georeferenced harvest locations for sea scallops in the Study Area during 2010 and 6'x6' grid cell locations during 2015 are shown in Figure 4.39. Sea scallops are harvested nearshore in northern Placentia Bay, in water depths <200 m. During 2010, one harvest location occurred within the Red Island proposed sea cage site. Harvest locations were otherwise <2 km of proposed sea cage sites within the Red Island BMA, and >3 km from the Merasheen BMA proposed sea cage sites. The 2010 harvest locations closest to the Long Harbour BMA proposed sea cage sites were in the vicinity of the town of Placentia. No harvest sites were located near the Rushoon BMA proposed sea cage sites during 2010. During 2015, sea scallop grid cell harvest locations overlapped with the Ship Island, Butler Island and Red Island proposed sea cage sites. The TAC for 3Ps inshore sea scallop in effect from 2016–2019 is

872 mt round weight and 105 mt meats, an overall quota decrease of 22% from 2015 (DFO 2016a). A recent DFO requirement stipulates that only vessels registered in the Newfoundland and Labrador Region during the past 12 consecutive months are permitted to participate in the 3Ps inshore sea scallop fishery on the north bed and in the core area (DFO 2016a).



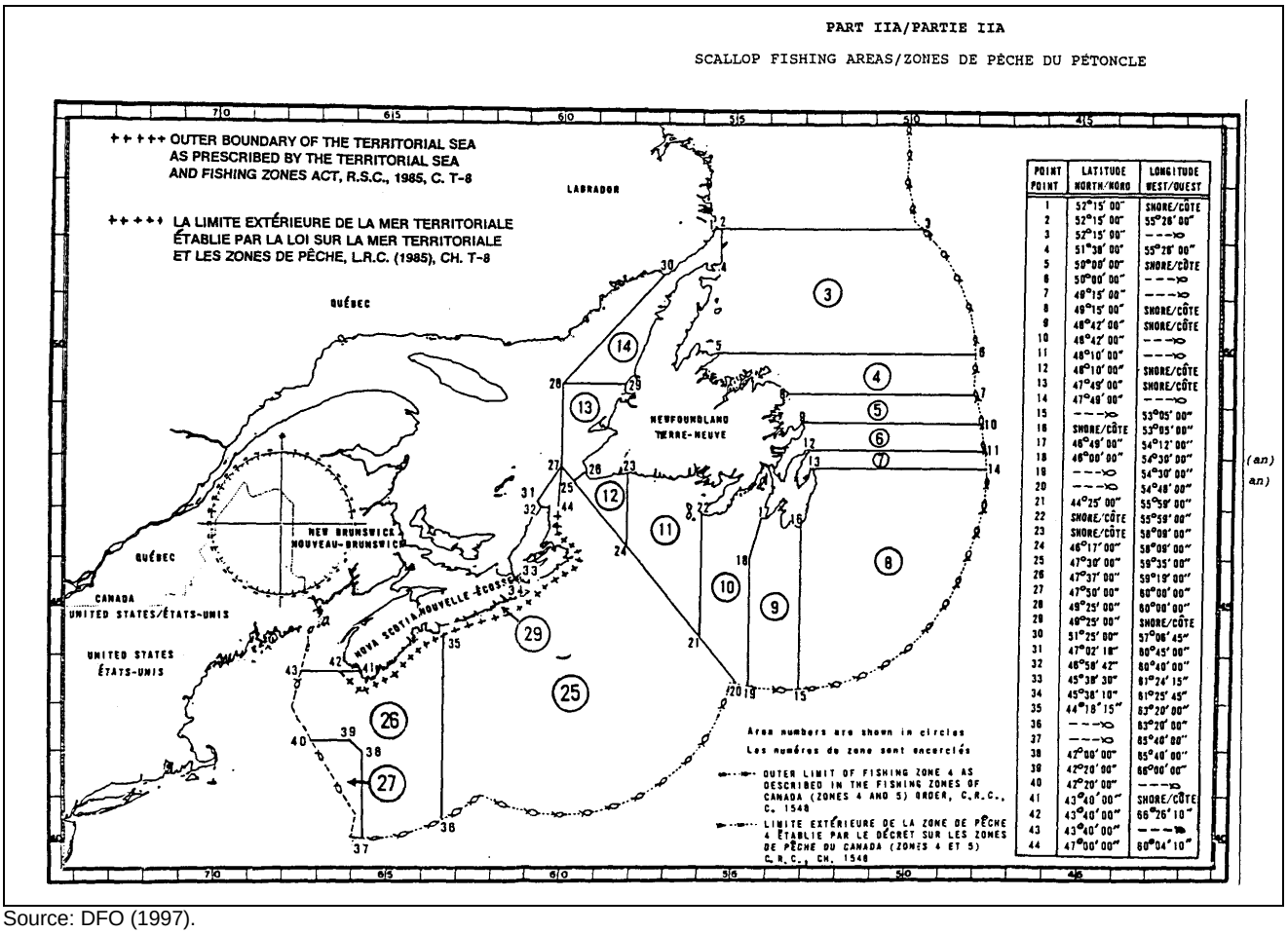

Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.36. Total catch weight, 2010 (left), and annual total sum of catch weight quartile codes, 2011–2015 (right) for sea scallops within the Study Area (within NAFO UA 3PSc for 2010).**



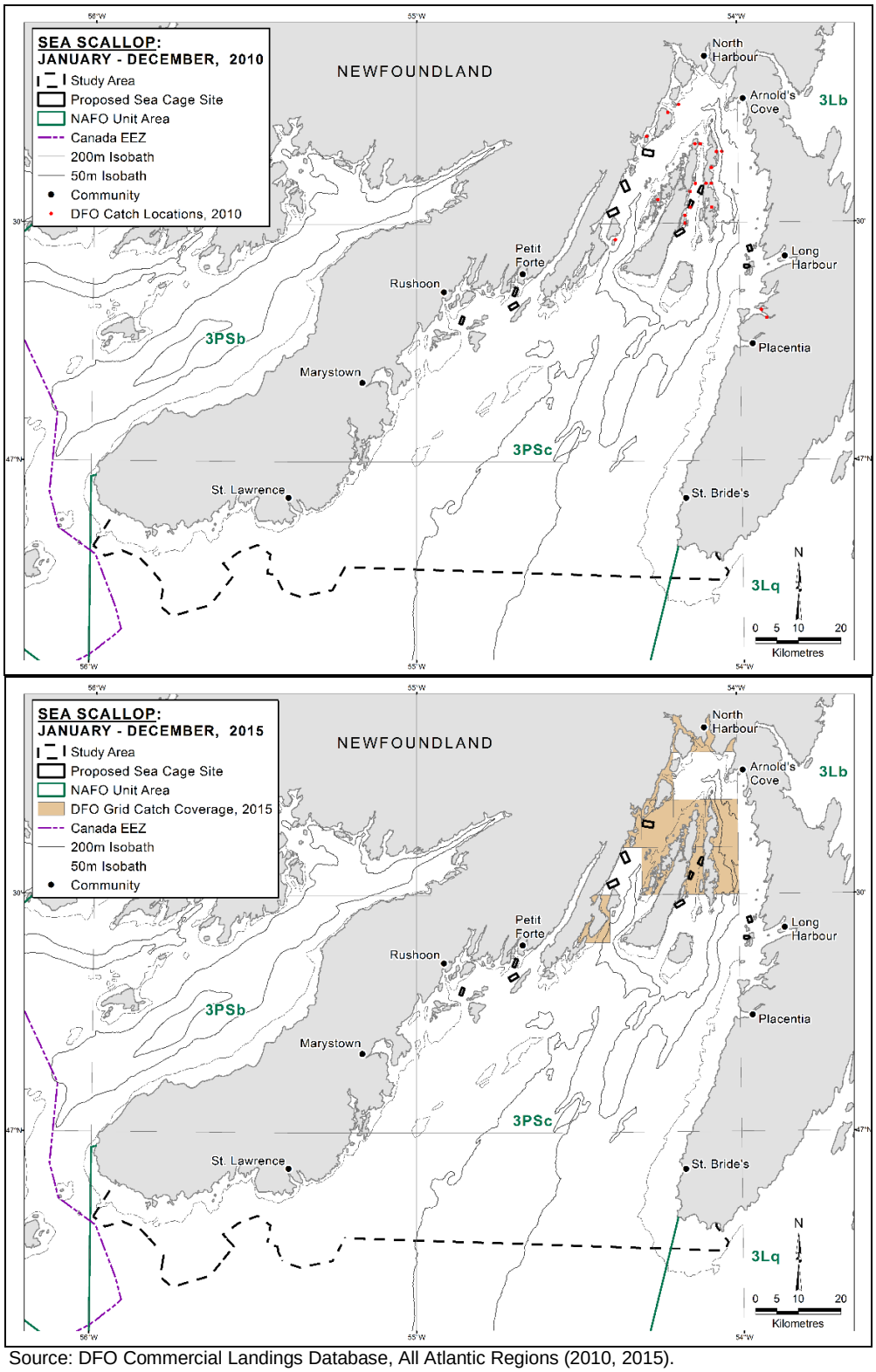

Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.37. Total monthly catch weight, 2010 (left), and monthly total sum of catch weight quartile codes, 2011–2015 (right) for sea scallops within the Study Area (within NAFO UA 3PSc for 2010).**




Source: DFO (1997).

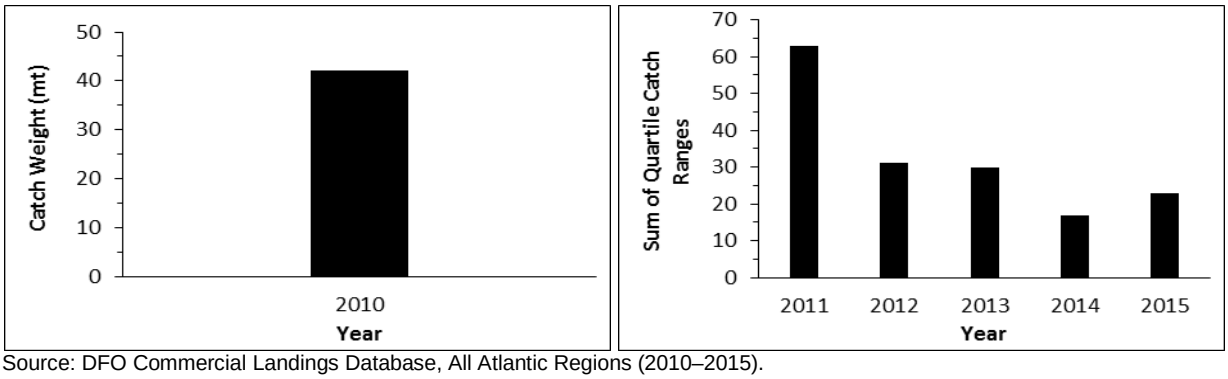
**Figure 4.38. DFO Scallop Fishing Areas.**




Source: DFO Commercial Landings Database, All Atlantic Regions (2010, 2015).

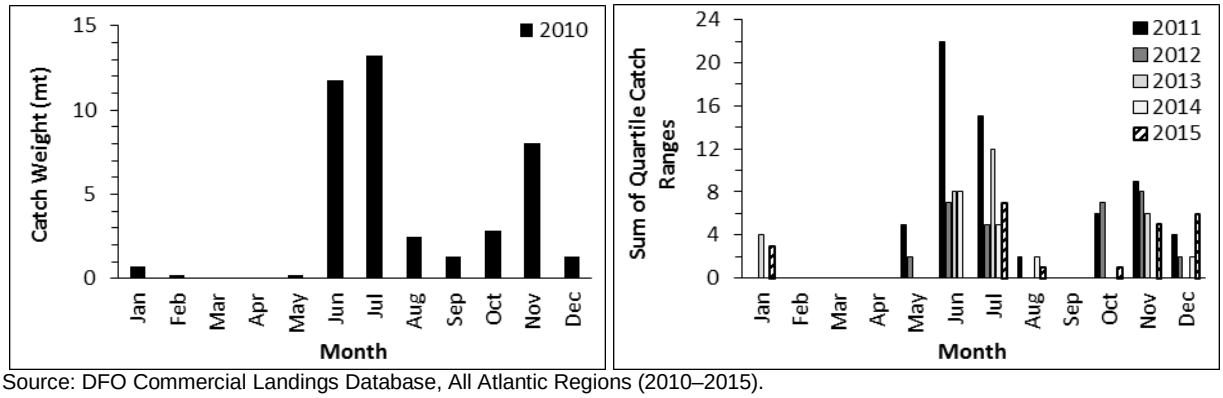
**Figure 4.39. Distribution of commercial harvest locations for sea scallops in the Study Area, 2010 (top) and 2015 (bottom).**

A moratorium on direct fishing for American plaice has been in place since September 1993 (Morgan et al. 2014). All American plaice captured during commercial fisheries in the Study Area are taken as bycatch. American plaice catches represented ~1% and 0.3% of the commercial catch weight and value, respectively, in 3PSc in 2010 (see Table 4.17), and ~2% of the total quartile code counts in the Study Area in 2015 (see Table 4.22). American plaice catches in the Study Area decreased by approximately 50% between 2011 and 2012, then remained relatively steady until another decrease in 2014, followed by a slight increase in 2015 (Figure 4.40). American plaice are caught primarily during June and July in the Study Area, with a small peak during late-fall (Figure 4.41). The majority of American plaice are taken as bycatch in the directed Atlantic cod and witch flounder fisheries (Morgan et al. 2014). American plaice were caught in water depths <200 m throughout Placentia Bay during 2010, coinciding with Atlantic cod harvest locations (see Figures 4.30 and 4.42). While no American plaice harvest locations were reported within any of the proposed sea cage sites during either 2010 or 2015, several catch locations were in the vicinity of the Ship Island and Valen Island proposed sea cage site of the Merasheen BMA. Forty-six and 50 mt of American plaice were taken in Div. 3Ps in 2016 and 2017, respectively, by vessels <65' operating fixed gear (DFO 2018e).



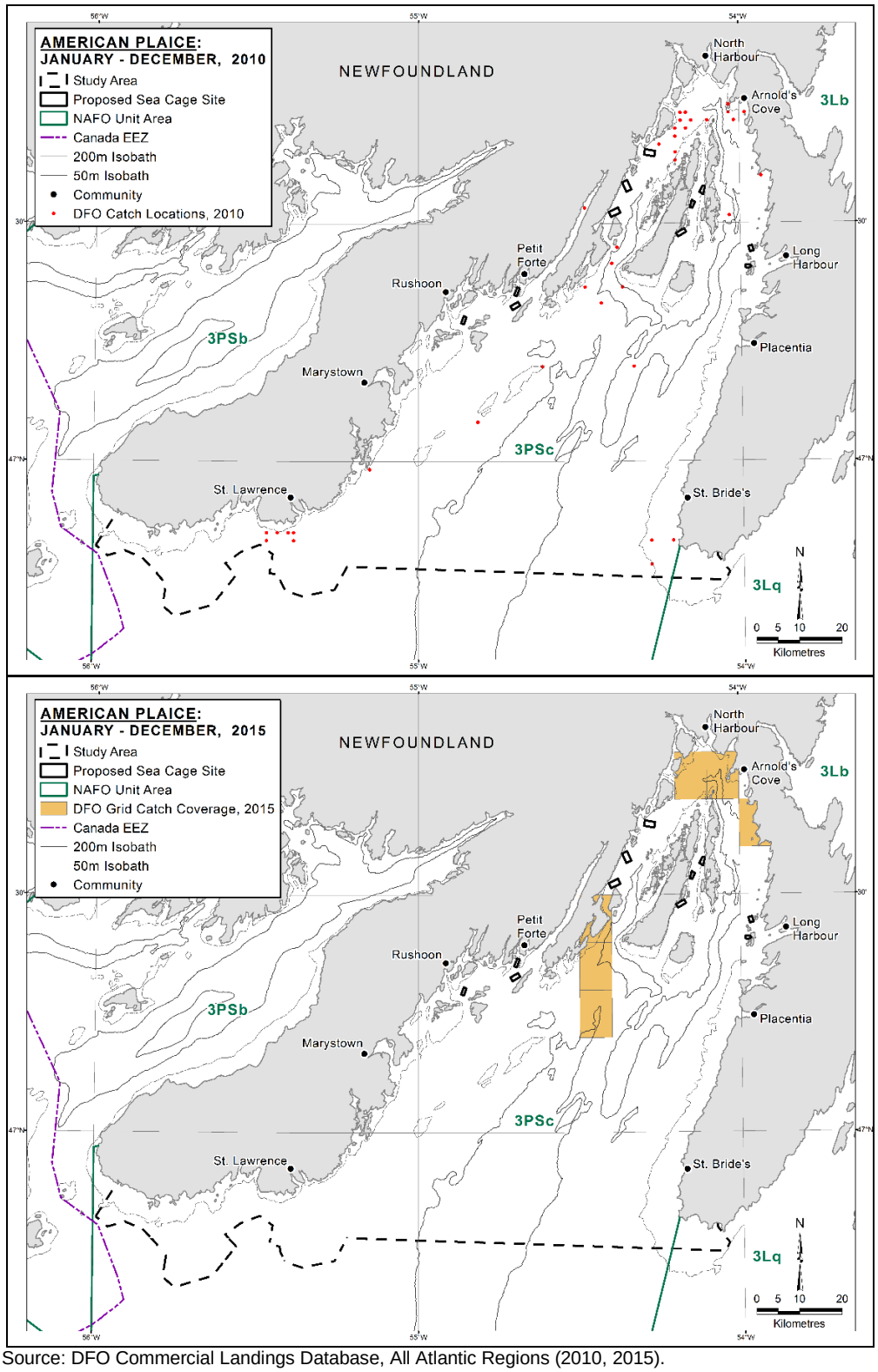

Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.40. Total catch weight, 2010 (left), and annual total sum of catch weight quartile codes, 2011–2015 (right) for America plaice within the Study Area (within NAFO UA 3PSc for 2010).**




Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

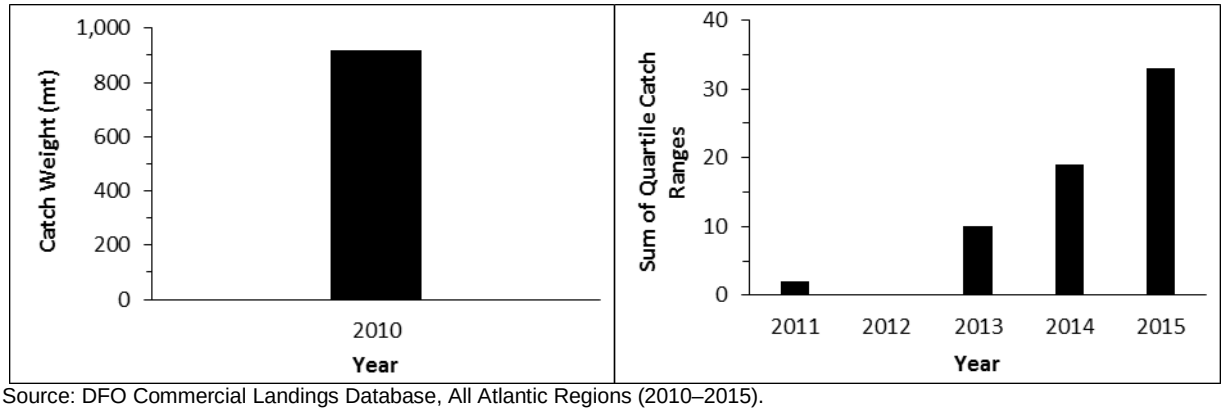
**Figure 4.41. Total monthly catch weight, 2010 (left), and monthly total sum of catch weight quartile codes, 2011–2015 (right) for American plaice within the Study Area (within NAFO UA 3PSc for 2010).**




Source: DFO Commercial Landings Database, All Atlantic Regions (2010, 2015).

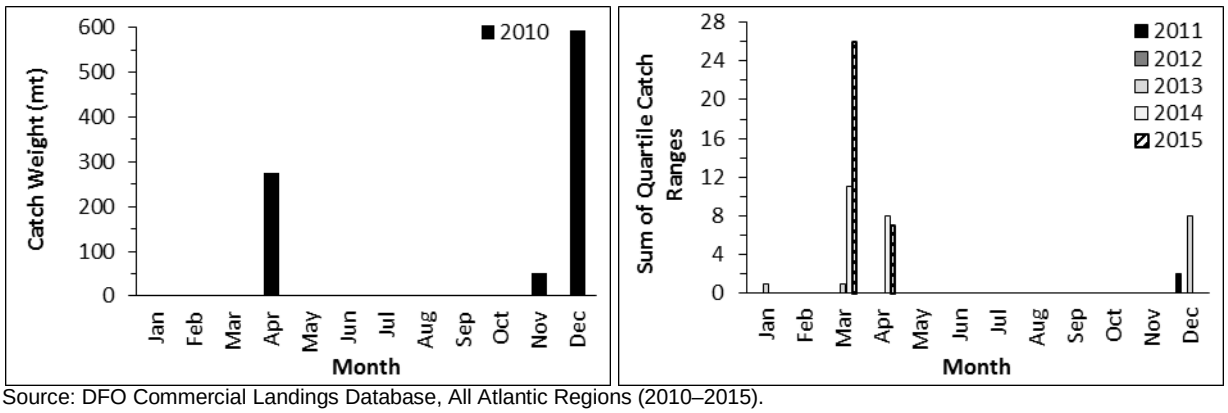
**Figure 4.42. Distribution of commercial harvest locations for American plaice in the Study Area, 2010 (top) and 2015 (bottom).**

Atlantic herring comprised ~14% and ~2% of the 3PSc 2010 commercial fishery catch weight and catch value, respectively (see Table 4.17), and ~2% of the total quartile code counts in the Study Area during 2015 (see Table 4.22). While there were only a few Atlantic herring harvests within the Study Area during 2011 and none during 2012, herring harvests have steadily increased since 2013 (Figure 4.43). Atlantic herring are only harvested during the spring and winter in the Study Area, with the majority of recent harvests occurring during March (Figure 4.44). The Atlantic herring fishery for mobile gear vessels >55' (16.76 m) in Placentia Bay (Herring Fishing Area 10; Figure 4.45) opened on 30 January 2018 (DFO 2018g). In the Study Area, Atlantic herring were mainly harvested nearshore in northern Placentia Bay during 2010, typically in water depths <100 m. Several harvesting locations near the mouth of Placentia Bay were also reported in 2010 (Figure 4.46). There were no harvest locations within the proposed sea cage sites in either 2010 or 2015. The nearest harvest locations were along the northern side of Bar Haven Island. The combined TAC for St. Mary's Bay and Placentia Bay is 2,100 mt for 2017–2018, unchanged from the previous year, and the minimum size limit for herring in 2017–2018 is 24.76 cm (DFO 2017e). Fixed gear fishers are only permitted to fish in their Fishing Area of residence, and mobile fishers living on the southeast coast of Newfoundland are permitted to fish in Herring Fishing Areas 9 and 10 (Cape Race to Point Crewe) (DFO 2017e). In an effort to minimize potential bycatch of salmon in the commercial herring fishery, it is prohibited for harvesters to utilize monofilament netting in herring trap net leaders and gillnets, or trap net leaders with a mesh size between two and seven inches (DFO 2017e). Measures have also been taken in the herring bait fishery to minimize salmon bycatch, including a requirement for bait nets to be set parallel to the nearest shore with the head ropes no less than one fathom below the surface, and no setting of bait nets during peak salmon run periods (in most areas) (DFO 2017e). All licenced herring fishers operating vessels ≥35' as well as those operating mobile gear vessels of all lengths are required to provide detailed logbooks of catch and fishing activity. As of 2017, it is mandatory for harvesters to return bait logbooks (DFO 2017e). At the request of DFO, purse seine herring licence holders will be required to carry an at-sea observer intermittently throughout the fishery, and to provide information on their activities specific to DFO's Science program requirements (DFO 2017e). The Atlantic herring fishery is subject to a Dockside Monitoring Program (DFO 2017e).



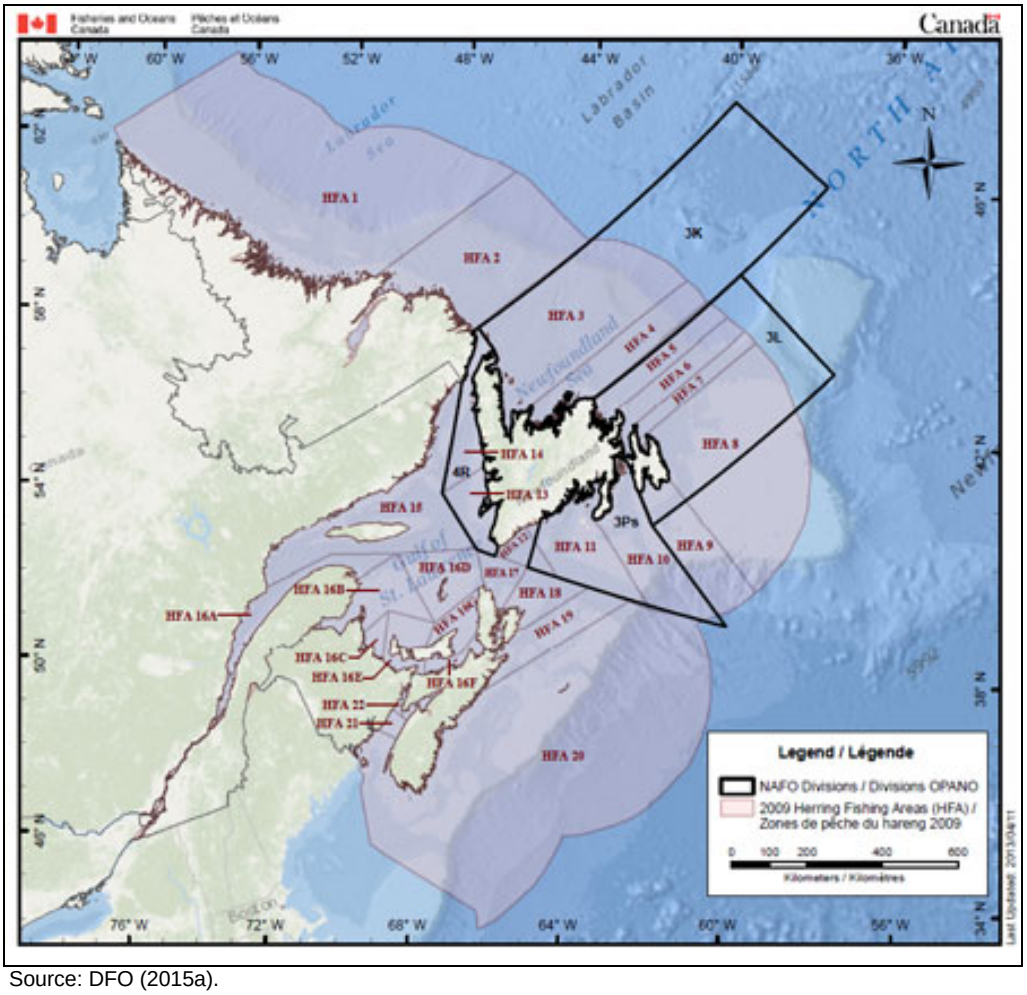

Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.43. Total catch weight, 2010 (left), and annual total sum of catch weight quartile codes, 2011–2015 (right) for Atlantic herring within the Study Area (within NAFO UA 3PSc for 2010).**



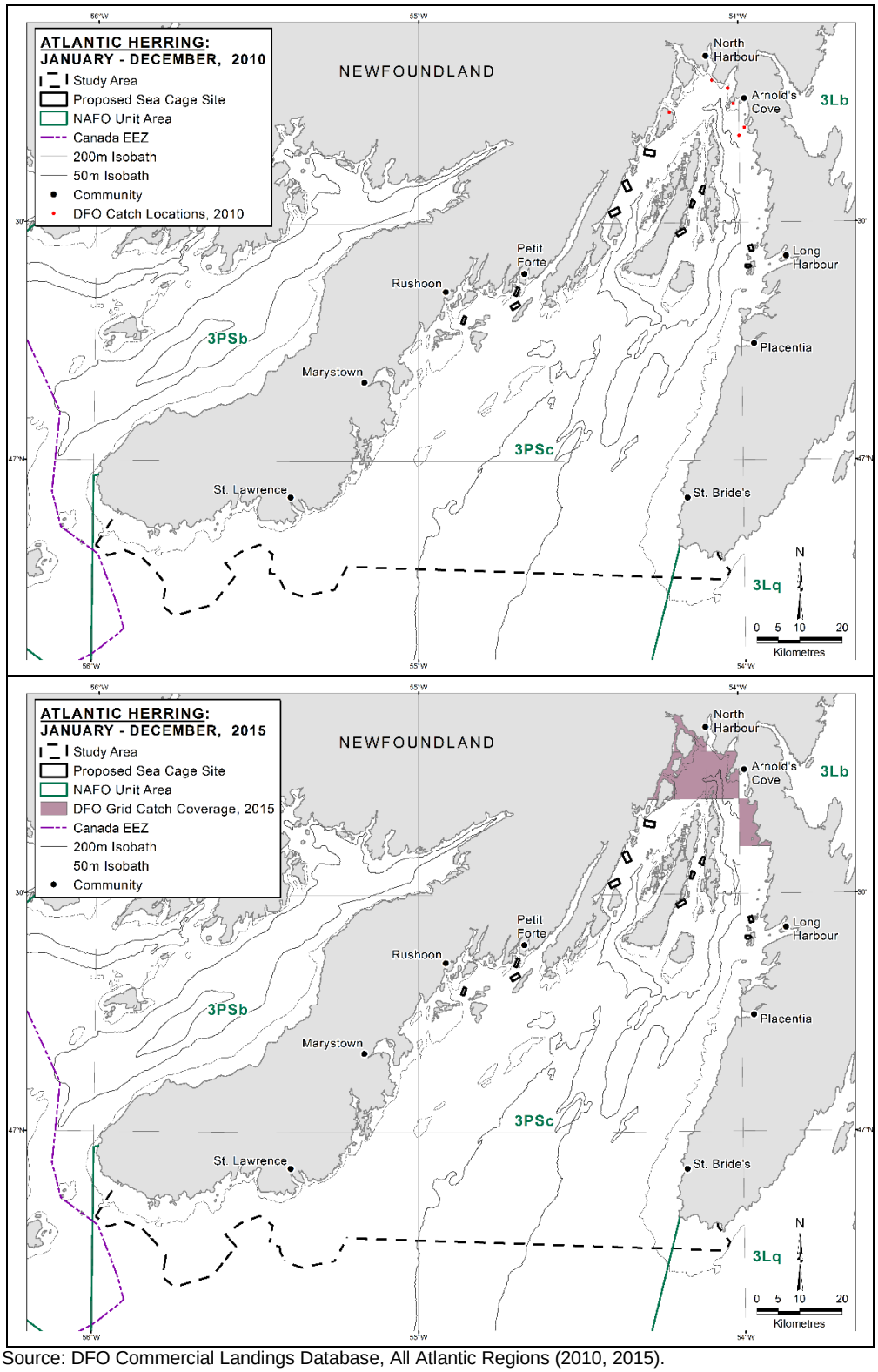

Source: DFO Commercial Landings Database, All Atlantic Regions (2010–2015).

**Figure 4.44. Total monthly catch weight, 2010 (left), and monthly total sum of catch weight quartile codes, 2011–2015 (right) for Atlantic herring within the Study Area (within NAFO UA 3PSc for 2010).**




Source: DFO (2015a).

**Figure 4.45. DFO Herring Fishing Areas (HFAs).**




Source: DFO Commercial Landings Database, All Atlantic Regions (2010, 2015).

**Figure 4.46. Distribution of commercial harvest locations for Atlantic herring in the Study Area, 2010 (top) and 2015 (bottom).**

*Licences, Vessels and Enterprises*

Under the system established by DFO in 1996, a "core" fishing enterprise is a commercial fishing enterprise which holds key species licences (Vale 2008). Generally, new core enterprises are not created but rather existing enterprises may be transferrable to a new eligible harvester (Vale 2008). In the event of a transfer, DFO requires that the enterprise go to a Level II professional fish harvester, certified by the Professional Fish Harvesters Certification Board (PFHCB) of Newfoundland and Labrador (Vale 2008). A "non-core" enterprise holds other and/or single species licences (Vale 2008). As of 17 April 2018, within the Placentia Bay region, 426 and 108 core and non-core enterprises (i.e., vessel registrations) were held by vessels ≤35' (≤10.7 m) and >35' (>10.7 m), respectively (Table 4.26). The majority of enterprises were held by harvesters with home ports of Parkers Cove, Baine Harbour, Rushoon, Oderin, Red Harbour, Jean de Baie, Little Bay, Fox Cove, Mortier, Port au Bras and Burin, and Southern Harbour (Table 4.26).

**Table 4.26. Core and non-core vessel registrations in Placentia Bay as of 17 April 2018, by home port and vessel size.**

| Home Port | Number of Vessel Registrations | | Total No. Vessels |
|---|---|---|---|
| | LOA ≤35' (≤10.7 m) | LOA >35' (>10.7 m) | |
| St. Bride's & Patrick's Cove* | 24 | 15 | **39** |
| Placentia (Incl. Southeast) | 12 | 6 | **18** |
| Dunville, Jerseyside, Freshwater, Freshwater, Fox Harbour & Ship Harbour* | 39 | 9 | **48** |
| Mt. Arlington Heights, Fair Haven & Little Harbour East* | 36 | 6 | **42** |
| Southern Harbour | 47 | 14 | **61** |
| Arnold's Cove, Come By Chance & North Harbour* | 29 | 7 | **36** |
| Garden Cove, Prowseton, Sand Harbour, Davis Cove, Bar Haven, Red Island, Merasheen & Isle Au Valen* | 32 | 10 | **42** |
| Little Paradise & Great Paradise* | 5 | 0 | **5** |
| South East Bight | 40 | 5 | **45** |
| Monkstown | 8 | 0 | **8** |
| Petit Forte | 28 | 9 | **37** |
| Boat Harbour (Incl. Brookside) | 7 | 0 | **7** |
| Parkers Cove, Baine Harbour, Rushoon, Oderin, Red Harbour, Jean de Baie, Little Bay, Fox Cove, Mortier, Port au Bras & Burin* | 56 | 11 | **67** |
| Little St. Lawrence, St. Lawrence & Lawn* | 24 | 10 | **34** |
| Lord's Cove, Point UA Gal, Lamaline & Point May* | 39 | 6 | **45** |
| **Total** | **426** | **108** | **534** |

Source: E. Careen, Senior Regional Aquaculture Management Officer, DFO, pers. comm. 23 April 2018. Data were derived from the Newfoundland and Labrador Fisheries Information Network (NLFIN).
LOA = Length overall; Incl. = Includes.
* Denotes homeports were grouped in accordance with the Privacy Rule of 5, whereby data are combined if there are <5 registered vessels in order to protect the privacy and identification of individual fishers.

Across all species, the total number of licences in the Placentia Bay area as of 17 April 2018 was 3,609 (Table 4.27). The majority of licences are for snow crab (586 licences), lobster (532) and bait (527), and the fewest are for eel (8) and sea urchin (7). The number of licences for commercial and recreational scallop harvests are roughly equivalent, at 179 and 171, respectively. In accordance with the most recent integrated fisheries management plan for snow crab (DFO 2010a), no new licences are available for this closed fishery beyond the total 813 licences allotted for Div. 3Ps during 2009, of which 713 and 100 were designated for the inshore and supplementary snow crab fisheries, respectively. The number of licences decreased over time with the implementation of enterprise combining in 2008 (DFO 2010a). Div. 3Ps harvesters currently hold a total of 597 snow crab licences (FFAW|Unifor 2017a).

**Table 4.27. Core, non-core and recreational licences in Placentia Bay as of 17 April 2018, by species.**

| Species | Number of Licences |
|---|---|
| Bait | 527 |
| Capelin | 82 |
| Eel | 8 |
| Groundfish | 144 |
| Herring | 266 |
| Lobster | 532 |
| Mackerel | 298 |
| Scallop (Commercial) | 179 |
| Scallop (Recreational) | 171 |
| Sea Cucumber | 35 |
| Sea Urchin | 7 |
| Seal (Commercial) | 13 |
| Seal (Personal Use) | 95 |
| Snow Crab | 586 |
| Squid | 328 |
| Tuna (Bluefin) | 17 |
| Whelk | 321 |
| **Total** | **3,609** |

Source: E. Careen, Senior Regional Aquaculture Management Officer, DFO, pers. comm. 23 April 2018. Data were derived from the Newfoundland and Labrador Fisheries Information Network (NLFIN).

The commercial fisheries in Placentia Bay are prosecuted using primarily small vessels (<45' [13.7 m]) (Table 4.28). During 2010 and 2015, no vessels >65' (19.8 m) were used during commercial fisheries within the Study Area. Including vessel crew members, there are currently about 1,500 harvesters in the NAFO Div. 3Ps region (FFAW|Unifor 2017a).

**Table 4.28. Commercial fisheries harvest catch weight within NAFO UA 3PSc in 2010 and commercial catch weights in the Study Area in 2015, by vessel class (2015 values indicate the frequency of catch weight quartile codes [i.e., 1–4] attributed to each vessel class).**

| Vessel Class | 2010 Catch Weight | | 2015 Catch Weight Quartile Code Counts[a] | | | | |
|---|---|---|---|---|---|---|---|
| | mt | % of Total | 1 | 2 | 3 | 4 | Total Counts[b] |
| 1–34.9' (0.3–10.6 m) | 3,889 | 58 | 137 | 87 | 12 | 1 | 237 |
| 35–44.9' (10.7–13.7 m) | 1,958 | 29 | 158 | 116 | 24 | 4 | 302 |
| 45–64.9' (13.7–19.8 m) | 869 | 13 | 5 | 19 | 7 | 3 | 34 |
| 65–99.9' (19.8–30.5 m) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100–124.9' (30.5–38.1 m) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ≥125' (≥38.1 m) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **6,716** | **1005** | **300** | **222** | **43** | **8** | **573** |

Source: DFO Commercial Landings Database, All Atlantic Regions (2010, 2015).

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2015 quartile ranges: 1 = 0 – 2,253 kg, 2 = 2,254 – 9,535 kg, 3 = 9,536 – 40,703 kg, 4 = ≥ 40,704 kg.

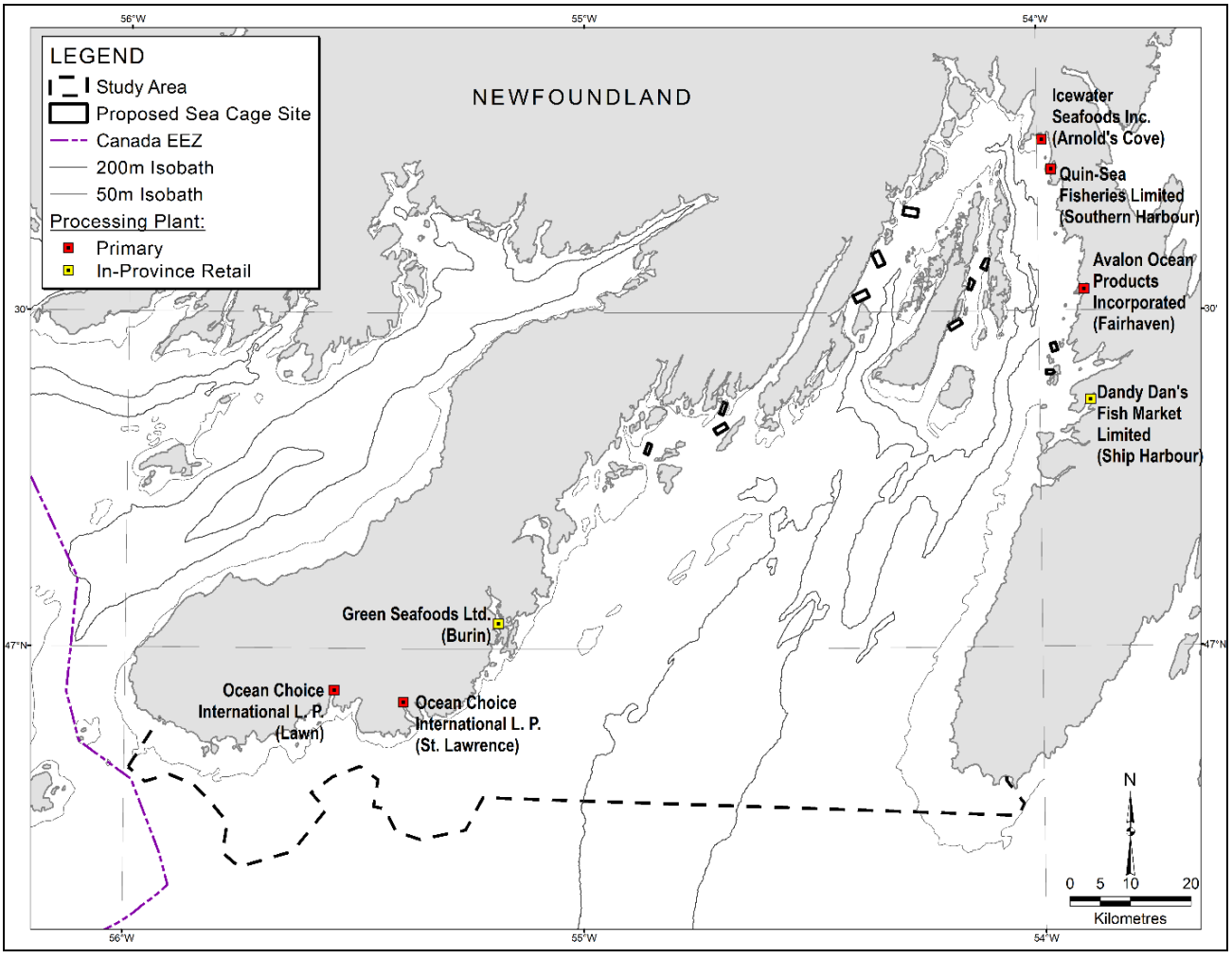
[b] Total counts of the number of catch records per vessel class.

*Processing*

The DFLR (formerly DFA) licenses fish processing operations, conducts market research, maintains an overview of current market conditions for major species, and supports the fish price negotiation process by providing marketing information to fishers and fish processor's representatives (DFO 2016c). The DFLR Fisheries Technology and New Opportunities Program "provides support for harvesting, processing and marketing initiatives, in order to diversify and increase the overall viability of the

provincial seafood industry" (DFO 2016c). The Program focuses on research and development into the harvesting and processing sectors, emphasising "more efficient use of traditional species, better use of under-used species and enhanced value-realization of all fisheries resources" (DFO 2016c). The Program will also underscore the recovery of raw material wastage and reduced discards of fishery by-products (DFO 2016c).

During 2016, there were 92 licenced fish processing plants in Newfoundland and Labrador, of which 73 held primary licences (for primary processing; e.g., cleaning, icing, cooking, canning, etc.), two held secondary licences (for secondary processing; e.g., adding ingredients other than water or salt, breading, battering, smoking, marinating, etc.), six were aquaculture licences, and 11 were in-province retail establishments (DFLR 2017a). There are currently seven licenced fish processors in Placentia Bay, of which five are primary licence holders and two are in-province retail establishments (NLSA 2018a; Figure 4.47). The nearest processors to the proposed sea cage sites are the Avalon Ocean Products Incorporated primary licenced plant in Fairhaven, and Dandy Dan's Fish Market Limited in-province retailer in Ship Harbour, both of which are within ~10 km of the proposed sea cage sites in the seasonal Long Harbour BMA.




Source: NLSA (2018a).

**Figure 4.47. Fish processing plants in Placentia Bay.**

### *Potential Fisheries in the Study Area*

One of the objectives of the DFLR is to consider the use of underutilized species (DFO 2016c). Evaluating a potential fishery in an area requires consideration of biological and socio-economic factors, such as the presence and volume of exploitable biomass, status of a species, market demand and value, and skills or equipment required by harvesters (Nalcor 2011). One method to determine the presence of underutilized species is to analyze the catch data of macroinvertebrates and fishes collected during annual DFO RV multi-species trawl surveys. The following subsection describes species collected during DFO RV surveys in Placentia Bay during recent years.

*Macroinvertebrates and Fishes Collected during DFO Research Vessel Surveys, 2010–2015*

The total catch weight during the 2010–2015 DFO RV surveys in the Study Area was ~2.6 mt, ranging from 0.3–0.6 mt per year. DFO RV surveys were only conducted during the spring (March–May) within the Study Area during this period. Data collected during these surveys were analyzed, and catch weights, catch numbers and mean catch depths of species/groups contributing ≥0.1% of the total catch weight as well as sensitive species (e.g., corals and sponges) are presented in Table 4.29.

**Table 4.29. Catch weights and numbers, and mean catch depths of macroinvertebrates and fishes collected during DFO RV surveys within the Study Area, 2010–2015.**

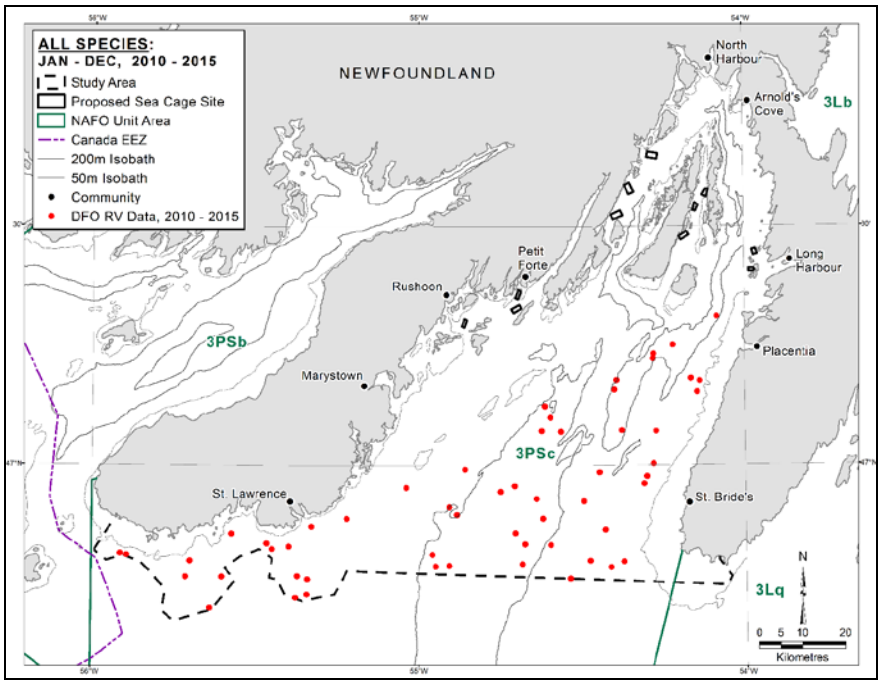
| Species | Catch Weight (mt) | Catch Number | Mean Catch Depth (m) |
|---|---|---|---|
| Capelin | 0.4 | 51,789 | 162 |
| Northern Shrimp | 0.4 | 86,530 | 190 |
| American Plaice | 0.3 | 4,119 | 143 |
| Striped Shrimp | 0.2 | 61,875 | 135 |
| Atlantic Cod | 0.2 | 997 | 139 |
| Snow Crab | 0.1 | 2,149 | 141 |
| Greenland Halibut | 0.1 | 478 | 206 |
| Basket Star (*Gorgonocephalus arcticus*) | 0.1 | 0[a] | 139 |
| Shorthorn Sculpin | 0.1 | 218 | 128 |
| Arctic Argid Shrimp (*Argis dentata*) | 0.1 | 12,069 | 151 |
| Basket Star (Gorgonocephalidae) | 0.1 | 2 | 130 |
| Green Sea Urchin | 0.1 | 2,526 | 125 |
| Sea Raven | 0.1 | 76 | 151 |
| Greenland Shrimp | 0.1 | 46,470 | 179 |
| Lumpfish (*Cyclopterus lumpus*) | 0.1 | 31 | 162 |
| Thorny Skate | <0.1 | 16 | 217 |
| Mud Star (*Ctenodiscus crispatus*) | <0.1 | 2,483 | 192 |
| Arctic Cod | <0.1 | 2,552 | 154 |
| Sculptured Shrimp (*Sclerocrangon boreas*) | <0.1 | 2,511 | 130 |
| Arctic Eelpout | <0.1 | 29 | 155 |
| Toad Crab (*Hyas* sp.) | <0.1 | 1,758 | 132 |
| Northern Alligatorfish | <0.1 | 882 | 162 |
| Mailed Sculpin | <0.1 | 1,401 | 127 |
| Eelpout (*Lycodes* sp.) | <0.1 | 182 | 177 |
| Moustache Sculpin | <0.1 | 1,413 | 131 |
| Eelpout (Zoarcidae) | <0.1 | 219 | 187 |
| Atlantic Herring | <0.1 | 206 | 156 |
| Offshore Sand Lance | <0.1 | 505 | 85 |
| Brittle Star (*Ophiura sarsi*) | <0.1 | 99 | 127 |
| Longhorn Sculpin | <0.1 | 87 | 117 |
| Sea Urchin (*Strongylocentrotus* sp.) | <0.1 | 305 | 105 |
| Sea Anemone (Actinaria) | <0.1 | 287 | 157 |
| Seasnail (Liparidae) | <0.1 | 336 | 180 |
| Spatulate Sculpin | <0.1 | 401 | 152 |
| Spiny Lumpfish | <0.1 | 362 | 110 |
| Shanny (*Lumpenus maculatus*) | <0.1 | 323 | 160 |

| Species | Catch Weight (mt) | Catch Number | Mean Catch Depth (m) |
|---|---|---|---|
| Rigid Cushion Star | <0.1 | 300 | 224 |
| Corals | <0.1 | 120 | 139 |
| Yellowtail Flounder | <0.1 | 23 | 97 |
| Winter Skate | <0.1 | 3 | 128 |
| Iceland Scallop | <0.1 | 69 | 101 |
| Sessile Tunicate (*Boltenia* sp.) | <0.1 | 72 | 136 |
| Sea Star (*Crossaster papposus*) | <0.1 | 149 | 98 |
| Sponges | <0.1 | 0[a] | 113 |
| Snake Blenny | <0.1 | 137 | 160 |
| Common Alligatorfish | <0.1 | 154 | 148 |
| Polar Sea Star | <0.1 | 29 | 102 |
| Shrimp (*Eualus gaimardii gaimardi*) | <0.1 | 1,767 | 150 |
| Atlantic Wolffish | <0.1 | 21 | 73 |
| Comb Jelly (Ctenophora) | <0.1 | 0[a] | 76 |
| Orange-footed Sea Cucumber | <0.1 | 4 | 77 |
| Sea Urchin (Echinoida) | <0.1 | 92 | 84 |
| (Common) Ocean Pout | <0.1 | 7 | 72 |
| Arctic Mailed Sculpin | <0.1 | 200 | 73 |
| Hookear Sculpin (*Artediellus* sp.) | <0.1 | 230 | 133 |
| Parrot Shrimp (*Spirontocaris spinus*) | <0.1 | 812 | 107 |
| Smooth Skate | <0.1 | 1 | 106 |
| Deepwater Redfish | <0.1 | 13 | 96 |
| **Total** | **2.6** | **289,889** | **136** |

Source: DFO RV Survey Data (2010–2015).
[a] Denotes data incomplete.

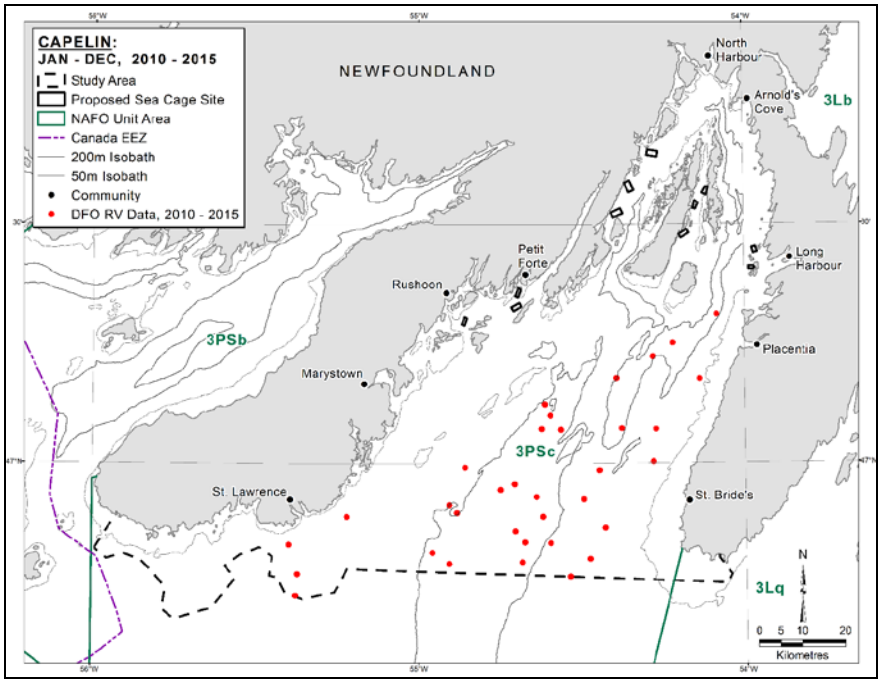
Capelin accounted for 16% of the total catch weight within the Study Area during 2010–2015, followed by northern shrimp (*Pandalus borealis*; 14%), American plaice (10%), striped shrimp (*Pandalus montagui*; 7%), Atlantic cod (7%), snow crab (5%) and Greenland halibut (5%). All other species/groups accounted for <5% each of the total 2010–2015 catch weight in the Study Area. The average mean depth during the 2010–2015 RV surveys within the Study Area was 136 m (min: 67 m; max: 258 m). Principal species captured during the 2010–2015 DFO RV surveys were generally reflective of predominant species targeted using mobile gear (bottom trawls) in the commercial fishery during recent years.

Species were caught predominantly in the southern and southeastern portion of the Study Area during the 2010–2015 DFO RV surveys in water depths >50 m (Figure 4.48). No RV catch locations during this period were within 10 km of the proposed sea cage sites. The nearest catch location was ~13 km southwest of the Iona Islands proposed sea cage site within the Long Harbour BMA. DFO RV survey catch locations for capelin, northern shrimp, American plaice, striped shrimp, Atlantic cod, snow crab, Greenland halibut, Atlantic wolffish (*Anarhichas lupus*), corals and sponges during 2010–2015 are shown in Figures 4.49–4.58, respectively.



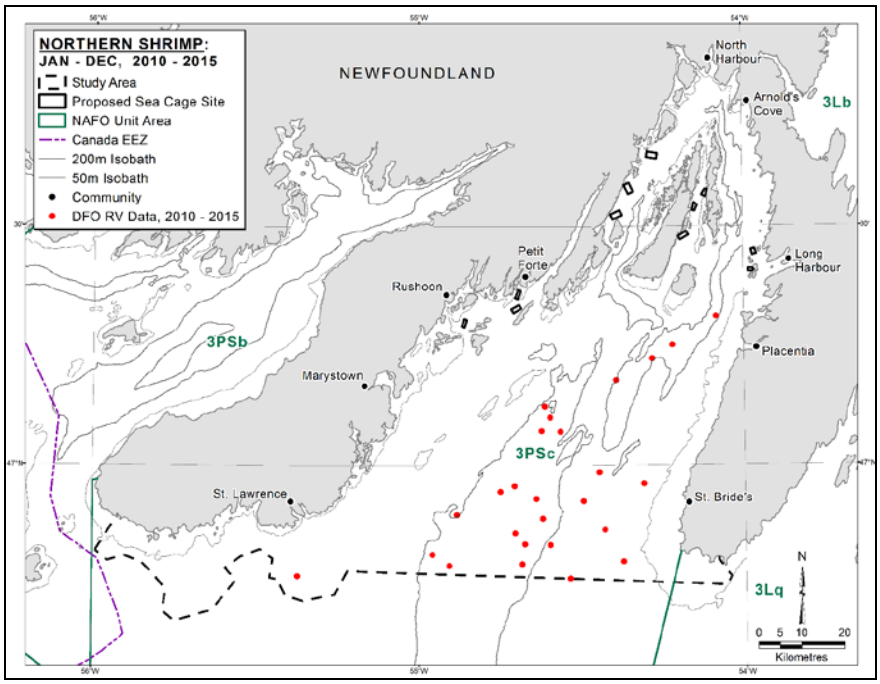

Source: DFO RV Survey Database (2010–2015).

**Figure 4.48. Distribution of DFO RV survey catch locations in the Study Area, all species, 2010–2015.**



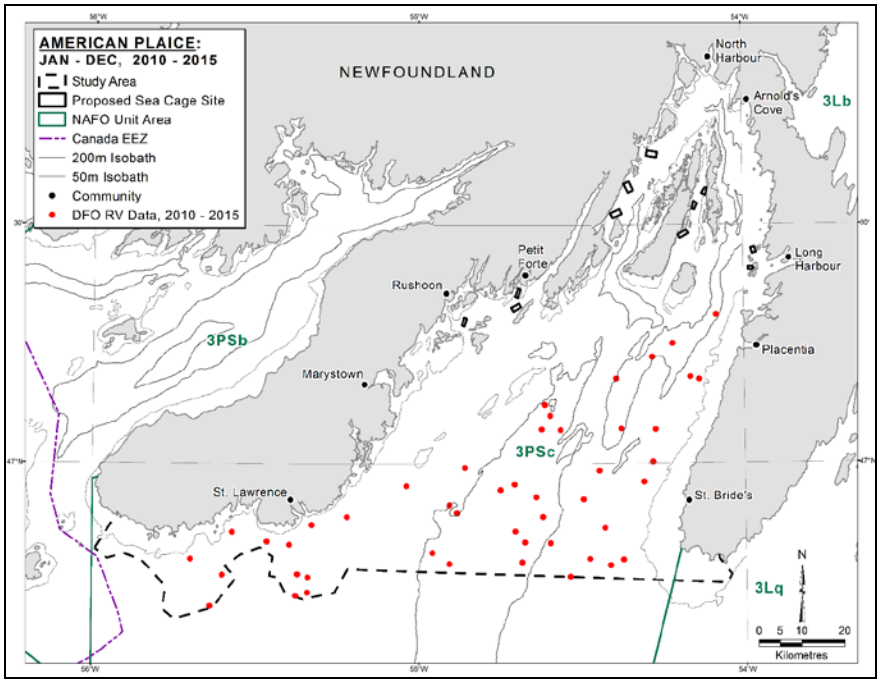

Source: DFO RV Survey Database (2010–2015).

**Figure 4.49. Distribution of DFO RV survey catch locations of capelin in the Study Area, 2010–2015.**



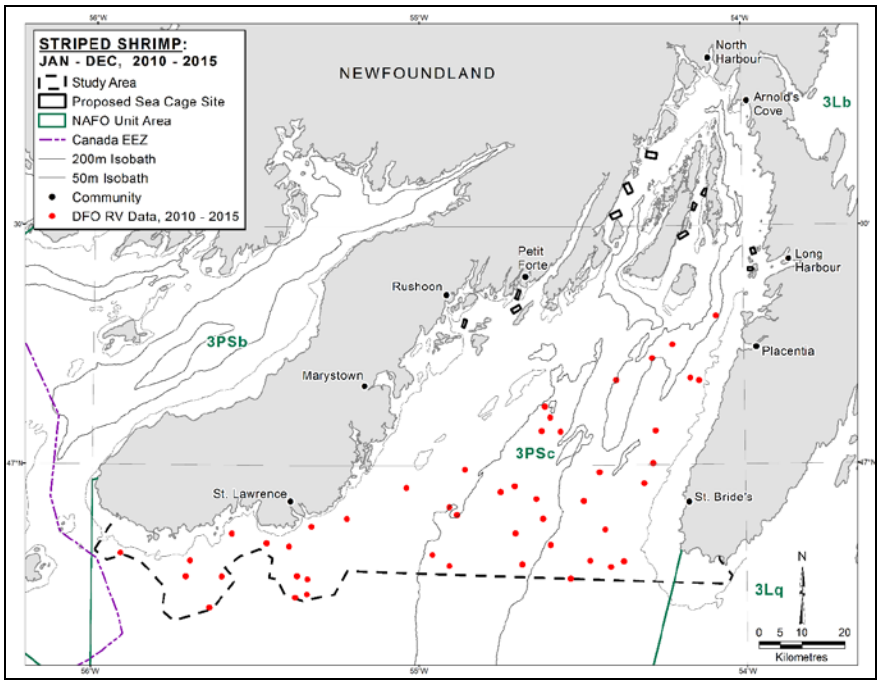

Source: DFO RV Survey Database (2010–2015).

**Figure 4.50. Distribution of DFO RV survey catch locations of northern shrimp in the Study Area, 2010–2015.**



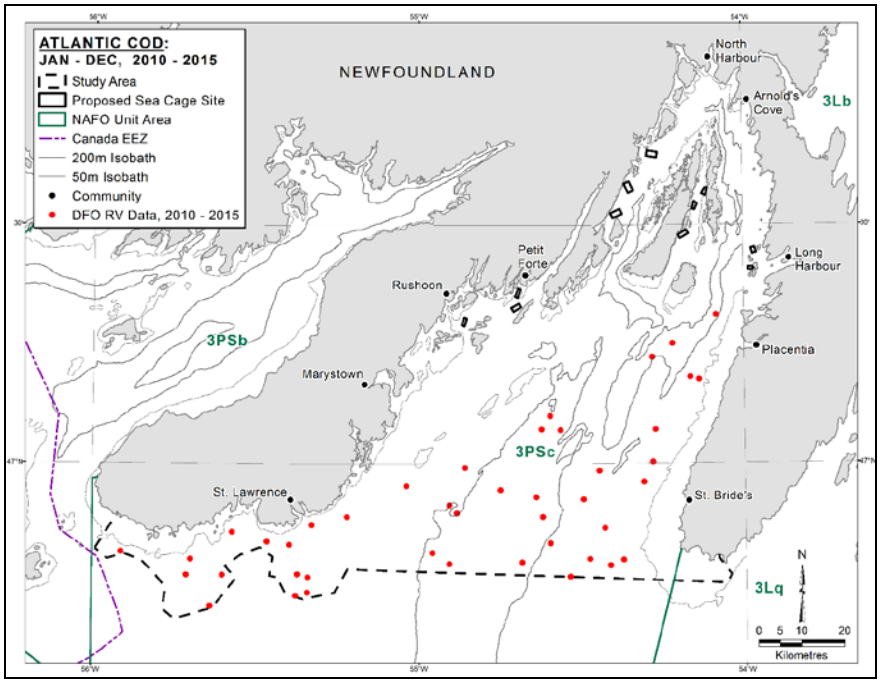

Source: DFO RV Survey Database (2010–2015).

**Figure 4.51. Distribution of DFO RV survey catch locations of American plaice in the Study Area, 2010–2015.**



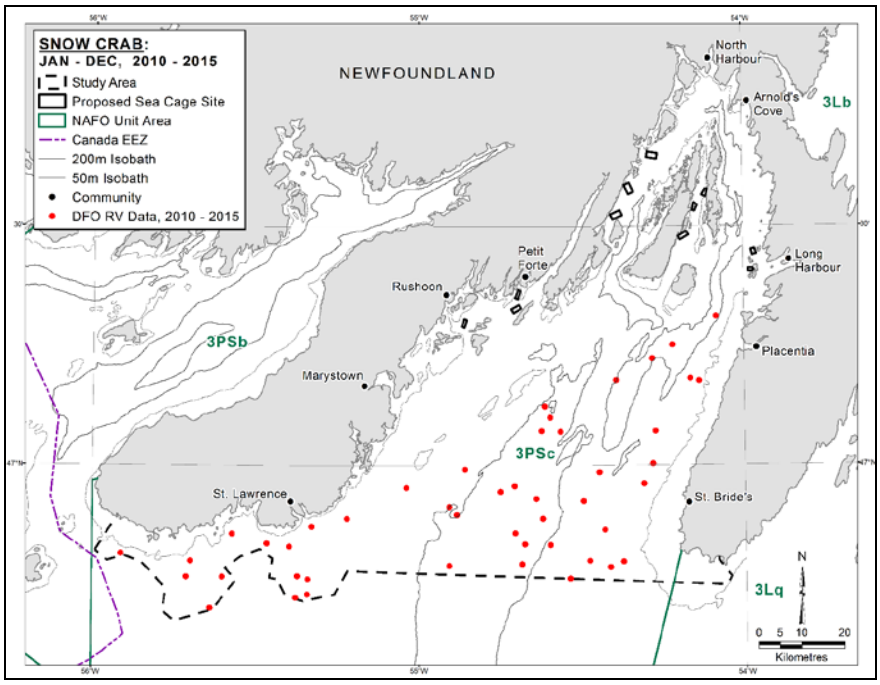

Source: DFO RV Survey Database (2010–2015).

**Figure 4.52. Distribution of DFO RV survey catch locations of striped shrimp in the Study Area, 2010–2015.**



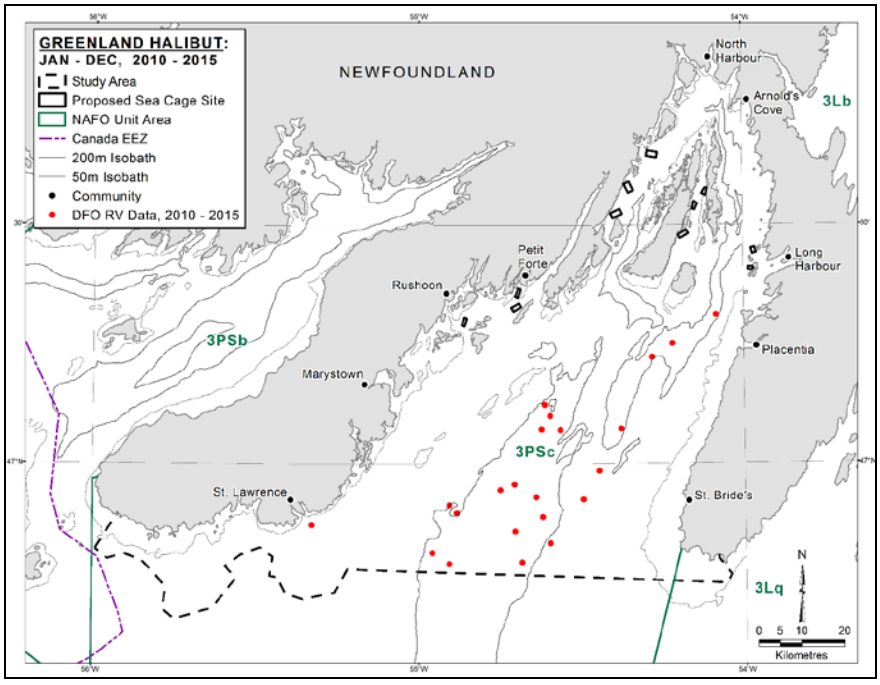

Source: DFO RV Survey Database (2010–2015).

**Figure 4.53. Distribution of DFO RV survey catch locations of Atlantic cod in the Study Area, 2010–2015.**



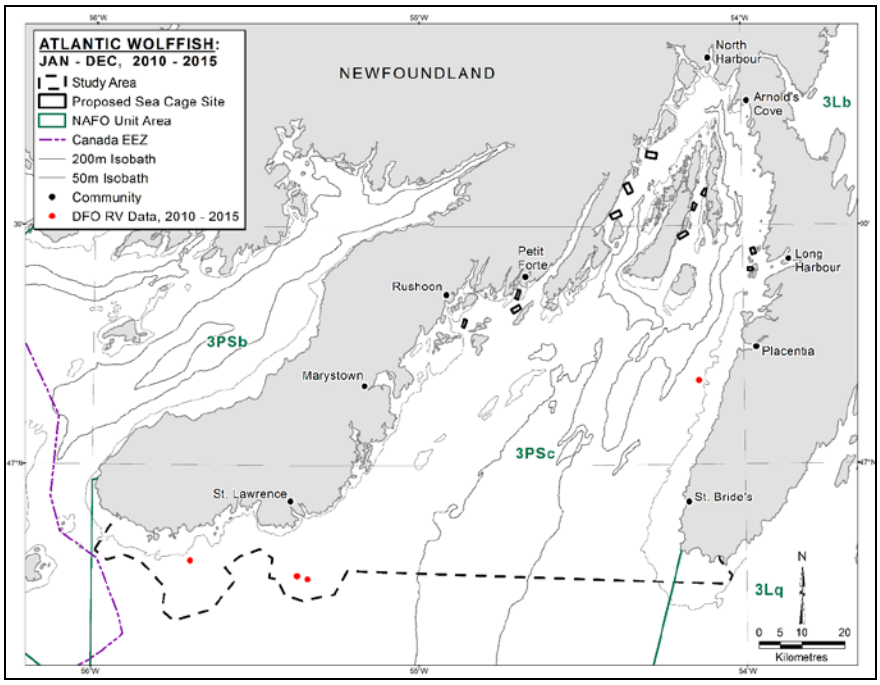

Source: DFO RV Survey Database (2010–2015).

**Figure 4.54. Distribution of DFO RV survey catch locations of snow crab in the Study Area, 2010–2015.**



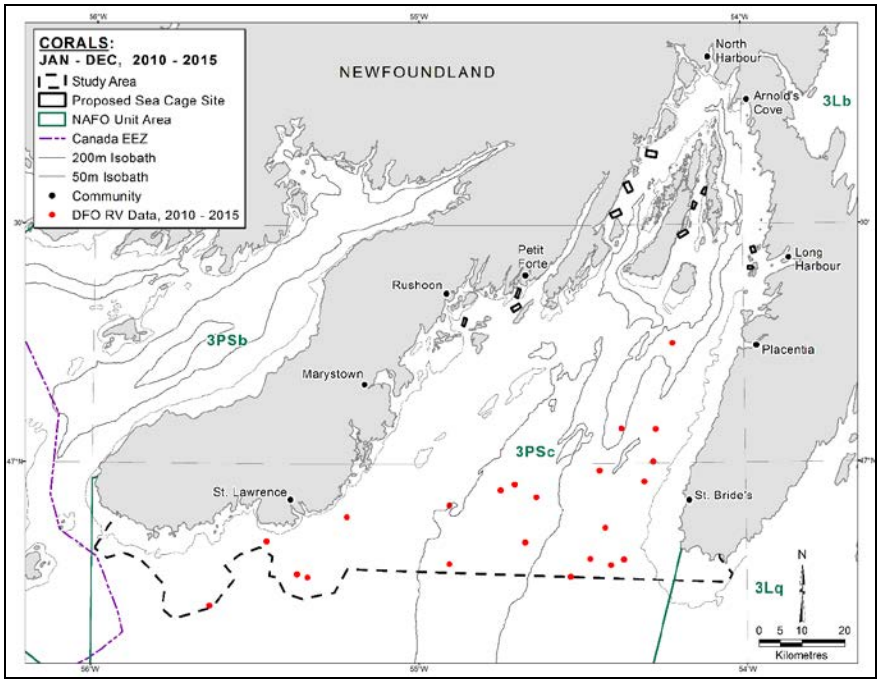

Source: DFO RV Survey Database (2010–2015).

**Figure 4.55. Distribution of DFO RV survey catch locations of Greenland halibut in the Study Area, 2010–2015.**



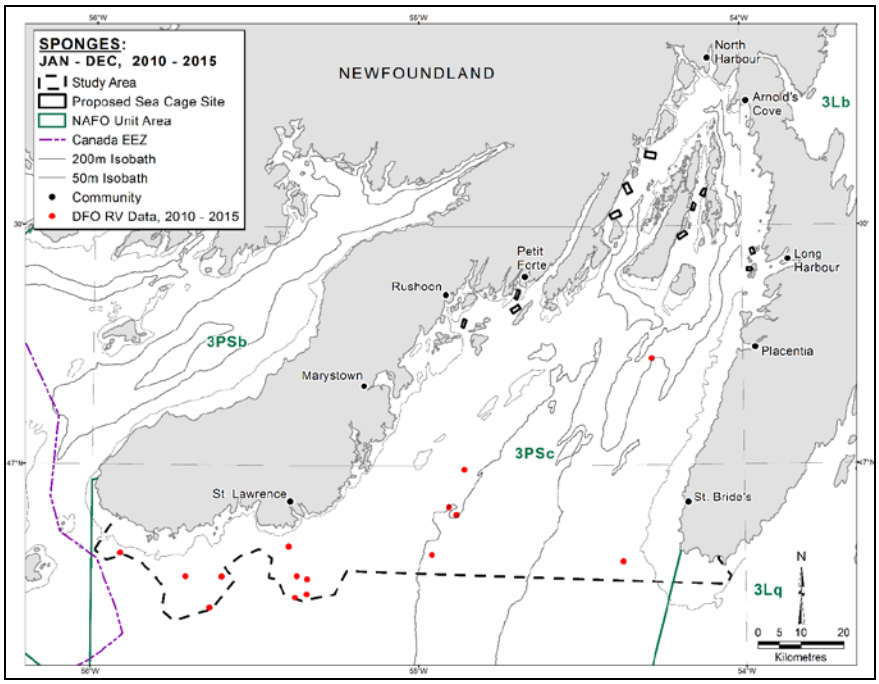

Source: DFO RV Survey Database (2010–2015).

**Figure 4.56. Distribution of DFO RV survey catch locations of Atlantic wolffish in the Study Area, 2010–2015.**




Source: DFO RV Survey Database (2010–2015).

**Figure 4.57. Distribution of DFO RV survey catch locations of corals in the Study Area, 2010–2015.**




Source: DFO RV Survey Database (2010–2015).

**Figure 4.58. Distribution of DFO RV survey catch locations of sponges in the Study Area, 2010–2015.**

Catches at various mean depth ranges were also examined. Total catch weights and predominant species/groups caught within each mean depth range in the Study Area during 2010–2015 are shown in Table 4.30. Atlantic cod (predominant commercial species targeted using mobile gear) were caught primarily at depths ranging from 100–200 m, similar to cod catch depths observed during the commercial fisheries in Placentia Bay.

**Table 4.30. Total catch weights and predominant species/groups caught at various mean catch depth ranges, DFO RV Surveys, 2010–2015.**

| Mean Catch Depth Range (m) | Total Catch Weight (mt) | Predominant Species (% of Total Catch Weight) |
|---|---|---|
| <100 | 0.02 | Offshore Sand Lance (34%)<br>Atlantic Wolffish (9%)<br>Comb Jelly (Ctenophora; 8%)<br>Sea Urchin (Echinoida; 8%)<br>Orange-footed Sea Cucumber (8%)<br>(Common) Ocean Pout (8%) |
| 100–199 | 2.4 | Capelin (17%)<br>Northern Shrimp (15%)<br>American Plaice (11%)<br>Striped Shrimp (8%)<br>Atlantic Cod (8%) |
| 200–299 | 0.2 | Greenland Halibut (72%)<br>Thorny Skate (25%) |
| 300–399 | 0 | - |
| 400–499 | 0 | - |
| 500–599 | 0 | - |
| 600–699 | 0 | - |

| Mean Catch Depth Range (m) | Total Catch Weight (mt) | Predominant Species (% of Total Catch Weight) |
|---|---|---|
| 700–799 | 0 | - |
| 800–899 | 0 | - |
| 900–999 | 0 | - |
| ≥1,000 | 0 | - |

Source: DFO RV Survey Database (2010–2015).

### 4.4.2.4 Aquaculture

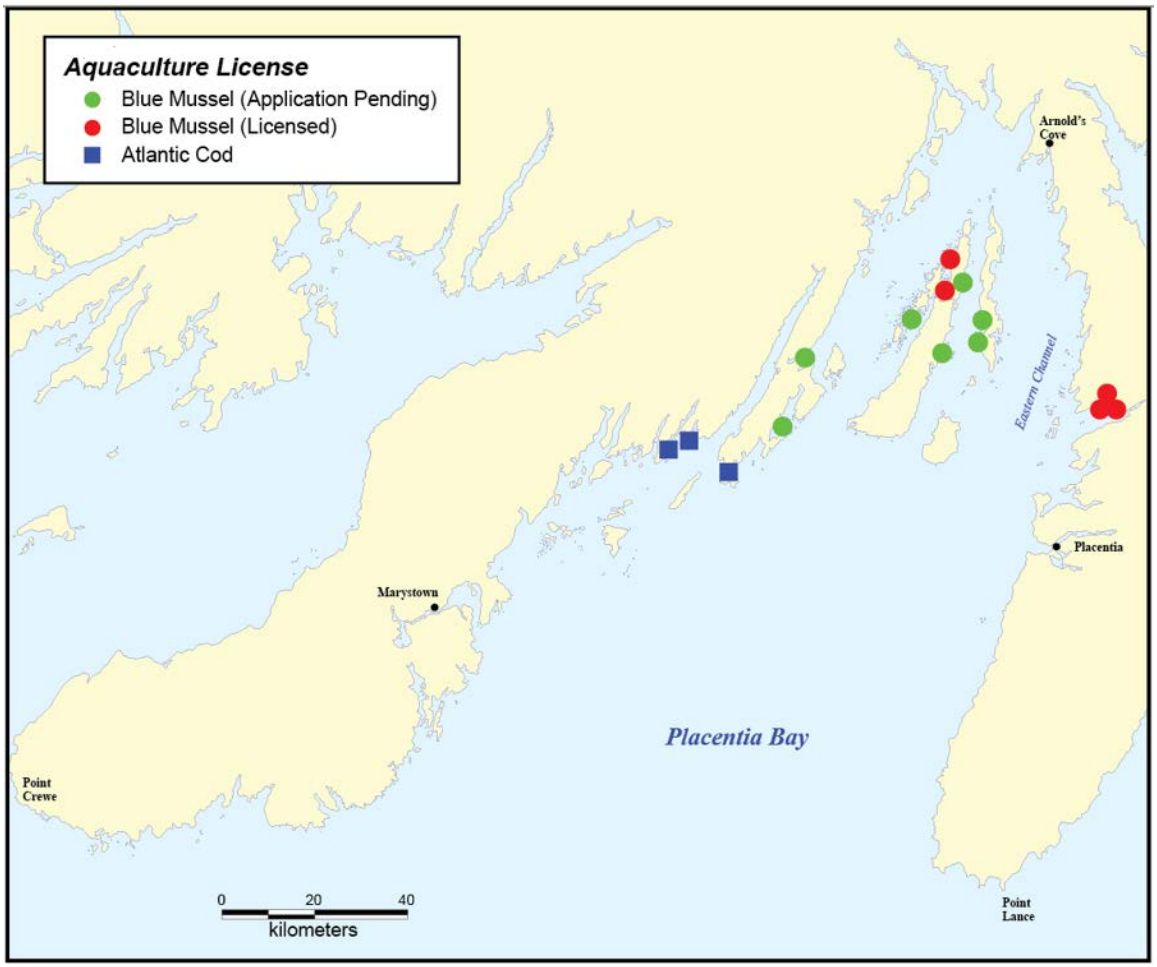
There are currently four principal marine species farmed in Newfoundland and Labrador: (1) Atlantic salmon; (2) blue mussels; (3), steelhead trout (*Oncorhynchus mykiss irideus*); and Atlantic cod (NAIA 2011). As of the end of 2015, a total of 152 aquaculture licences were held by enterprises throughout Newfoundland and Labrador, including 87 for salmonid operations, 51 for shellfish, four for hatcheries and an additional ten for unspecified operations (DFLR 2016). Of the licenced salmonid aquaculture cage sites, 38 were active during 2015 (i.e., had fish on-site at some point during the calendar year), and 49 were non-active (i.e., not currently part of a regular production schedule or in fallow) (DFLR 2017b). Aquaculture licences are valid for one year and require annual renewal (DFLR 2017b). Aquaculture companies in Newfoundland and Labrador are required to "operate within progressive fish health management policies based upon site and year class separation and regionally-based aquaculture plans", promoting "industry responsibility for maintaining environmental integrity" (DFLR 2017b). The province's first Aquaculture Strategic Plan was developed in 1999 in a collaborative effort involving governmental departments and industry, and has since been updated in 2002, 2005 and 2014 (DFLR 2017b).

The total market value for aquaculture products in Newfoundland and Labrador (primarily for Atlantic salmon, steelhead trout and blue mussel) was $59 and $161 million during 2014 and 2015, respectively. The industry employed ~439 individuals for aquaculture hatchery and grow-out activities during 2014–2015 (DFLR 2016). While the production weight remained relatively unchanged in the province for shellfish during 2014 and 2015 (3,260 mt vs. 3,130 mt, respectively), salmonid production increased substantially (5,980 mt in 2014 vs. 19,684 mt in 2015) (DFLR 2016). During 1999, the total aquaculture production and estimated market values within Placentia Bay for blue mussel (*Mytilus edulis*) and Atlantic cod were $90,000 and >$500,000, respectively (DFO 2008). Production value was also $90,000 in Placentia Bay during 2006 (DFO 2008). During 2006–2007, mussel production levels in Placentia Bay were an estimated 3.5 million pounds with a primary product value (i.e., before processing) of ~1.4 million (NLRC 2007).

Aquaculture sites are located inshore, typically in sheltered coves or along protected shorelines, with specific site locations influenced by water temperatures, tides, bathymetry, benthic conditions, prevailing winds and currents, salinity, littoral factors and influences, proximity to other human activities (e.g., commercial fishing, pleasure craft use, shipping, or other marine-oriented industries), community sewage outfalls, and access to services such as roads and electricity (Vale 2008). As Atlantic salmon require relatively warm water during the winter, virtually all finfish production in Newfoundland occurs along the south coast of the province (NAIA 2011). The majority of salmonid aquaculture sites are located along the Connaigre Peninsula on the south coast of Newfoundland, while the shellfish sector is principally located along the northeast coast of Newfoundland, particularly in the Green Bay/Notre Dame Bay region (DFLR 2017b).

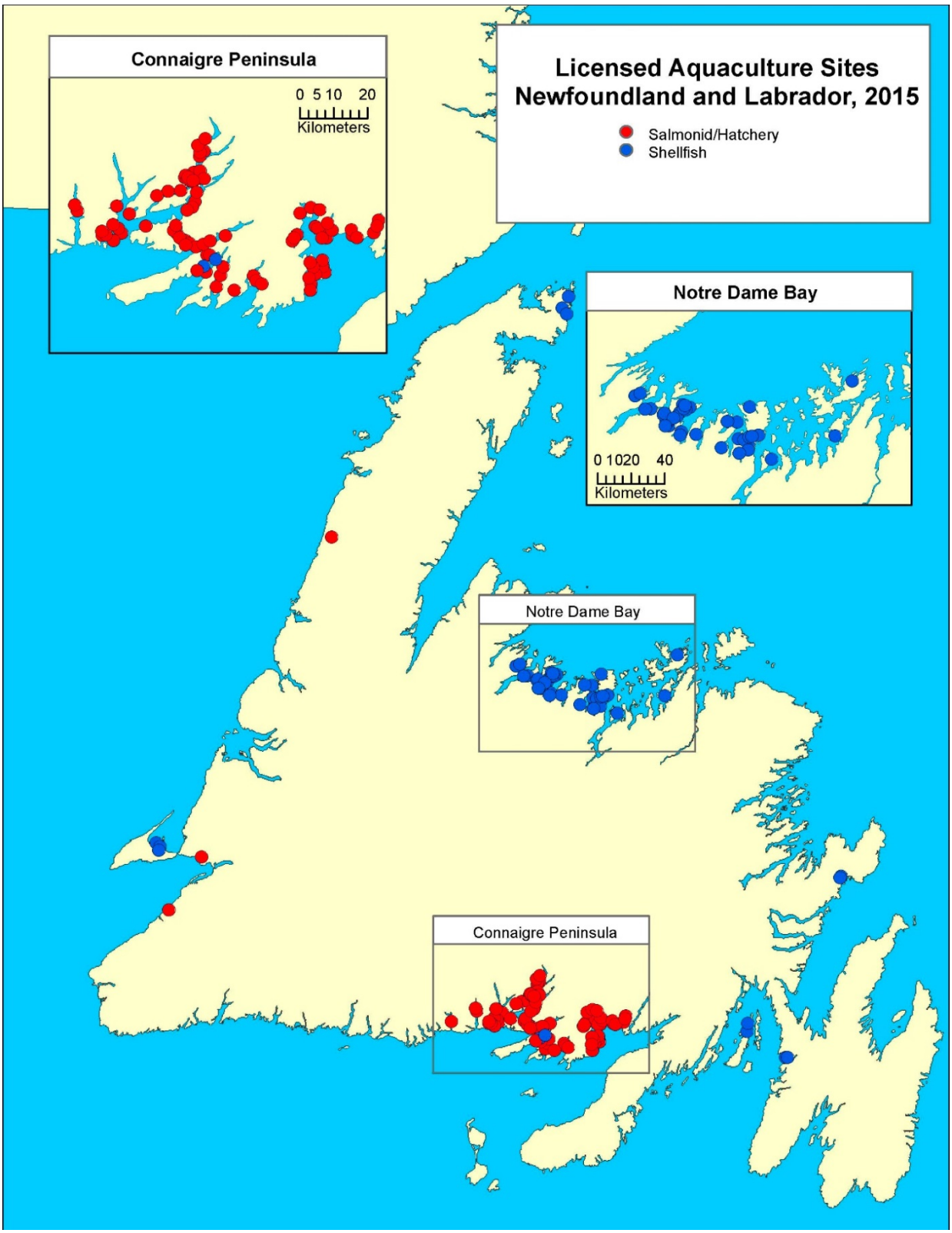
Within Placentia Bay, the aquaculture industry has previously focussed on blue mussels and cod, and aquaculture farms were typically family-run with owners generally having other/additional sources of

income (DFO 2008). In 1997, there were approximately seven active aquaculture operations and several applications to investigate/develop additional sites within Placentia Bay (Vale 2008). During 2000–2003, the DFLR deployed thermographs in several locations in Placentia Bay to monitor water temperatures and assess their suitability as aquaculture sites. This was in response to aquaculture expansion and increased interest in the development of new sites, particularly on the Burin Peninsula and near Merasheen Island (Vale 2008). By 2003, there were 15 approved aquaculture operations in the Placentia Bay region, including six blue mussel sites and nine cod grow-out facilities. However, during 2004, only four operators were selling their product on a commercial basis, including a cod farming facility at Jerseyman Island, three blue mussel sites in Long Harbour (Crawley Island and St. Croix Bay), and two mussel sites near Merasheen Island (Vale 2008). As of 2007, there were 13 licenced aquaculture operations within Placentia Bay, including five mussel farms (commercially-active) and eight Atlantic cod grow-out sites (inactive commercially since 2003) (Vale 2008). During 2008, three licenced Atlantic cod aquaculture sites were located north and east of the Long Island and Gallows Harbour proposed sea cage sites in the Rushoon BMA, several blue mussel operations were located on the coast and among the islands in the vicinity of the proposed sea cage sites within the Merasheen and Red Island BMAs, and within Long Harbour (Figure 4.59). As of 2015, only four shellfish aquaculture sites were operating within Placentia Bay, two along Merasheen Island and two in Long Harbour. There were no salmonid nor hatchery sites remaining (Figure 4.60; Table 4.31).




Source: DFO (2008).

**Figure 4.59. Licenced aquaculture sites within Placentia Bay during 2008.**




Source: DFLR (2017a).

**Figure 4.60. Licenced aquaculture sites within Newfoundland and Labrador during 2015.**

**Table 4.31. Placentia Bay aquaculture site licences, 2015.**

| Licencee | Location | Site Size (Ha) | Latitude | Longitude | Species |
|---|---|---|---|---|---|
| Merasheen Mussel Farms Inc. | Merasheen Island | 112 | 47.6165 | -54.1642 | Blue Mussel; Oyster |
| Merasheen Mussel Farms Inc. | Big South West Cove, Merasheen Island | 54.3 | 47.5733 | -54.1727 | Blue Mussel; Oyster |
| Joseph Keating (Baie Sea Farms Limited) | Crawley Island, Long Harbour | 3.5 | 47.4250 | -53.8723 | Blue Mussel |
| Joseph Keating (Baie Sea Farms Limited) | Crawley Island, Long Harbour | 3.3 | 47.4250 | -53.8592 | Blue Mussel |

Source: DFLR (2017b).

### 4.4.2.5 Recreational Fisheries

In Newfoundland and Labrador, species fished recreationally include Atlantic salmon, brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), ouananiche (landlocked salmon; *Salmo salar ouananiche*), Arctic char (*Salvelinus alpinus*), smelt (Osmeridae), northern pike (*Esox lucius*) and whitefish (*Coregonus* sp.) (DFO 2017k). Groundfish species and scallop are also caught recreationally (DFO 2017e,g).

Management measures for recreational fishing in Newfoundland and Labrador are developed in consultation with user groups and stakeholders, including anglers, outfitters, conservationists, indigenous groups and the provincial government (DFO 2017k). The Minister of Fisheries, Oceans and the Canadian Coast Guard may alter management measures at any time for conservation reasons (DFO 2017k). An Adaptive Management Strategy for recreational salmon angling involves a river classification system wherein individual rivers are rated Class 0, 2, 4 or 6, with each Class associated with specific retention limits, tag use and catch-and-release requirements (DFO 2008, 2017k). Ratings are based on several factors, including salmon population, spawner returns, river size, angling pressure, and river remoteness (DFO 2017k). Where salmon retention is permitted, a tag, provided by DFO (DFO 2017c), must be immediately and securely locked through the gills and mouth of the fish, and the month and day must be cut out from the vinyl portion of the tag (DFO 2017k). Only single, barbless hooks may be used on scheduled salmon rivers throughout Newfoundland and Labrador, and the barbs cannot be baited, weighted or attached to a spinner or similar device (DFO 2017k).

The entirety of insular Newfoundland is included within Trout Angling Zone 1, and Zones 2–6 are in Labrador (DFO 2017k). The Study Area includes rivers from Salmon Fishing Area (SFA) 10 (or 'Salmon Angling Zone 10'), which includes 20 scheduled rivers/tributaries which empty into Placentia Bay (Figure 4.61). The 2017–2018 winter and summer season dates for trout and other species (other than Atlantic salmon) in Trout Angling Zone 1 (non-scheduled waters) are 1 February–15 April and 15 May–7 September, respectively (DFO 2017k). The 2017 season for scheduled waters for brown trout in the Placentia Bay area was 8 September–7 October, including Northeast River, Southeast River, Come by Chance River and Piper's Hole River (DFO 2017k). The 2017 season dates for Atlantic salmon within Salmon Angling Zone 10 were 1 June–7 September (DFO 2017e,k). The lowest salmon returns on record occurred within the majority of SFAs in Newfoundland during 2017, and as a result all scheduled and non-scheduled salmon rivers on the island of Newfoundland were restricted to catch-and-release only effective as of 6 August 2017 (DFO 2017l; D. Ball, Resource Management and Aboriginal Fisheries [RMAF], DFO, pers. comm., 8 February 2018).

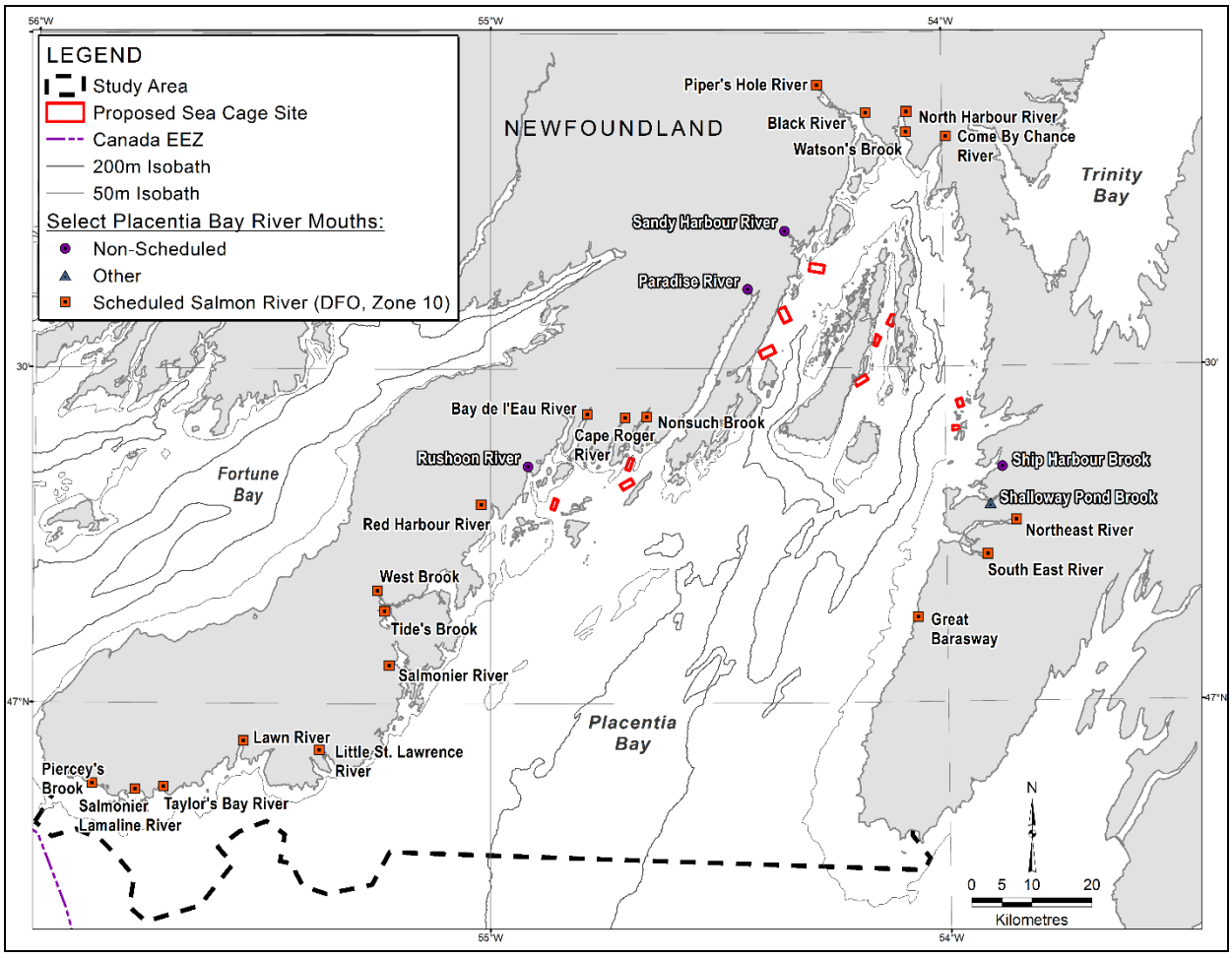



**Figure 4.61. Scheduled and non-scheduled salmon rivers within Salmon Fishing Area 10 (Placentia Bay).**

Within Newfoundland, the daily bag limit consists of 12 trout (any species) or five pounds round weight and one fish of any trout species, whichever is attained first (DFO 2017k). No rainbow or ouananiche of length <20 cm may be retained (DFO 2017k). The possession limit is twice the daily bag limit (DFO 2017k). The same regulations apply for Arctic char (DFO 2017k), and there are no daily bag limits, size restrictions or possession limits for smelt (DFO 2017k). Only the retention of brown trout is permitted on scheduled salmon rivers during 8 September–7 October 2018, and anglers must possess a valid salmon licence (DFO 2017k).

A valid inland fishery licence must be purchased by anglers to fish for salmon on unscheduled or scheduled rivers in Newfoundland and Labrador (including for catch-and-release), and no salmon fry, parr, smolt or salmon of length <30 cm may be retained (DFO 2017k). An estimated total of 24,791 recreational salmon fishery licences were sold in Newfoundland and Labrador during 2016 (Veinott et al. 2018), an increase from 20,003 licences during 2010 (Dempson et al. 2012). Two salmon may be retained per day on unscheduled rivers in Newfoundland and Labrador, and anglers must use red tags 1 and 2 (DFO 2017k). One scheduled river within SFA 10, Nonsuch Brook (north and northeast of the Long Island and Gallows Harbour proposed sea cage sites, respectively), is rated Class 0, indicating

that no salmon may be retained, and anglers may catch-and release a maximum of two fish per day (DFO 2017k). The remaining 19 scheduled rivers within SFA 10 are rated Class 2, whereby an angler may retain two fish per year, red tags 1 and 2 must be used, and a maximum of four fish may be caught-and-released per day (DFO 2017k). A recent announcement by DFO stated that the 2018 Newfoundland and Labrador recreational salmon fishing season will begin with only one fish retention permitted on all rivers that currently have retention and a reduction of catch-and-release limits to three fish per day for all rivers in the Province, with a departmental review during the season (DFO 2018i). Further details will be provided within the 2018-2019 Angler's Guide, which has not yet been released**.** Licenced salmon anglers are asked to complete and return salmon angling logbooks to DFO as soon as possible after the season closes (DFO 2017k).").

There were a total of 8,880 rod days on scheduled salmon rivers in SFA 10 during 2016, resulting in a total catch of 2,511 salmon of which 1,437 were released (Table 4.32). On average, 156 salmon were caught per river during 2010–2016, with ~40% and 60% of salmon retained and released, respectively (Table 4.33). The majority of recreational salmon fishing occurred in Bay de l'Eau River, Tide's Brook, Southeast River, Northeast River, Piper's Hole River, Cape Rodger River and Come by Chance River (Tables 4.32 and 4.33).

**Table 4.32. Total number of salmon retained (ret.) and released (rel.), effort and catch per unit effort (CPUE) for scheduled salmon rivers in SFA 10 during 2016.**

| Scheduled Salmon River | No. of Small Salmon (<63 cm) | | No. of Large Salmon (≥63 cm) | | Total No. of Salmon | | | Effort (Rod Days) | CPUE |
|---|---|---|---|---|---|---|---|---|---|
| | Ret. | Rel. | Ret[a] | Rel. | Ret. | Rel. | Total | | |
| Great Barasway Brook | - | - | - | - | - | - | - | - | - |
| Southeast River | 55 | 92 | 0 | 42 | 55 | 134 | 189 | 1,040 | 0.18 |
| Northeast River | 171 | 97 | 0 | 35 | 171 | 132 | 303 | 978 | 0.31 |
| Come By Chance River | 40 | 33 | 0 | 2 | 40 | 35 | 75 | 713 | 0.11 |
| North Harbour River | 115 | 31 | 0 | 7 | 115 | 38 | 153 | 538 | 0.28 |
| Watson's Brook | 0 | 25 | 0 | 14 | 0 | 39 | 39 | 55 | 0.71 |
| Black River | 33 | 5 | 0 | 0 | 33 | 5 | 38 | 210 | 0.18 |
| Piper's Hole River | 69 | 156 | 0 | 13 | 69 | 169 | 238 | 825 | 0.29 |
| Nonsuch River | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0.00 |
| Cape Rodger River | 106 | 90 | 0 | 19 | 106 | 109 | 215 | 776 | 0.28 |
| Bay de l'Eau River | 274 | 444 | 0 | 26 | 274 | 470 | 744 | 1,591 | 0.47 |
| Red Harbour River | 38 | 31 | 0 | 0 | 38 | 31 | 69 | 192 | 0.36 |
| West Brook, North West Arm, Mortier Bay, & tributary streams | - | - | - | - | - | - | - | - | - |
| Tide's Brook | 96 | 152 | 0 | 18 | 96 | 170 | 266 | 1,308 | 0.20 |
| Big Salmonier Brook | - | - | - | - | - | - | - | - | - |
| Little St. Lawrence River & tributary streams | - | - | - | - | - | - | - | - | - |
| Lawn River | - | - | - | - | - | - | - | - | - |
| Taylor Bay Brook | 11 | 5 | 0 | 7 | 11 | 12 | 23 | 27 | 0.85 |
| Salmonier River (Lamaline) | 66 | 86 | 0 | 7 | 66 | 93 | 159 | 538 | 0.30 |
| Piercey's Brook | - | - | - | - | - | - | - | - | - |
| **Total** | **1,074** | **1,247** | **0** | **190** | **1,074** | **1,437** | **2,511** | **8,800** | **0.29** |

Source: G. Veinott, Research Scientist, Atlantic Salmon, DFO, pers. comm., 19 February 2018 (unpublished data).
"-" Denotes data unavailable.
[a] It is prohibited to retain large salmon (≥63 cm) in insular Newfoundland.

**Table 4.33. Average number of salmon retained (ret.) and released (rel.), effort and catch per unit effort (CPUE) for scheduled salmon rivers in SFA 10 during 2010–2016.**

| Scheduled Salmon River | No. of Small Salmon (<63 cm) | | No. of Large Salmon (≥63 cm) | | Total No. of Salmon | | | Effort (Rod Days) | CPUE |
|---|---|---|---|---|---|---|---|---|---|
| | Ret. | Rel. | Ret[a] | Rel. | Ret. | Rel. | Total | | |
| Great Barasway Brook* | 5 | 4 | 0 | 1 | 5 | 5 | 9 | 18 | 0.55 |
| Southeast River | 91 | 119 | 0 | 32 | 91 | 151 | 242 | 994 | 0.25 |
| Northeast River | 131 | 130 | 0 | 19 | 131 | 148 | 280 | 927 | 0.27 |
| Come By Chance River | 48 | 89 | 0 | 38 | 48 | 128 | 176 | 510 | 0.40 |
| North Harbour River | 46 | 31 | 0 | 9 | 46 | 40 | 86 | 300 | 0.28 |
| Watson's Brook | 1 | 13 | 0 | 4 | 1 | 17 | 18 | 22 | 0.59 |
| Black River | 28 | 22 | 0 | 3 | 28 | 25 | 53 | 146 | 0.38 |
| Piper's Hole River | 129 | 248 | 0 | 21 | 129 | 269 | 397 | 1,008 | 0.42 |
| Nonsuch River* | 2 | 10 | 0 | 0 | 2 | 10 | 12 | 21 | 0.35 |
| Cape Rodger River | 128 | 206 | 0 | 13 | 126 | 219 | 342 | 725 | 0.47 |
| Bay de l'Eau River | 179 | 250 | 0 | 32 | 179 | 282 | 461 | 1,157 | 0.38 |
| Red Harbour River | 19 | 8 | 0 | 0 | 19 | 8 | 27 | 128 | 0.24 |
| West Brook, North West Arm, Mortier Bay, & tributary streams | - | - | - | - | - | - | - | - | - |
| Tide's Brook | 111 | 51 | 0 | 22 | 111 | 73 | 184 | 1,063 | 0.18 |
| Big Salmonier Brook* | 2 | 4 | 0 | 0 | 2 | 4 | 6 | 42 | 0.14 |
| Little St. Lawrence River & tributary streams | - | - | - | - | - | - | - | - | - |
| Lawn River* | 5 | 13 | 0 | 2 | 5 | 15 | 19 | 55 | 0.30 |
| Taylor Bay Brook* | 5 | 9 | 0 | 3 | 5 | 12 | 17 | 43 | 0.58 |
| Salmonier River (Lamaline) | 33 | 45 | 0 | 3 | 33 | 48 | 81 | 335 | 0.23 |
| Piercey's Brook* | 5 | 3 | 0 | 0 | 5 | 3 | 7 | 27 | 0.27 |
| **Total** | **63** | **81** | **0** | **13** | **63** | **94** | **156** | **483** | **0.34** |

Source: G. Veinott, Research Scientist, Atlantic Salmon, DFO, pers. comm., 19 February 2018 (unpublished data).
* Denotes that data were not available for all years during 2010–2016.
"-" Denotes data unavailable.
[a] It is prohibited to retain large salmon (≥63 cm) in insular Newfoundland.

Fishers may angle for trout and salmon year-round in coastal Newfoundland and Labrador waters (i.e., all marine waters outside DFO caution signs posted in the estuaries of some scheduled and non-scheduled salmon rivers, and outside the spring tide low-water mark in all other areas), and there is no closed season or licence requirement (DFO 2017k). The trout angling regulations noted above apply in coastal waters, but the retention of salmon in coastal waters is prohibited and angling must be catch-and-release (DFO 2017k).

In marine waters, only angling gear and hand lines (including artificial lures, baited hooks or feathered hooks) with up to three hooks are permitted to catch groundfish recreationally. Jiggers are only permitted if they are modified to have a single hook (DFO 2017e).

The 2017 groundfish recreational fishery was open for a total of 46 days, with the summer season during 1 July–4 September and the winter season during 23 September–1 October (DFO 2017e). The periods during which scallops may be harvested recreationally are dependent upon sanitary conditions and the potential for water contamination, which can be influenced by factors such as heavy rainfall. Opening and closure notices are provided to harvesters (e.g., DFO 2017g).

There is currently no requirement for licences or tags for groundfish (DFO 2017e). All groundfish caught recreationally must be retained, although sculpins and cunners may be released. It is prohibited to retain Atlantic halibut, spotted or northern wolffish, or any species of shark during the groundfish recreational fishery (DFO 2017e). All retained groundfish must be kept in a readily identifiable state, up to a bag limit of five groundfish per day (DFO 2017e). The most recent survey of the recreational cod fishery in

Newfoundland and Labrador was conducted in 2007. During 2007, 73,425 anglers participated in the five-week recreational cod fishery in Newfoundland and Labrador, and caught an estimated 1.2 million cod (BriLev 2008). Approximately 7% (5,380) of the participating anglers resided in the Burin-South Coast area, the majority of which were over 16 years of age (BriLev 2008). Recreational cod anglers residing in the Burin-South Coast area fished for a total of 21,998 days during 2007, catching a total of 95,450 cod at an average of 4.3 cod/day (BriLev 2008). An estimated 1,600 anglers throughout Newfoundland and Labrador reported catching wolffish incidentally during the 2007 recreational cod fishery for a total of 3,601 wolffish, all of which were successfully returned to the water (BriLev 2008).

Scallop fishers must hold a recreational scallop licence, and the authorized daily bag limit for the 2018 season is 50 scallops per day, with a possession limit of 100 scallops (DFO 2018h). DFO is presently reviewing the recreational scallop fishery (DFO 2018i).

Minimal recreational use of the marine waters of Placentia Bay in the vicinity of the proposed sea cage sites has been noted by Grieg NL during recent years. Fishers interviewed in February 2018 indicated that, over the past five to ten years, there has been an increase in recreational boating, with boats travelling to the Bay's islands (there are cabins or seasonal homes on several of the previously resettled islands) (C. Hepditch, Fisher, Baine Harbour, pers. comm., 21 February 2018). The food fishery in the area is generally prosecuted in waters just outside the communities where residents live (P. Power, Human Resources Manager, Grieg NL, pers. comm., 4 February 2018).

#### 4.4.2.6 Indigenous Fisheries

In addition to those Fishing Areas identified in previous subsections (see the Commercial Fisheries and Recreational Fisheries subsections), Placentia Bay is located in Sealing Area 8, Capelin Fishing Area 10, Mackerel Fishing Area 10 and Squid Fishing Area 10 (DFO 2009, 2016d, 2018i). At least six indigenous groups from Newfoundland and Labrador hold communal commercial fishing licences that would allow fishing in Placentia Bay: (1) the Miawpukek First Nation (MFN) holds multiple enterprises and licences that give access to groundfish, tuna, swordfish and whelk in NAFO Div. 3Ps, squid in Squid Fishing Area 10, and seal for Sealing Aras 4–33; (2) the Qalipu Mi'kmaq First Nation Band holds an inshore enterprise for capelin and mackerel giving them access to Capelin Fishing Areas 1–11 and Mackerel Fishing Areas 1–11; (3) the Mi'kmaq Alsumk Mowimsikik Koqoey Association (MAMKA), formed by the MFN and Qalipu Mi'kmaq First Nation Band, has an enterprise with a groundfish licence providing access to Div. 3Ps, capelin and herring licences providing access to Capelin Fishing Area 10 and Herring Fishing Area 10, and a whelk licence for Div. 3Ps; (4) the Nunatsiavut Government holds seal licences for Sealing Areas 4–33; (5) the Innu Nation has a mid-shore enterprise (65–100') with a groundfish licence providing access to a variety of areas throughout the Atlantic, including Div. 3Ps; and (6) the NunatuKavut Community Council holds seal licences with access in Sealing Areas 4–33 (D. Ball, RMAF, DFO, pers. comm., 9 February 2018).

Unlike other commercial fisheries enterprises in the region, the FFAW is not a representative for indigenous fisheries in Newfoundland and Labrador, and although the DFO database includes locations in which commercial licences held by indigenous groups permit activity, it does not indicate whether specific areas are utilized (D. Ball, RMAF, DFO, pers. comm., 8 February 2018). Therefore, the Proponent reached out to key contacts within each indigenous group (provided by DFO [D. Ball, RMAF, DFO, pers. comm., 9 February 2018]), to determine if the aforementioned licences have been or are likely to be used within Placentia Bay. To date, only the Nunatsiavut Government has replied, indicating that they have not used their licence to hunt seals in Placentia Bay.

In Newfoundland, MFN holds a Food, Social or Ceremonial (FSC) communal salmon fishing licence, but has chosen not to harvest salmon under this licence since 1997 due to conservation concerns (Veinott et al. 2018). Otherwise, there are no FSC licences issued for Placentia Bay (D. Ball, RMAF, DFO, pers. comm., 9 February 2018).

### 4.4.2.7 Industry and Science Surveys

Annual fisheries research surveys conducted by DFO and the fishing industry are vital in determining stock status for the commercial fisheries. In a given year, there will be spatial overlap between the Study Area and research surveys in NAFO Div. 3Ps.

The tentative schedule of DFO RV surveys in the Study Area in 2018 is indicated in Table 4.34. Spring surveys within the Study Area may occur during April and early-May.

**Table 4.34. Tentative 2018 schedule of DFO RV surveys in the Study Area vicinity.**

| NAFO Division | Start Date | End Date | Vessel | Activity |
|---|---|---|---|---|
| 3P | 31 March | 12 April | *Needler* | NL Spring Survey |
| 3P | 12 April | 24 April | *Needler* | NL Spring Survey |
| 3P + 3O | 25 April | 8 May | *Needler* | NL Spring Survey |
| 3P + 3KLMNO | 26 April | 1 May | *Teleost* | Calibrations |

Note: Start/end dates subject to change as trip plans are finalized (D. Power, NAFO Senior Science Advisor/Coordinator, Science Branch, DFO, pers. comm., 31 January 2018).

#### *DFO-Industry Collaborative Post-Season Snow Crab Trap Survey*

Prior to 2003, the fall DFO RV surveys were the primary index of abundance for the assessment of snow crab. Industry felt that a "survey dedicated solely for snow crab using commercial and modified commercial snow crab traps would allow the fishing industry to more accurately assess and ultimately better manage the valuable snow crab resource" (FFAW|Unifor 2018a). After extensive consultations between fish harvesters and scientists, the DFO-Industry Collaborative Post-Season Snow Crab Trap Survey was implemented in 2003, and by 2008, results of this survey were fully integrated into the snow crab scientific assessment methodology (FFAW|Unifor 2018a). As a result, harvesters and managers have improved partnership and higher confidence in the accuracy of recent stock status assessments (LGL 2016; FFAW|Unifor 2018a). Since the Trap Survey began, there have been approximately 900 participating snow crab harvesters (FFAW|Unifor 2018a).

The Post-Season Snow Crab Trap Survey typically occurs between early-September and November (LGL 2016). The annual snow crab TAC for this survey was 350 mt during the 2015 and 2016 seasons, and 470 mt during 2017 (DFO 2016a, 2017e). The 1,257 station locations remained consistent from year to year throughout all crab management areas up to and including the 2016 survey year. As of 2017, there was an increase in the total number of stations (to 1,316, including three new stations within Placentia Bay) and an alteration of methodology in that all of the stations will not necessarily be sampled during a given year. The new plan strategy is to randomize the survey locations within each NAFO Div. (N. Paddy, Contract Manager, PGS, pers. comm., 11 February 2017). A total of 73 station locations occur within the Study Area (Figure 4.62). While no stations are located within any proposed sea cage sites, several are located <10 km from some proposed sea cage sites in all four BMAs.

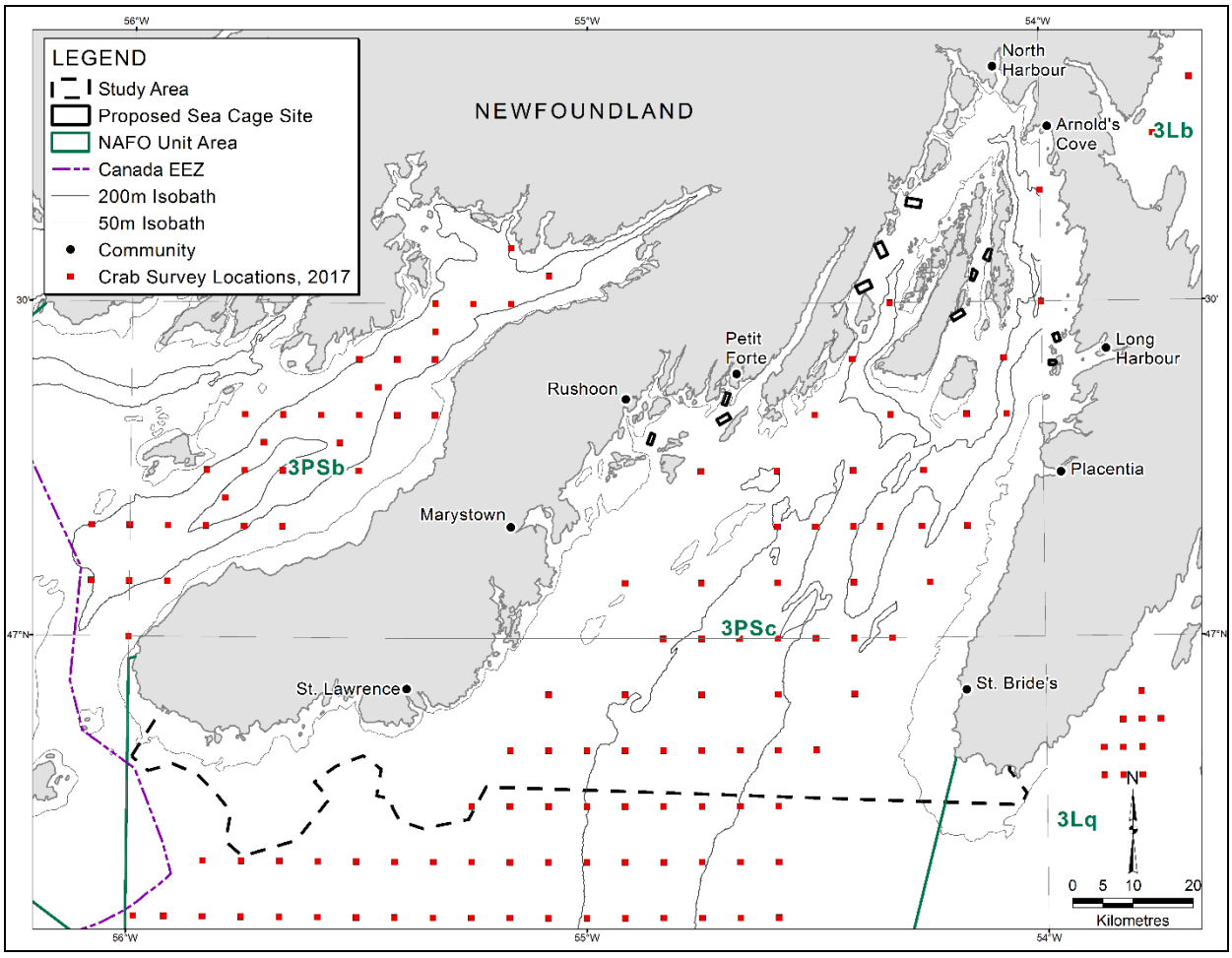



**Figure 4.62. Locations of DFO-Industry Collaborative Post-Season Snow Crab Trap Survey stations in the Study Area.**

### *Coastal Restoration Project – Placentia Bay*

Eelgrass in Placentia Bay has decreased over the past 20 years, perhaps due to an increase in the local population of the invasive species green crab (*Carcinus maenas*) (K. Best, Fisheries Biologist, Marine Institute of MI, pers. comm., 13 February 2018). As a result, the Coastal Restoration Project, managed by the MI in collaboration with FFAW, seeks to restore eelgrass sites within Placentia Bay utilizing globally-established eelgrass transplantation methodology. An important aspect of site preparation for eelgrass restoration is the removal of green crab for research and population control. This research has provided an increased understanding of green crab biology, the effects of green crab on the catchability of, and competition with lobster, and the effects of green crab on eelgrass beds (FFAW|Unifor 2018b). There are nine sites within Placentia Bay from which green crab are removed for eelgrass restoration site preparation: three along the western portion of Placentia Bay, two in the north and four to the east. All are located ≥5 km from the proposed sea cage sites (see Figure 4.9 *in* Section 4.2.3.1; K. Best, Fisheries Biologist, MI, pers. comm., 13 February 2018).

Through a contractual agreement between the MI and FFAW, harvesters catch green crab in accordance with the FFAW's standard compensation rate for research purposes (K. Best, Fisheries Biologist, MI, pers. comm., 13 February 2018). Eligible fishers (i.e., those residing either from North Harbour to Swift Current, Baine Harbour to Petit Forte including Boat Harbour and St. Josephs], or Fox Harbour to Southeast Arm [including Placentia Sound and Northeast Arm]) (FFAW|Unifor 2017b), wanting to participate in the Coastal Restoration Project submit applications to FFAW and one-year contracts are awarded to fishers on a lottery basis year (K. Best, Fisheries Biologist, MI, pers. comm., 13 February 2018). Unless conditions dictate otherwise, ten fishers per year harvest green crab at each of the nine eelgrass restoration preparation sites. The green crab harvest component of site preparation began in October 2017 and will continue until the end of March 2018 (FFAW|Unifor 2017b). The next fiscal year's (1 April–31 March) lottery results will be released by FFAW in mid-March. It will be the first full year involving green crab removal for the purpose of eelgrass site restoration preparation and it is anticipated to start in June of this year (K. Best, Fisheries Biologist, MI, pers. comm., 13 February 2018).

All crab removed from the water are culled once biological data are collected (e.g., carapace width measurements) in accordance with standard protocols (K. Best, Fisheries Biologist, MI, pers. comm., 13 February 2018). A subsample of the crab are collected for scientific analyses, and the remaining crab are either sent to a landfill or donated (e.g., to processing plants where they may be incorporated into fish meal) but not sold. Donated crab may be frozen at a large freezer terminal at the port in Argentia and distributed to companies which produce bi-products (K. Best, Fisheries Biologist, MI, pers. comm., 13 February 2018).

***Inshore Sentinel Program – Red Harbour (Placentia Bay) Sentinel Site***

The inshore sentinel fishery that occurs off the coasts of Newfoundland and Labrador in NAFO Div. 2J, 3KLPsPn and 4R is a fisheries science program involving inshore fish harvesters working collaboratively with DFO scientists to collect data on cod (FFAW|Unifor 2018c). Harvesters from the province have participated in the cod sentinel surveys since 1994/1995. Cod are fished in accordance with "systematic, well-defined and rigorous scientific protocols" in order to collect information on stock abundance trends, and the distribution, migration, condition and age of fish, which is incorporated into cod stock assessments (FFAW|Unifor 2018b,c). There are currently 74 fixed gear fishing enterprises involved in the sentinel program around the province, and four mobile gear vessels conducting stratified random bottom trawl surveys in NAFO Div. 4R and 3Pn (FFAW|Unifor 2018b). The FFAW is currently accepting applications from harvesters until 14 July 2018 to fish the Red Harbour, Placentia Bay, sentinel site (FFAW|Unifor 2017c). Red Harbour is located in the west-central portion of Placentia Bay, between Rushoon and Marystown, and harvesters eligible to apply for the sentinel fishery for this site are those residing from Baine Harbour to Jean de Baie (FFAW|Unifor 2017c).

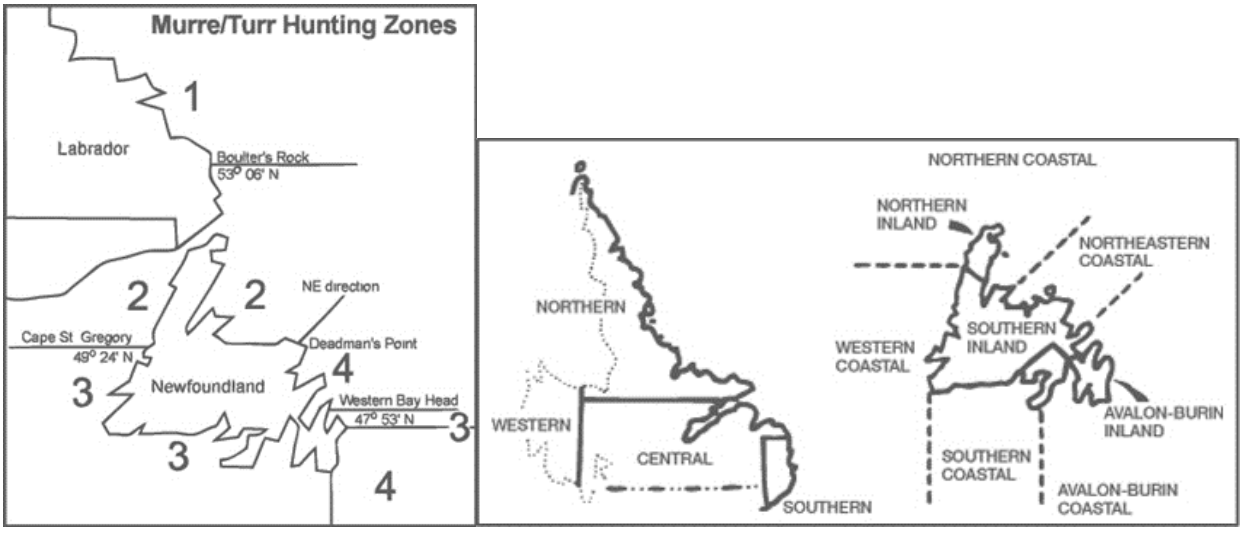
### 4.4.2.8 Seabird Bycatch and Hunting

The rich, diverse feeding and breeding grounds of Placentia Bay attract a variety of marine birds to the area (DFO 2010b). At least 27 seabird species have been observed in Placentia Bay (ORCA Inc. 2005 *in* DFO 2010b), along with numerous nesting colonies (Community Resource Services Ltd & Jacques Whitford Environment Ltd 2001 *in* DFO 2010b). Some of these seabird species are year-round residents, while others undergo annual migrations (Lock et al. 1994 *in* DFO 2010b).

In shallow inshore waters, gillnets may take a high bycatch of seabirds, particularly birds that regularly dive below the surface to feed (DFO 2010b). An estimated 22,070 Common Murres (*Uria aalge*) per year were killed as bycatch in eastern Newfoundland during the early 1980s, but with the reduction in gillnet fisheries the bycatch is now <10% of the previous levels (Wiese and Robertson 2004 *in*

DFO 2010b). Benjamins et al. (2008, *in* DFO 2010b) determined that 2,000–7,000 murres and >2,000 shearwaters were captured in Newfoundland and Labrador gillnet fisheries during 2001–2003, along with significant numbers of gannets, Northern Fulmars (*Fulmarus glacialis*), cormorants, Razorbill Murres (*Alca torda*), puffins, Black Guillemots (*Cephhus grylle*) and Dovekies (*Alle alle*). Baited hooks, such as longlines, may also attract and capture various seabird species, although longline use is relatively low within Placentia Bay (DFO 2010b).

Hunters are required to possess a valid federal Migratory Game Bird Hunting Permit with a Canadian Wildlife Habitat Conservation Stamp in order to hunt migratory birds in Canada, including murres (locally known as "turrs") (ECCC 2017c). Placentia Bay is located within Murre/Turr Hunting Zone 3 (Figure 4.63), with murres hunted primarily around Point Lance (southeast Placentia Bay) but otherwise throughout the Bay (DFO 2010b). Common Murres are the primary seabirds targeted during annual hunts in Placentia Bay, with Razor-bill Murres, Dovekies, guillemots and puffins also taken (DFO 2010b). Within Placentia Bay, harvests are typically comprised of up to 30% Common Murres and the remainder is mostly Thick-billed Murres (G. Robertson, pers. comm. *in* DFO 2010b). The murre hunt is only open to residents of Newfoundland and Labrador, and murres are the only migratory bird that can be legally hunted from a power boat (ECCC 2017c). Non-toxic shot must be used to hunt migratory birds, with the exception of murres which can still be hunted with lead shot (ECCC 2017c). The open season for murre within Zone 3 runs from 25 November 2017–10 March 2018, with daily bag limits of 20 murres and a possession limit of 40 murres (ECCC 2017c). Numerous common seabird species, such as gannets, terns, petrels and gulls are not significantly impacted by hunting activities, although all over-wintering birds within Placentia Bay may be disturbed by hunts conducted using high-powered speed boats and/or shot guns (DFO 2010b). Since Placentia Bay is within a large Hunting Zone, seabird catch data specific to the Bay is not available (DFO 2010b). An estimated 250,000–300,000 birds were harvested in Newfoundland and Labrador during 2010, with a precautionary estimate of 25,000 birds taken in Placentia Bay (DFO 2010b).




Source: ECCC (2017).

**Figure 4.63. Murre/turr (left) and Waterfowl and Snipe (right) Hunting Zones in Newfoundland and Labrador.**

Waterfowl and snipe are hunted in coastal areas of Newfoundland and Labrador (i.e., coastal portions within 100 m of the mean ordinary high-water mark), including offshore islands and adjacent marine coastal waters (ECCC 2017c). Placentia Bay is within the Avalon-Burin Coastal Hunting Zone (see Figure 4.63). Within Placentia Bay, residents from North Harbour indicated that the area is a good location for duck and goose hunting (NLRC 2007). Open seasons in Newfoundland for long-tailed ducks, eiders and scoters are from 25 November 2017 to 10 March 2018 (daily bag limits of 6 and possessions limit of 12), and for other ducks, geese and snipe from 16 September–30 December 2017 (ECCC 2017c). Other ducks, geese and snipe have daily bag limits of 6, 5 and 10, respectively, and a possession limit of 18, 10 and 20, respectively. Limits on taking Barrow's Goldeneye (*Bucephala islandica*) and American Black Ducks (*Anas rubripes*) incidentally are one and four, respectively (ECCC 2017c).

Concerns have been raised recently regarding the low number of wildlife officers and the associated inability to adequately patrol waters of Newfoundland and Labrador to enforce federal migratory bird hunting regulations (CBC 2016). Poaching can become a major issue in such situations. A local murre hunter residing in Placentia Bay noted that "hunters are arriving in Placentia Bay by the dozen, filling their boats with seabirds, and coming back for more…it seems…every time the weather is fit to go out" (W. Parsons, pers. comm. *in* CBC 2016). Mr. Parsons had been told that some hunters arrive in Placentia Bay, "dump their turrs aboard a waiting truck and head out again", and that many murres are being sold. Mr. Parsons expressed concern that "at the rate [murres] are being slaughtered now", he felt that few would live "to see their fifth birthday", a concern given that murres do not typically reach sexual maturity until age four to five years. As of June 2017, the Environmental Violations Administrative Monetary Penalties Regulations came into effect and administrative monetary penalties are now "available to game officers to enforce designated violations of the *Migratory Birds Convention Act* (*MBCA*)…and its associated regulations" (ECCC 2017c). The monetary fine regime and sentencing provisions of the *MBCA*, including the Designation of Regulatory Provisions for the Purposes of Enforcement Regulations, were amended and implemented in July 2017, with the goal of ensuring that "court-imposed fines more accurately reflect the seriousness of environmental offences", including the imposition of minimum and higher maximum fines (ECCC 2017c).

### 4.4.3 Tourism, Outfitters, Cabins and Recreation

Tourism was a $1.13 billion industry in the province in 2017 with spending split almost equally between non-resident visitors and resident tourism. More than 553,000 visitors made their way to the province in 2017 and spent an estimated $575 million. This is the highest level of non-resident visitation and spending in the history of Newfoundland and Labrador (HNL 2018; TCII 2018a).

Commercial tourism operators of accommodation and restaurant businesses on the Burin Peninsula rely on all types of travelers throughout the year, including those doing business and working in the area. However, most of the people who visit the Burin Peninsula are friends and relatives of local residents.

The comprehensive exit survey of visitors as they left the province in 2016 provided a profile of Burin Peninsula vacation travelers. Of the 211,000 parties who visited the province from May–October in 2016, 3.5% of non-resident party visits, or 7,400, visited the Burin Peninsula. Of these, 36% of the non-resident parties were in the region for vacation/pleasure, which was slightly higher than the provincial average of 34%. Most of the non-resident parties that reported an overnight visit to the region were from Ontario (35%). The rest came from western/other Canada (27%) and the Maritimes (17%) with fewer from international origins (8%) and the United States (4%). Visitors destined for Saint Pierre et Miquelon (SPM) also generate tourism travel on the Burin Peninsula, with the remaining 9% of visitors from Quebec (>5% provincial share of visitors from that province).

Of those visiting the Burin Peninsula, 73% graduated from university, slightly less than the 78% university graduate visitor proportion for the Province. Forty percent reported a household income of $100,000 or more, compared to 53% for the Province. The average party size was 2.1 persons, of which close to half (46%) were couples with no children, 16% higher than the Province as a whole. Close to a third (29%) of the visitors travelled alone, 18% lower than the overall provincial average. Over half (56%) of the non-resident travelers were 55 or older, as compared to 48% for the Province (TCII 2018b).

#### 4.4.3.1 Tourism on the Burin Peninsula: 'Come Stay a Spell'

Tourism on the Burin Peninsula is encouraged and monitored by the Heritage Run Tourism Association (HRTA) (HRTA 2016). The HRTA includes the entire Burin Peninsula as well as the French islands of SPM. The HRTA membership includes businesses, educational institutions, individual museums, towns/municipalities, the provincial government and a number of associations, such as the Burin Heritage Tourism Association; Grand Bank Heritage Society; Placentia West Heritage Committee; St. Lawrence Historical Advisory Committee; Grand Bank Development Association; and the Burin Peninsula Chamber of Commerce. Other organizations also provide experiences for residents and visitors, such as the Burin Peninsula Arts Council.

The HRTA website (HRTA 2016) is a major marketing tool for tourism and provides thorough and up-to-date information about the history of the Burin Peninsula and its communities, logistics, services, accommodation, attractions and seasonal events. As guidance for visitors to the Burin Peninsula, highways are used as the connecting link among Heritage Run communities to provide travelers with information, including Mariner Drive, Captain Cook Drive, Captain Clarke Drive and French Island Drive (HRTA 2016).

Tourism marketing and product development on the Burin Peninsula's Heritage Run is also within the mandate of the Eastern Destination Marketing Organization (EDMO), also known as Legendary Coasts, one of the four provincial DMOs representing regional tourism industry operators and organizations (EDMO NL 2013). Employees of the EDMO are active in tourism marketing initiatives and assist with regional tourism product and experience development on the peninsula. Legendary Coasts describes the Heritage Run as follows (EDMO NL 2013):

**"**Encompassing the entire Burin Peninsula, the Heritage Run heads south from the Trans-Canada Highway at Goobies. Past the hills overlooking Swift Current, the Heritage Run will take you past fertile woodlands, stark barrens, and dramatic coastal scenery. At Marystown, the road forks to form a loop around "The Boot". To the east is the town of Burin, snuggled amongst coastal heights, and further south is St. Lawrence, whose history as a mining town is punctuated with stories of incredible history. At the southwest corner of the peninsula are the beaches of Lamaline, which coax the road northward to the town of Fortune, where the ferry service to another country – France to be specific – can be found. The historic town of Grand Bank – whose mariners are the stuff of legends – will round out the loop as it returns to Marystown."

There has been regularly-scheduled passenger ferry service for the 25-km trip between Fortune, on the west side of the peninsula, and St. Pierre for many years. Two new car/passenger ferries are expected to enter into service after docking facilities are prepared in Fortune within the next year, which will greatly enhance travel between SPM and the Province. The EDMO, HRTA and SPM are working together to plan for the anticipated increased numbers of travelers, including the 6,000 French island residents and residents and visitors from Newfoundland.

The Government of France has partnered with the Government of Newfoundland and Labrador and the EDMO to support Legendary Coasts' marketing of the French islands, and the development of itineraries in partnership with the Burin Peninsula and other provincial operators. Dedicated staff and partnership programming has been funded to plan experiences and marketing to increase travel to and from the islands. Tourism operators and communities on the Burin Peninsula have the most potential to benefit from the initiative, by capturing a greater share of travelers from Quebec and France (D. Ambs, SPM Tourism Officer, Eastern Destination Marketing Organization, pers. comm., 7 February 2018).

#### 4.4.3.2 Accommodation Occupancies Reflect the Burin Peninsula Economy

Accommodation occupancy rates reveal the impact of industrial activity on the Burin Peninsula. There is a core market that rents rooms for other business and vacation reasons. Roofed accommodations include three groups: (1) hotels/motels/resorts/suites; (2) B & B's/inns/tourist homes; and (3) cottages and vacation homes. Table 4.35 demonstrates that the volume of rooms available has steadily increased since 2003, and how industrial activity stimulated peaks every five years in 2005, 2010 and 2015, associated with Marystown fabrication yards for offshore oil platform construction projects. Accommodation and occupancy on the Burin Peninsula in 2016 represented 2.7% of total rooms available in the Province and 1.4% of revenue from all rooms sold in the Province, respectively (Table 4.36).

**Table 4.35. Burin Peninsula accommodation revenue and occupancy rates in 2017.**

| Year | Total No. Rooms Available | Total No. Rooms Sold | Occupancy Rate (%) | Total Room Revenue ($CAD, Million) | Average Daily Rate ($CAD) |
|---|---|---|---|---|---|
| 2003 | 70,713 | 26,495 | 37.47 | 1.93 | 73.05 |
| 2004 | 71,531 | 31,400 | 43.90 | 2.55 | 81.40 |
| 2005 | 73,355 | 33,589 | 45.79 | 3.64 | 108.50 |
| 2006 | 63,762 | 18,910 | 29.66 | 2.04 | 108.04 |
| 2007 | 67,500 | 23,743 | 35.17 | 2.80 | 118.21 |
| 2008 | 69,324 | 25,482 | 36.76 | 3.01 | 118.17 |
| 2009 | 69,760 | 23,182 | 33.23 | 2.51 | 108.17 |
| 2010 | 72,378 | 33,247 | 45.94 | 3.09 | 93.02 |
| 2011 | 73,112 | 27,003 | 36.93 | 2.67 | 99.00 |
| 2012 | 73,240 | 33,178 | 45.30 | 3.71 | 111.86 |
| 2013 | 76,425 | 24,073 | 31.50 | 2.64 | 109.75 |
| 2014 | 78,068 | 29,459 | 37.74 | 3.23 | 109.65 |
| 2015 | 83,870 | 35,386 | 42.19 | 4.14 | 117.05 |
| 2016 | 82,166 | 22,988 | 27.98 | 2.78 | 120.80 |
| 2017 | 80,862 | 22,874 | 28.29 | 2.80 | 122.55 |

Source: TCII (2018c); R. Haynes, Research Analyst, Tourism Research Division, Department of Tourism, Culture, Industry and Innovation, pers. comm., 2 March 2018.

**Table 4.36. Newfoundland and Labrador accommodation revenue and occupancy rates in 2017.**

| Year | Total No. Rooms Available | Total No. Rooms Sold | Occupancy Rate (%) | Total Room Revenue ($CAD, Million) | Average Daily Rate ($CAD) |
|---|---|---|---|---|---|
| 2016 | 2,914,974 | 1,457,272 | 49.99% | $201.78M | $120.80 |

Source: TCII (2018c).

Other Burin Peninsula tourism indicators reveal predominantly resident tourism activity, such as overnight stays in Frenchman's Cove Provincial Park during 2013–2017 (values are number of nights sold and seasonal occupancy rate [%], respectively) (R. Haynes, Research Analyst, Tourism Research Division, Department of Tourism, Culture, Industry and Innovation, pers. comm., 2 March 2018).

- 2013: 5,535 and 59%
- 2014: 5,837 and 62%
- 2015: 5,518 and 59%
- 2016: 4,662 and 49%
- 2017: 3,981 and 49%

Residents are the predominant Frenchman's Cove Provincial Park users, representing 82% of overnight visitors in 2017. The remaining overnight visitors were from other Canadian provinces (15%), the US (2%), and other foreign countries (1%) (R. Haynes, Research Analyst, Tourism Research Division, Department of Tourism, Culture, Industry and Innovation, pers. comm., 2 March 2018).

The Provincial Seaman's Museum in Grand Bank receives ~3,000 visitors per year, and visitor information centres in Marystown, Fortune and Goobies receive ~2,400, 4,000 and 5,400 visitors per year, respectively (the visitor centre in Goobies was closed during 2017) (R. Haynes, Research Analyst, Tourism Research Division, Department of Tourism, Culture, Industry and Innovation, pers. comm., 2 March 2018).

#### 4.4.3.3 Tourism Attractions

Tourism on the Burin Peninsula and around Placentia Bay (see Figure 4.64 for communities involved in tourism) is based on family visits, heritage attractions and the natural environment, with hiking, camping, paddling, sailing and driving primarily pursued on an individual or self-guided basis.

There is one marine tourism operator based in Placentia Bay offering marine adventure tours, outfitting or diving. Commercial operations, such as inns, bed and breakfasts, motels and attractions (e.g., museums, signage, trails) are available to tourists. The provincial government takes the lead role in promotion, augmented by volunteer heritage and/or tourism association support in many communities, including via advertising, websites, visitor information centres and an annual Traveler's Guide (GNL 2018b). The 2018 Traveler's Guide (GNL 2018b) provided a list of licensed tourism properties and main community events on the Burin Peninsula (Table 4.37).

While not tourism activity per se, there is also seasonal use of an estimated 400 cabins located on the islands and isolated shoreline of Placentia Bay. These cabins are predominantly used during the summer months for recreation purposes, and occasionally as a base for commercial fishing.

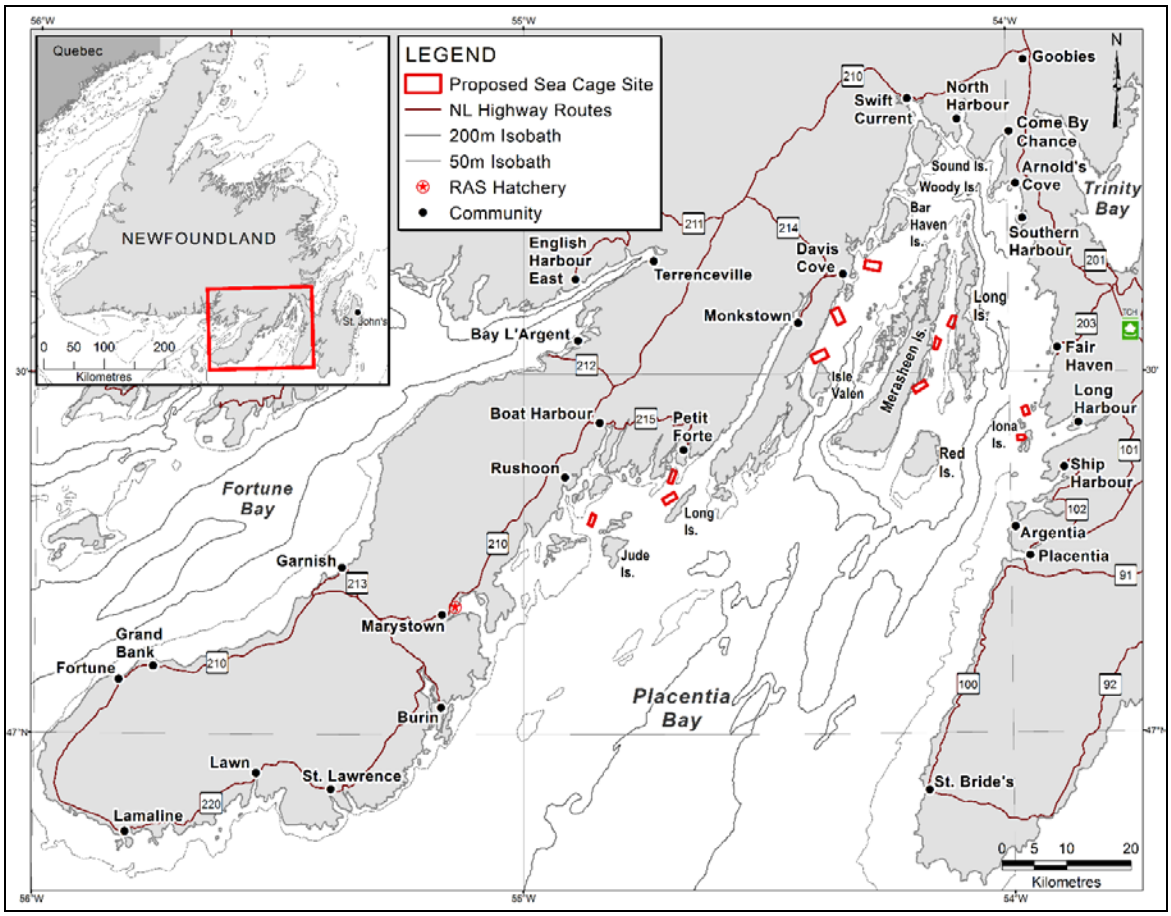



**Figure 4.64. Communities with tourism involvement on the Burin Peninsula and around Placentia Bay, relative to the proposed sea cage sites.**

**Table 4.37. List of 2018 tourism properties and events.**

| Tourism Properties / Events | Location | Description |
|---|---|---|
| ***Built Attractions*** | | |
| Vernon's Antique Toy Shop | Swift Current, Route 210 | 60+ antique cars |
| Grand Meadows Golf Course | Frenchman's Cove, Route 213 | 9-hole golf course next to Frenchman's Cove Park |
| Golden Sands Amusement Park | Burin, Route 221 | Family park with pond and beach |
| ***Heritage Attractions*** | | |
| Livyer's Lot Heritage Site | Boat Harbour, Route 210 | Traditional lifestyles' exhibits; café |
| Marystown Heritage Museum | Marystown, Route 210 | Artifacts & murals |
| Burin Heritage Museums | Burin, Route 221 | Gallery, café, tidal wave & fishery exhibits |
| Oldest Colony Trust Building | Burin, Route 221 | Former cold storage, repurposed |
| Echoes of Valour | St. Lawrence, Route 220 | Commemoration sculpture for mining and ship disasters |
| Miner's Memorial Museum | St. Lawrence, Route 220 | Tools, artifacts and murals |
| Provincial Seamen's Museum | Grand Bank, Route 220 | Fishing family artifacts |
| Provincial Mariners' Memorial | Grand Bank, Route 220 | Tribute to mariner tragedies |
| Fortune Fishing Sheds | Fortune, Route 220 | Recreated fishing sheds and stages |
| Fortune History Board | Fortune, Route 220 | Mariner and town history |
| Lake Heritage House | Fortune, Route 220 | 125-year-old fishing family home |
| Wade Drake & Burch Nash Park | Fortune, Route 220 | Memorial to victims of Cougar helicopter |

| Tourism Properties / Events | Location | Description |
|---|---|---|
| | | tragedy |
| George Harris House | Grand Bank, Route 220 | Merchant house and museum |
| Lighthouse and Waterfront | Grand Bank, Route 220 | 1850s historic properties |
| Heritage Walk | Grand Bank, Route 220 | Historic settings throughout town |
| ***Natural Attractions*** | | |
| Fortune Head Ecological Reserve | Fortune, Route 220 | Rocks on exposed cliffs re: Precambrian and Cambrian eras |
| Fortune Head Geology Centre | Fortune, Route 220 | Interpretation, rock collections, reserve tours, camps, Fossil Shop |
| Shoal Cove Beach | St. Lawrence, Route 220 | Natural beach |
| Lawn Bay Ecological Reserve | Roundabout, Route 220 | Seabird breeding colonies on 3 islands in the bay |
| Frenchman's Cove Provincial Park | Frenchman's Cove, Route 213 | Natural habitat and 9-hole golf course |
| ***Trails and Lookouts*** | | |
| Cook's Lookout Trail | Burin, Route 221 | 6 km gravel & boardwalk |
| Salt Pond Walking Trail | Burin, Route 221 | Trail around pond |
| Cape Chapeau Rouge View Park and Trail | St. Lawrence, Route 220 | Centre town lookout and storyboards, trail to highest point |
| Chamber Cove Heritage Walk | St. Lawrence, Route 220 | 5 km trail tracing rescue route of *USS Truxton* and *USS Pollux* ship disasters; and old mine |
| St. Lawrence Nature Walk | St. Lawrence, Route 220 | 16 km trails on old mine roads |
| Horse Brook Walking Trail | Fortune, Route 220 | Ecological reserve view, with panels |
| Grand Bank Nature Trail | Grand Bank, Route 220 | 5 km trail to Bennett Hill, view salmon ladder |
| Marine Hike | Grand Bank, Route 220 | 7 km to Grand Bank Cape |
| Garnish Point Rosie Trail | Garnish, Route 213 | 50 km trail for ATV use, and recreation |
| ***Festivals and Events*** | | |
| Grand Bank Winter Carnival | Grand Bank, Route 220 | January 29-Febuary 3 |
| *USS Truxton* and *USS Pollux* commemorative service | St. Lawrence, Route 220 | Annual memorial service for victims of ship disaster (February 18) |
| Grand Bank Regional Theatre | Grand Bank, Route 220 | Summer plays and dinners; art displays (July 4-Aug 30) |
| Burin Peninsula Festival of Folk and Song | Burin, Route 221 | Traditional music performances and dances, workshops, food (July 6–8) |
| Grand Bank Summer Festival | Grand Bank, Route 220 | Week of family activities<br>July 28–August 4 |
| Burin Heritage Weekend | Burin, Route 221 | 4-day community event |
| St. Lawrence Laurentians Day | St. Lawrence, Route 220 | Annual games and parade, food, fireworks (August 3–5) |
| Garnish Bakeapple Festival | Garnish, Route 231 | Week of community events and food, entertainment (August TBA) |
| *Feller From Fortune* International Festival | Fortune, Route 220 | 4-day community event<br>August 16–19 |
| George Harris House Garden Party | Grand Bank, Route 220 | Community event at the merchant house and museum (July 31) |
| Annual Burin Peninsula Arts Council Craft Fair | Marystown, Route 210 | Fall fair of local crafts, music and workshops (November 2–4) |
| ***Shops and Galleries*** | | |
| Burin Heritage Crafts | Burin, Route 221 | Local crafts, hooked mats, art |
| Island Rock Jewelry & Crafts | St. Lawrence, Route 220 | Fluorspar jewelry and products; gift shop at Miner's Museum |
| Grand Bank Heritage Crafts | Grand Bank, Route 220 | Local crafts, sealskin, dories, art |
| Craft Tea Room | Fortune, Route 220 | Traditional crafts and food |
| ***Tours*** | | |
| Saint Pierre Ferry office | Fortune, Route 220 | Hour long ride, overnight packages |
| ***Accommodations and Campgrounds*** | | |
| Kilmory Resort & Trailer Park | Swift Current, Route 210 | 4-star 21 waterfront cottages; 2 ½-star 10 semi-services sites; trout, salmon fishing, boat rentals, trails |
| Woody Island Resort | Woody Island via Garden Cove, Route 210 | Resettled community, lodge |
| Marystown Motel and Convention Centre | Marystown, Route 210 | 3 ½-star 113 rooms, suites, conference rooms, restaurant, bar |
| Braxton Suites | Marystown, Route 210 | 4-star 13 housekeeping suites |
| Spanish Room Manor B&B | Marystown/Spanish Room | 4 ½-star 7 rooms, villa on 3 acres |

| Tourism Properties / Events | Location | Description |
|---|---|---|
| Burin Efficiency Units | Salt Pond/Burin, Route 220 | 4-star 6 efficiency units |
| Golden Sands Resort & Trailer Park | Burin, Route 221 | 3-star 18 cottages, 4 chalets; 2 ½-star 137 sites |
| | St. Lawrence, Route 220 | 2½-star 16 rooms, pizza takeout |
| Dockside Efficiency Unit | Fortune, Route 220 | 3 ½-star 3 efficiency units |
| Fortune Harbourview Tourist Home | Fortune, Route 220 | 3 ½-star 5 rooms |
| Hotel Fortune | Fortune, Route 220 | 3 ½-star 8 rooms |
| Horseback Trailer Park | Fortune, Route 220 | 2-star 48 serviced sites |
| Abbie's Garden Suites | Grand Bank, Route 220 | 4 ½-star 5 rooms |
| Burin Peninsula Motes | Grand Bank, Route 220 | 3-star-10 rooms |
| Thorndyke B&B | Grand Bank, Route 220 | 4-star-4 rooms heritage home |
| Cape View Suite | Grand Bank, Route 220 | 3 ½-star efficiency suite |
| Dolly's Place | Grand Bank, Route 220 | 4-star-vacation home |
| Fishermen's View B&B | Grand Bank, Route 220 | 4-star-4 rooms |
| Grand Fairways Resort Cottages | Frenchman's Cove, Route 213 | 3 ½-star 6 cottages at golf course |
| Frenchman's Cove Provincial Park | Frenchman's Cove, Route 213 | 76 sites |
| Long Ridge Cottages | Garnish, Route 213 | 3 ½-star 4 cottages |

Source: GNL (2018).

### 4.4.3.4 Community-based Tourism Marketing

Larger communities on the peninsula also promote their attractions and events individually at visitor information centres, located at strategic locations such as on the main highway, the Trans-Canada Highway and within communities, using brochures, attractive websites and on-site signage. Information and suggested itineraries are provided on the provincial tourism website (NLT n.d.).

***Marystown***

Marystown has a Visitor Information Centre that provides information for the rest for the peninsula as well as Marystown itself. Marystown has recently developed an update to its Integrated Community Sustainability/Municipal Plan (Tract 2017). The Town wants to attract more commercial, industrial and tourism business to diversify its tax base. The report suggests that, currently, non-resident tourists "…generally use Marystown as a service center and maybe a stop-over on the way to another destination. Marystown needs to define itself as a gateway destination, not just another stop on the Heritage Run" (Tract 2017).

Marystown lists several tourist attractions, including the largest conference venue, Marystown Heritage Museum, St. Gabriel's Hall/Veterans Centre Memorial Room. There is currently an effort to re-energize St. Gabriel's Hall (which has a 400-person auditorium/theatre space) and turn it into a multi-function facility (P. Curran, Lead Consultant, Pat Curran and Associates Ltd., pers. comm., 20 February 2018). Marystown has established sports facilities and attracts 'sports tourism'. The natural environment and sheltered ocean areas around Marystown have not historically been a focus for tourism, and provide potential for future tourism opportunities. Industrial tourism may also be a possibility, as the Grieg NL hatchery is planning to have visitor and education capabilities.

Near Marystown, at Midway on the Burin Highway (Route 210), the Heritage Committee, a sub-committee of the Development Association, established and operates an econo-musée showcasing textile craft, a specialty of the area. Econo-musées function to pass on traditional skills (E. Murphy, Chair, Placentia West Tourism Committee, pers. comm., 20 February 2018). The Committee also runs a café, The Tea Rose, at the same location, along with a museum and gift shop.

The HRTA's information regarding 'Mariner Drive' includes the communities on both sides of the Burin Peninsula that are encountered after leaving the Trans-Canada Highway (see Figure 4.64). A passenger ferry to the isolated community of Rencontre East (and further west to the Connaigre Peninsula) operates out of Bay L'Argent on Burin Peninsula's west coast.

***Burin***

Burin, an incorporated community adjacent to Marystown to the south, has recently prepared a Strategic Plan for 2018–2022, '*Navigating Our Way Forward'* (JW 2018) (K. Lundrigan, Mayor, Town of Burin, pers. comm., 21 February 2018). The Burin council *"…places a high value on the town's rich history and wishes to work with various levels of government and with enterprising individuals and community groups to continue to carve out our niche market and develop our heritage area (and events). The current council feels it's far from complete yet. We are merely scratching the surface. Our past is worth celebrating. And our heritage area has a wealth of opportunity and potential for increased tourism and economic growth" (JW 2018).*

*The council has moved quickly on a key heritage tourism initiative, the Burin Heritage Square Revitalization Project (MLS 2017*). Local people commonly refer to the community as Old Burin and New Burin, with Old Burin being the most seaward area of the community, essentially the end of a peninsula surrounded on three sides by Little Burin Bay, Placentia Bay (L. Hartsen, Town Manager, Town of Burin, pers. comm., 22 February 2018). Heritage Square is within the Old Burin area. T*he intent of the project is to revitalize this historic area (e.g., redevelop some of the historic buildings, add amenities such as walking trails and performance venues), using two guidance documents to build on Burin's culture, people and natural environment: Tourism Destination Visitor Appeal Assessment: Eastern Region (TDVAA)* (BT and TC 2014) and *Uncommon Potential: A Vision for Newfoundland and Labrador Tourism* (*Vision 2020*) (HNL 2013). The proposed revitalization plan has been put on the town's website for residents' review and comment.

***St. Lawrence and Adjacent Communities***

While the main tourism draw of the Burin Peninsula is the beauty of the natural environment, the Town of St. Lawrence is also known for sports (especially soccer) and mining (TSL 2015). The Town was awarded federal and provincial funding in 2016 for the renovation of the Community Centre as a sports and events complex, and to expand and enhance the Miner's Memorial Museum by adding exhibit space for both mining and the *Truxton* and *Pollux* naval disaster, as well as an experiential component in jewelry making using fluorspar and an electronic self-guided walking tour (expected to be available in 2018/2019).

St. Lawrence, the neighbouring community of Lawn, and several communities to the south (Lord's Cove, Taylor's Bay, Point aux Gaul and Lamaline) have museums and/or signage associated with a 1929 natural disaster, a tsunami which destroyed much of the communities and the fishing infrastructure. In addition, Allan's Cove highlights the Our Lady of the Lourdes Grotto, and Point May has Point Crewe Heritage Park and a view of the French islands of SPM.

***Fortune Bay***

On the Fortune Bay side of the Burin Peninsula, the two communities of Fortune and Grand Bank are associated with the HRTA. Fortune is the point of departure by ferry between Newfoundland and SPM, France. Recently, a geological find is an added draw to Fortune; it is the site of the geological time boundary between the Precambrian Era and Cambrian period (i.e., rock and fossils from 541 million years

ago that mark the increase in biodiversity on Earth). The Fortune Head Geology Centre supports this attraction, known officially as the Global Boundary Stratotype Section and Point (GSSP).

Grand Bank celebrates a long history of fishing through community architecture and museums, such as the Provincial Seamen's Museum. The Grand Bank Regional Theatre offers programs to both residents and visitors. Near-by Frenchman's Cove has a golf course and a Provincial Park, while Garnish advertises ATV trails.

***Head of the Bay***

Arnold's Cove at 'the head of the Bay' (or innermost area) and the Placentia area on the east coast of the Bay also have active tourism associations.

Arnold's Cove viewpoints show both the natural beauty of the area and some of the main industrial activity in the Bay, with views of tankers travelling or at anchor in the Bay, heading to the refinery at Come By Chance or transshipment terminal at nearby Whiffen Head (TAC 2010a).

The cultural history in Arnold's Cove is focused on the Government of Newfoundland and Labrador's Resettlement Program, an initiative started in the 1960s to move residents of small, isolated communities on the islands within Placentia Bay into larger settlements. This interest was highlighted in the 2016 *Stories of Resettlement*, a year-long commemoration of 50 years of the resettlement of the Placentia Bay Islands, with a program of events including presentations, tours and theatre shows (TAC 2010a). Arnold's Cove has maintained interest in resettlement via the museum located in Drake House, now The Heritage House. This house was originally built and located in Haystack, an island community. In 1969, it was floated to Arnold's Cove and is now maintained by the Placentia Bay Islands and Area Heritage Foundation (Heritage NL 2016).

Arnold's Cove is a gateway for boaters (recreational and fishing) who wish to visit the islands and resettled communities, with travel facilitated by the development of facilities such as floating wharves and a new breakwater by the Harbour Authority (M. Slade, Harbor Authority, Arnold's Cove, pers. comm., 23 February 2018). There can be upwards of 75–100 pleasure craft using the wharves, both power boats and open speed boats. In some cases, boats overwinter in Arnold's Cove and use the Swift Current and Garden Cove wharves during the summer.

*Cabins and Islands*

Previous research (NLRC 2007) and personal communication (L. Pomeroy, Woody Island Resort Owner/Operator, Placentia Bay, pers. comm., 24 February 2018) suggests that there are likely more than 400 cabins on the Placentia Bay islands and some areas of the coast, principally on Merasheen, Long, Woody and Red Islands, and Bar Haven. Woody Island Resort is the only large marine tour operator in the area, and owns and operates a complex of four lodges/houses on Woody Island during the summer months, transporting visitors using its own vessel from Garden Cove to Woody Island (Figure 4.65). In the past, at times there were as many as three operators licensed to carry up to 25 passengers out to the islands from the Garden Cove area (L. Pomeroy, Owner/Operator, Woody Island Resort, Placentia Bay, pers. comm., 24 February 2018).



Source: WIR (2018).

**Figure 4.65. Woody Island Resort, Placentia Bay.**

There are several small communities near Marystown and the proposed sea cages in the Rushoon BMA, including South East Bight, Petit Forte, Baine Harbour, Boat Harbour, Rushoon, St. Joseph and Parker's Cove. Grieg NL met with fishers from Petit Forte, Boat Harbour and Baine Harbour in February 2018 (Appendix A *in* Grattan et al. 2018, Volume 3). During these meetings, fishers indicated that there has been an increase in pleasure boating, mainly power boats, over the last several years, primarily travelling to the islands, often to cabins built there. For some, it is a return to land abandoned during resettlement.

***East Coast of Placentia Bay***

Placentia is the largest community on the east coast of Placentia Bay and has a long history, dating from the 1600s (TP 2014). Tourism attractions include archaeological sites (e.g., Fort Louis, British New Fort and the Placentia Cultural Interpretation Centre), museums (e.g., Castle Hill), historic architecture and a town square that includes Sacred Heart Roman Catholic Church, one of Placentia's key architectural landmarks, and Our Lady of the Angels Convent. The square also includes modern additions such as the Placentia Bay Cultural Arts Centre, a state-of-the-art multipurpose facility fully equipped for cultural events and performances, conferences, exhibits and gallery space. The Centre also houses the Voices of Placentia Bay Exhibit, a celebration of singers, musicians and storytellers from Placentia Bay. This exhibit has interactive components where visitors can play music, tell their own story, and sing their own song.

Placentia is the entry to the Port of Argentia, a marine industrial area and location of the seasonal Marine Atlantic car/passenger ferry to Nova Scotia and the 'Cape Shore', i.e., the coastline area extending south and east toward the ecological reserve at Cape St. Mary's, featuring seasonal populations of gannets, murres and kittiwakes.

### 4.4.3.5 Recreation

Recreation in Placentia Bay is typically connected to the natural environment, such as fishing, berry picking, hunting, hiking, bird watching and camping (NLRC 2007; Vale 2008). Many communities on the Burin Peninsula advertise and maintain trails and hiking paths and these are used by both visitors and residents alike (see Table 4.37).

***Sports and Recreation***

Several towns in Placentia Bay have active recreational facilities and programs for residents of all ages. The facilities in larger communities are used by neighbouring communities and are described below.

*Marystown*

Marystown is a regional hub for recreation and sport on the Burn Peninsula, with facilities including the Marystown Arena, a soccer pitch, two baseball diamonds, and a professional level track and field complex (TM 2011). The Marystown Recreation Complex, opened in February 2016, is owned by the Town and operated by the YMCA. It is open to all communities on the Burin Peninsula and soon to visitors from SPM, and offers a pool with lanes, play pool with waterslide, conditioning centre, indoor track, multipurpose gymnasium and facilities for young children (Tract 2017).

There is a full-time Director of Recreation and Community Services, and programming is available for all ages (TM 2011). In Marystown's recent planning document, opportunities are identified to further improve and connect trails within the town, increasing access and use by seniors (Tract 2017).

*Burin*

The Town of Burin has two regulation-size soccer pitches that are used by the Burin Minor Soccer Association. League soccer on the Burin Peninsula is highly competitive (e.g., the Challenge Cup), but the Association also welcomes young players (under 9 years of age) for recreational play and tournaments, using miniature sized nets (TB 2017). The Burin Minor Softball group supports softball and slow pitch leagues at the Craig Lundrigan Memorial Field, which is wheelchair accessible. In their recent Strategic Plan (JW 2018), recreation and community planning is identified as a priority for Council with a focus on the expansion of existing recreational facilities and programs, and providing increased access.

*St. Lawrence*

St. Lawrence is celebrated as the Soccer Capital of Canada (TSL 2015). The Town's men's team, the Laurentians, was established in 1904. There are two regulation-sized soccer pitches, as well as a multipurpose recreation centre, tennis courts, curling rink and softball field.

*Arnold's Cove*

Arnold's Cove has a volunteer-based Recreation Committee. Recreational facilities consist of a sportsplex area with a fenced, fully-equipped playground, regulation-sized ball field, outdoor rink and recreation building geared to the town's youth. An annual highlight is the summer Fog Festival, a two-day celebration, ongoing since the 1997 Come Home Year (TAC 2010a).

*Placentia*

On the eastern side of the Bay, Placentia has the Unity Parc, an indoor stadium that can be used for various sports, lessons, leagues, and school or family outings, such as skating, hockey, figure skating, curling and, for adults, an indoor walking program. The annual Placentia Regatta involves highly competitive rowing teams from several communities (TP 2014).

***Songs, Storytelling and Performance***

Recreational activities in Placentia Bay also include art, concerts, theatre, and performance. As previously mentioned, there are several performance venues on the Burin Peninsula.

One project in particular focuses on capturing the traditional use of songs and storytelling (especially in the form of recitations) by the people of Placentia Bay to provide social commentary. The *Voices of Placentia Bay* project is a collaborative effort by the Placentia Bay Historical Society, Town of Placentia and Research Centre for the Study of Music, Media and Place (RCSMMP n.d.). The collection of songs originating in Placentia Bay and/or from Placentia Bay's history, and the importance and tradition of music and storytelling in Placentia Bay, provide a very human accounting of the social history and culture of the Bay. The *Voices of Placentia Bay* project has archived the songs (collected mainly by Eric West, a Newfoundland traditional musician) with the Memorial University of Newfoundland Folklore and Language Archive (MUNFLA).

The *Voices of Placentia Bay* project organizes the collected songs based on local significance, including Resettlement, People and Places, Historical Events, and Social Commentary. Songs in the People and Place, and Historical Events categories tell stories about individuals, the memory of a specific place, and, in some cases, "…serve as a memorial to those lost in…tragic events, and a reminder to those who survived them," such as The Tidal Wave Song about the 1929 earthquake and tidal wave (RCSMMP n.d.). Songs in the Social Commentary category speak to economic situations and other facets of society, such as the treatment of crime and criminals. Visitors to the Placentia Bay Cultural Arts Centre in the Town of Placentia are provided the opportunity to view, listen to and sing along with an exhibit from the *Voices of Placentia Bay* project.

Resettlement was and is controversial, and is still a reason to get together and sing, tell stories and speak of memories. In 2016, Arnold's Cove hosted a Commemoration of 50 Years of Resettlement event that drew a large number of participants. Other resettled communities hold occasional reunions at community sites. The first reunion associated with Haystack, a resettled community on Long Island, held in 1998, had 500 participants (E. Johnson, resident of North Harbour and Haystack, pers. comm., 29 April 2018). Many of the resettled communities now contain cabins or seasonal residences, (L. Pomeroy, Woody Island Resort Owner/Operator, Placentia Bay, pers. comm., 24 February 2018), increasing the amount of recreational boat traffic during the last several years. Songs and stories are still being created and performed, such as the *Inspired B'y Life Experience, Red Island – Resettlement Girl*, written and performed by Marion Counsel, Helen Murphy and Barbara O'Keefe at The Rooms in St. John's, NL on 16 February 2018.

***Eco-tourism***

The physical landscape of the Burin Peninsula is well suited for hiking, exploring, camping, hunting and fishing, with barrens, woods, ponds, streams and rolling hills visible from the highway. The coastal waters are accessible for boating, sailing and paddling, with inlets, coves and islands to provide shelter from high winds and seas, and to give a glimpse of past life. The waters of the Bay support whales and

seals, with sightings of tuna and sharks not uncommon in recent years (C. Hepditch, Fisher, Baine Harbour, pers. comm., 20 February 2018). Eagles, otters, moose and caribou are commonly sighted on the shoreline from boats.

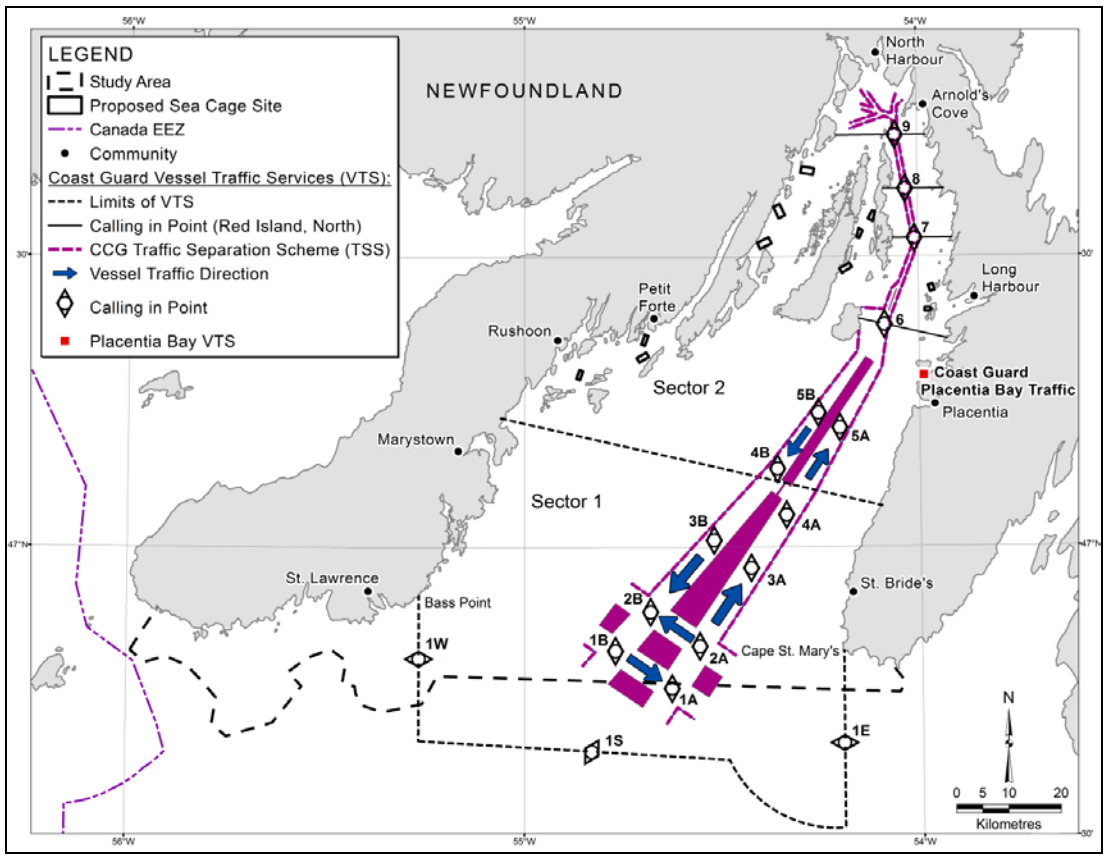
While there appears to be an opportunity for eco-tourism in the area, such ventures are currently deterred by the high cost of insurance required to be able to carry paying passengers (L. Pomeroy, Owner/Operator, Woody Island Resort, Placentia Bay, pers. comm., 24 February 2018). At present, there is a single tour operator providing single- and multi-day excursions on a commercial basis within the waters of Placentia Bay, travelling by vessel to accommodations on Woody Island, one of over 360 islands in the area.

Overall, the islands are frequently visited, with individuals and families building summer homes or cabins and wharves on many of the islands, some returning to family-held land and others exploring. Visitors travel to the islands by boat, either via their own vessel or through an arrangement with someone in a coastal community. Kayakers can arrange to be transported by fishing boat or speedboat across the open waters of the Bay to paddle and camp among the islands (D. Miller, Past President, Kayak NL, pers. comm., 25 February 2018). An estimated 400 cabins are located on the islands throughout Placentia Bay, and during the summer there are up to 200 recreational boaters on the water on a given day (NLRC 2007). Fishers in the communities nearest the proposed sea farms report that over the past five to ten years, there has been an increase in recreational boating in their fishing area during the summer months, with people visiting nearby islands to hike, stay at their cabins, or fish cod during the recreational fishery (K. Handrigan, Fisher, Petit Fort, pers. comm., 20 February 2018; C. Hepditch, Fisher, Baine Harbour, pers. comm., 20 February 2018).

### 4.4.4 Marine Navigation

There is considerable commercial vessel traffic in Placentia Bay, primarily large tankers or bulk carriers travelling into the inner bay to the refinery at Come By Chance, the International-Matex Tank Terminals (IMTT) Transshipment Terminal at Whiffen Head near Arnold’s Cove, and Vale’s Long Harbour Processing Plant (LHPP), as well as large fishing vessels travelling to the Icewater Seafood Inc. fish plant in Arnold’s Cove. Some commercial bulk carriers and seasonal Marine Atlantic car/passenger ferries that enter the Bay go into the Port of Argentia. Operating among these large vessels are many small fishing vessels, fishing crab at the edges of the vessel traffic lanes or crossing the lanes to reach fishing grounds (NLRC 2007).

Placentia Bay is designated a high-level traffic zone where Vessel Traffic Services function is needed. This service is provided by the CCG Placentia MCTS (A. Brown, Acting Head of Station, CCG, Placentia, pers. comm., 27 February 2018). The Placentia Bay Vessel Traffic Services zone comprises all Canadian waters between a line bearing 180° True from Bass Point (46°55’05”N, 055°15’55”W), and a line bearing 180° True from Cape St. Mary's lighthouse (46°49’22”N, 054°11’49”W), and includes two sectors and 12 calling-in points. All aspects of the Grieg NL proposed Project are within the Vessel Traffic Services area of Placentia Bay (Figure 4.66).




Source: CCG 2017.

**Figure 4.66. Vessel Traffic Services area of Placentia Bay.**

Vessel traffic is monitored by radar and Automatic Identification System (AIS). Vessels meeting the criteria below are required to call at calling-in points to provide an Estimated Time of Arrival (ETA) and receive relevant traffic information.

a. a ship ≥20 m in length; and/or
b. a ship engaged in towing or pushing any vessel or object, other than fishing gear, where:
    i. the combined length of the ship and any vessel or object towed or pushed by the ship is ≥45 m in length; or
    ii. the length of the vessel or object being towed or pushed by the ship is ≥20 m in length.

Participation by vessels meeting the above criteria is mandatory. Generally, recreational vessels are not required to participate, but some contact the MCTS Centre for vessel information when crossing the lanes in the Vessel Traffic Separation Scheme (VTSS) (M. Slade, Harbour Authority, Arnold's Cove, pers. comm., 22 February 2018). It is likely that most recreational boaters rely on cell phone and/or VHF for communication (R. Wareham, Resident, Arnold's Cove and Harbour Buffet, pers. comm., 31 January 2018). The vessel traffic lanes are managed as per the *Canada Shipping Act* and associated Collision Regulations. The vessel traffic system is managed by the MCTS Centre ('Placentia Traffic') located in Argentia (A. Brown, Acting Head of Station, CCG, Placentia MCTS, pers. comm., 26 February 2018).

The MCTS tracks, monitors and controls tankers and other commercial vessels >20 m length overall (LOA), as well as fishing vessels >24 m LOA and any other vessels that are visible on radar or by AIS, or call in to the Centre.

There is compulsory pilotage within the VTSS and optional pilotage for Long Harbour. The compulsory pilotage area within the Bay consists of all the navigable waters north of a line drawn from Long Harbour Head to Fox Island, thence along a line to a position of Latitude 47°20′ N, Longitude 54°06.5′ W, thence to Ragged Point (the most southerly point of Red Island), and Eastern Head. Grieg NL's marine operations planned in relatively nearshore waters within the west side of the Bay and between Merasheen and Long Islands are located beyond the large vessel traffic and traffic lanes (see Figure 4.66). Two proposed sea cage sites off the entrance of Long Harbour on the east side of the Bay are near but outside the vessel traffic lane into Long Harbour as well as the original VTSS.

Table 4.38 provides a snapshot of typical annual vessel traffic in Placentia Bay for a year. The data were developed for the Transport Canada 2006 public consultation regarding oil spill risk assessment on the south coast of Newfoundland (Transport Canada 2006 *in* NLRC 2007). The Vale LHPP began operations after these data were compiled. The Long Harbour facility receives eight visits by the ice-strengthened bulk carrier MV *Umiak*, and two to three bulk carriers carrying reagents during a year. Ten vessels are anticipated to transit to the Processing Plant during 2018, which may increase to 10–14 vessels per year in the near future (S. Hunt, LHPP Operations, pers. comm., 11 April 2018).

**Table 4.38. Placentia Bay Vessel Traffic: Annual movements, April 2004–March 2005.**

| Vessel Type | Inbound | Outbound | Transit | In-Zone | Out-Zone | Total |
|---|---|---|---|---|---|---|
| Tanker <50,000 DWT | 133 | 141 | 24 | 66 | 0 | 364 |
| Tanker >50,000 DWT | 352 | 355 | 12 | 193 | 0 | 912 |
| Chemical Tanker | 27 | 20 | 6 | 9 | 0 | 62 |
| General Cargo | 28 | 30 | 32 | 14 | 0 | 104 |
| Bulk Cargo | 6 | 6 | 14 | 0 | 0 | 26 |
| Container | 52 | 52 | 268 | 19 | 1 | 392 |
| Tug | 11 | 11 | 8 | 2,016 | 0 | 2,046 |
| Tug with Tow | 14 | 13 | 10 | 2 | 0 | 39 |
| Government | 46 | 48 | 18 | 119 | 0 | 231 |
| Fishing | 128 | 131 | 5 | 29 | 0 | 293 |
| Passenger | 2 | 1 | 5 | 0 | 0 | 8 |
| Other (recreation and fishing vessels >20m) | 3 | 2 | 5 | 1,286 | 0 | 1,296 |
| Vessels <20 m | 0 | 16 | 18 | 978 | 0 | 1,012 |
| **Sub-total Movements** | **802** | **826** | **425** | **4,731** | **1** | **6,785** |
| Ferry | 39 | 42 | 9 | 1,411 | 0 | 1,501 |
| **Total Movements** | **841** | **868** | **434** | **6,142** | **1** | **8,286** |

Source: Transport Canada (2006 *in* NLRC (2007).
Note: Vessel movements are categorized as follows;
Inbound: A vessel entering the Vessel Traffic Services (VTS) Zone;
Outbound: A vessel leaving the VTS Zone;
Transit: No arrival or departure port within the Zone;
In-Zone: A vessel movement that begins and ends within the VTS Zone (within Placentia Bay; and
Out-Zone: A vessel participating in VTS but which his not within the VTS Zone of responsibility.

## 4.4.5 Landscapes

Communities on the Burin Peninsula identify the beauty of the natural landscape as one of their assets for both residents and tourists alike, and take special pride in their attachment to the sea (P. Pike, Mayor,

St. Lawrence, Placentia Bay, pers. comm., 19 February 2018). Tourism in Placentia Bay is often based on the natural environment, including hiking, camping, paddling, sailing and driving (GNL 2018b). There is also seasonal use of an estimated 400 cabins located on the islands and isolated shorelines of Placentia Bay. These cabins are primarily visited during the summer months for recreation or as a base for commercial fishing. There are few communities within the BMAs on the west side of Placentia Bay, but there are seasonal residences and cabins on some of the islands. The sea cages will be well marked in order to be visible to passing recreational, tourism or fishing vessels. In the Rushoon, Merasheen and Long Harbour BMAs, some of the sea cages and/or associated vessels may be visible from cabins on the coast or islands.

Using satellite imagery (i.e., Microsoft Bing aerial imagery), potential cabins were identified (although it was not possible to determine if a structure was in use or not) and, using ArcGIS software, line of sight and distances from cabin to the centroid of the sea cage sites calculations were made (R. Elliott, GIS Specialist, LGL, pers. comm., 13 March 2018). It was assumed that some part of the sea cage array or barge(s) could be visible from a distance of 10 km. This can be considered a 'worst case'. Visibility of the cages will depend on multiple aspects, including the background (e.g., island, ocean), the orientation of the site, and the weather conditions (i.e., waves, fog). In some cases, the cages would not be visible beyond 500–1,000 m from the shore line depending on the conditions. The barges that Grieg NL will be using are considered 'soft shapes' due to their angled edges and staggered structure, rather than a harsh rectangular structure. This will have an impact on the ability to see a barge from a distance. The largest vessel (feed/accommodation barge) from the waterline to top of silo is 7.9 m x 44 m long, while the smaller satellite barges have a height above water of 4.5 m x 28.4 m. All barges are anchored on site and will be located in the middle of the sea cages (see Figures 2.36 and 2.37). The cage collars of each sea cage will be at the sea surface and the handrail around a cage walkway will be about 1.2 m above the surface. Transparent netting to keep aerial predators and birds out of a cage will be supported by flexible fibreglass poles, extending about 5 m above each cage (see Figure 2.20).

Within the Rushoon BMA, some of the sea cages or attending barge(s) may be within sight of some cabins on Flat Islands and Oderin Island (cabins on Oderin are 3–4 km from the sea cages and those on Flat Islands are ~6–7 km away). Within the Merasheen BMA, some of the cabins on Bar Haven Island are within 8–9 km of proposed sea cage sites off Isle Valen, and one cabin on Vigors Island is within ~5 km of this farm. There are several cabins on the western shore of Placentia Bay near Isle Valen (within 6–7 km) whose users may be able to see the Ship Island proposed sea cage site. Within the Long Harbour BMA, there is one cabin on Iona Islands that occurs in the line of sight of both sea cage sites (~2 km and 6 km from Brine Island and Iona Island proposed sea cage sites, respectively).

Each sea cage site (i.e., a group of up to 12 sea cages) will be supported on an ongoing basis by power boats with outboard engines during daylight hours (see Section 2.4.4). On occasion, a larger service vessel will be on site to clean and maintain the cages, and a well boat, which carries the fish in a midship well or hold, will place the smolts and collect them when they have grown to harvest size. All sea cage site activities will take place during daylight hours. Each of the two to four daily feedings will last ~30–40 minutes at a cage. The noise from the pumps (which are submerged) during these operations is similar to that generated by "an automatic dishwasher in the next room", ≤50 dB (P.A. Hjetland, AKVA Group, pers. comm., 11 April 2018).

At times, a BMA and the sea cage sites will be fallow (i.e., empty), with no cages in the sea and no activity. Both the provincial regulations and Grieg NL's operating procedures require fallowing at the cage sites and in the BMAs. Each BMA will have lengthy fallow periods, during which no sea cages, barges, fish, or related activity are present and there will be no effect on aesthetics for cabin owners and other users.

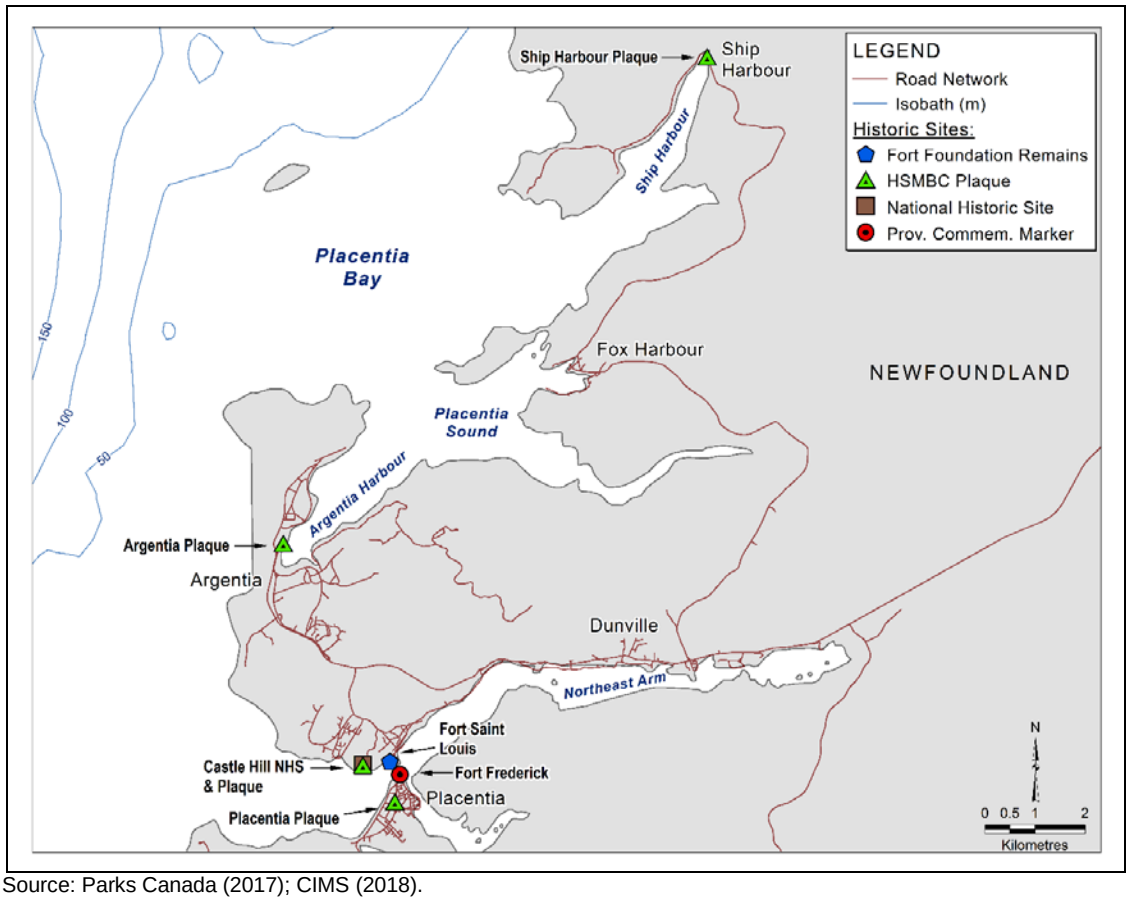
The RAS Hatchery will be located in an existing Marine Industrial Park in Marystown. As such, there will be no effect on aesthetics associated with the hatchery.

## 4.5 Heritage Resources

### 4.5.1 Historic and Archaeological Resources

#### 4.5.1.1 Historic Resources

Historic sites in the western, northern and northwestern portions of Placentia Bay are shown in Figure 4.67, and described below.




Source: Parks Canada (2017); CIMS (2018).
Note: entire Placentia Bay area not shown, as all relevant historic sites are located between Placentia and Ship Harbour

**Figure 4.67. Historic sites in western, northern and northeastern Placentia Bay.**

***National Historic Sites***

Parks Canada administers a system of National Historic Sites (NHS) across Canada, protecting and raising awareness of important components of Canada's history (Parks Canada 2007). The Castle Hill NHS is located near the town of Placentia, in the northeastern portion of the Study Area (Parks Canada 2018). Initially fortified in 1693, Castle Hill was designated an NHS in 1968 for its

important role in the defence of Placentia and the "economic and strategic interests" of Britain and France from 1692–1811, when these two countries fought for control of North America (Parks Canada 2007, 2018). The 0.24 $km^2$ NHS is strategically located on a high hill overlooking Placentia, and contains the remnants of skirmish sites and defences constructed by the French and later occupied by the British, who took possession of Placentia in 1713 (Parks Canada 2007, 2018). The Castle Hill NHS is open seasonally, operating every day from 1 June–3 September 2018 (Parks Canada 2018). Six smoothbore cannons of British origin placed on site in the 1930s are historically valued for their contribution to a better understanding of Castle Hill's historic roles, and are used for heritage presentation purposes (Parks Canada 2007). One cannon is located at the front entrance of the site's Visitor Reception Centre, while the remaining two are positioned along the breastworks of Fort Royal (Parks Canada 2007).

***Historic Site and Monuments Board of Canada Plaques***

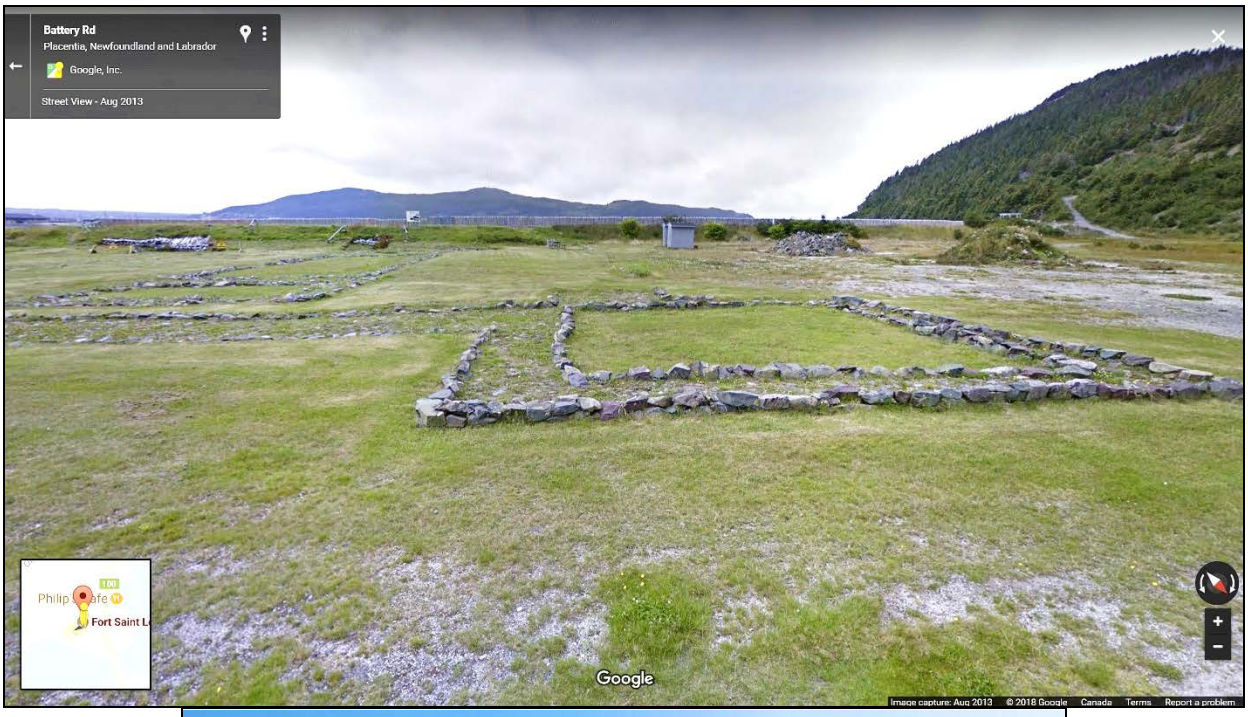
A bronze Historic Site and Monuments Board of Canada (HSMBC) Plaque is representative of the value bestowed upon places of national historic significance by Canadians (Parks Canada 2007, 2017). Four HSMBC plaques are located within the Study Area. One HSMBC plaque is prominently affixed to a rock cairn at the entrance to the Visitor Reception Centre at the Castle Hill NHS, near the town of Placentia (Parks Canada 2007). An HSMBC plaque is also located near the police station in the town of Placentia, for the role Placentia served as an important fishing station and as the capital of the French fishing colony in Newfoundland, ceded to Great Britain by the Treaty of Utrecht in 1713 (CIMS 2018; Parks Canada n.d. [a]). A third HSMBC plaque is mounted in Argentia, commemorating the American military presence in the form of military bases in Argentia, St. John's and Stephenville during World War II (CIMS 2018; Parks Canada n.d. [a]). The fourth HSMBC plaque in the Study Area is located in Ship Harbour, denoting the declaration of the Atlantic Charter by Winston Churchill and President Franklin Roosevelt, which became a basis for the United Nations Charter, issued in 1941 (CIMS 2018; Parks Canada n.d. [a]).

***Military Fort Remains and Markers***

In addition to Castle Hill, the town of Placentia features historic foundation remains of the French Fort Saint Louis and a marker for the site of the English Fort Frederick (Figure 4.68).

Fort Saint Louis was built during 1691–1703 on the north side of the narrows (now Jerseyside) in Placentia (Landry 2000). The French Fort had a circumference of ~229 m, including two bastions, the governor's headquarters and garrison barracks (Landry 2000). Initially, the Fort featured a wooden stockade surrounded on three sides by batteries of a total 26 cannons, and by 1703 the Fort was a stone structure with walls ~5 m high by ~2.5 m wide. Fort Saint Louis remained in use until the end of the French regime (Landry 2000). Now, only the stone foundations of the Fort remain.

A marker stone and plaque, mounted on a concrete monument and flanked by two cannons, marks the site of Fort Frederick, an English fort constructed during 1715–1717. The monument site was formally recognized as a Municipal Heritage Site in 1972 (see Section 4.5.4.4, Municipal Heritage Sites for further information regarding this form of designation; Parks Canada n.d. [b]). Fort Frederick consisted of a "semi-circular redoubt mounting 12 guns, a guard house, barracks and storehouse surrounded by a palisade" (Parks Canada n.d. [b]). Fort Frederick was the English military headquarters in Newfoundland during 1721–1746. The Fort was poorly maintained, and after some relatively minor repairs during 1744 and 1762, was allowed to decay until it was abandoned in 1811 after the removal of the ordnance (Parks Canada n.d. [b]). Two 12-pounder cannons, still on site today, were "mounted behind a temporary earthwork battery near this site in 1813 as protection against American privateers" (Parks Canada n.d. [b]).






Source: Google (2018); Parks Canada (n.d. [b]).

**Figure 4.68. Foundation remains of Fort Saint Louis (top) and marker site for Fort Frederick (bottom), Placentia, NL.**

### 4.5.1.2 Archaeological Resources

***National Historic Sites***

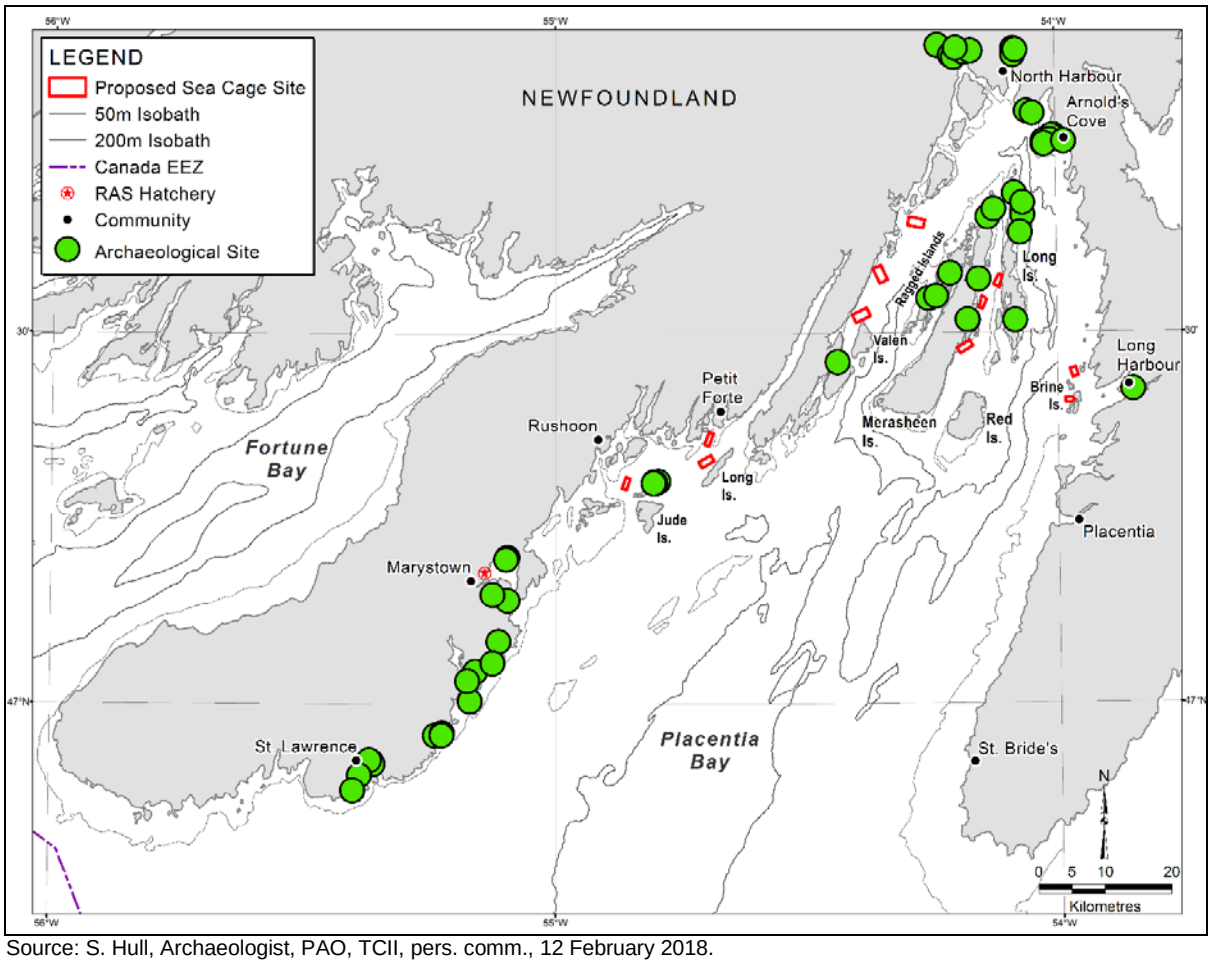
Archeological sites at the Castle Hill NHS (see Figure 4.67) are valued for "providing evidence of the physical components of Castle Hill's defences during the French and British periods and of construction materials and techniques used in military fortifications of the time" (Parks Canada 2007). Three archaeological sites have been excavated at the Castle Hill NHS, including earthworks and stone walls at Fort Royal, the Detached Redoubt and Le Gaillardin Redoubt (Parks Canada 2007, 2018). Unexcavated archaeological sites identified at the Castle Hill NHS include the remains of the Horseshoe Battery, La Fontaine Battery, and a well outside the walls of Fort Royal (Parks Canada 2007). Over ten thousand artifacts have been unearthed at the Castle Hill NHS, including construction tools, fishhooks, ceramics and military equipment (Parks Canada 2007).

***Newfoundland and Labrador Archaeological Site Records***

At the request of the Provincial Archaeology Office, in the interest of protecting and preserving archaeological sites within Placentia Bay, the exact locations of the sites are not shown or described in the EIS (S. Hull, Archaeologist, Provincial Archaeology Office [PAO], Department of Tourism, Culture, Industry and Innovation [TCII], pers. comm., 12 February 2018). There are 57 archeological sites within the western, northern and northeastern portions of coastal Placentia Bay (Figure 4.69). It is possible that some sites may extend beyond the bounds that were examined and/or excavated by archaeologists, and the fact that a specific location within the Study Area does not currently contain an archaeological site does not preclude the potential for a site to exist there (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018). Should the proposed aquaculture construction activity uncover artifacts or archaeological features, the Provincial Archaeological Office should be notified immediately (Aardvark Archaeology 2005).

Four sites are within the Rushoon BMA, near Baine Harbour. These sites include shipwreck remains from the 15$^{th}$ or 16$^{th}$ century (likely Basque); stone wall and earthenworks remains of a French fortification circa 1700–1715; remains of a probable English habitation site from the late-18$^{th}$ to early-19$^{th}$ century, including artifacts such as a flagstone floor from what was likely a residential structure, ceramics, glass, pipes, bricks and nails; and mixed remains from what was likely an early-18$^{th}$ century French residential site, which later became an Anglo-Newfoundlander residential site from the 18$^{th}$ to 20$^{th}$ centuries, abandoned during resettlement in 1966. Artifacts noted or recovered from the latter site include a low stone wall, rubble pile and headstone, collapsed 20$^{th}$ century houses, ceramics, glass, tobacco pipes, flint and iron nails (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018).

Four archaeological sites are within the Merasheen BMA. One of the archaeological sites is a Little Passage complex site of the Dorset cultural era. The direct ancestors of the Beothuks created tools and objects that archaeologists refer to as the "Little Passage complex", named for the first recognized Little Passage site on the south coast of Newfoundland (Pastore 1998). Archaeologists use the term "complex" to describe a "pattern of similar tools used throughout a region over a period of time, particularly when comparatively little is known about the people who produced those tools" (Pastore 1998). Two other archaeological sites are Beothuk burial grounds. The fourth site features building foundations, churches, a pathway and cemetery with standing headstones within and between two communities that were established as early as 1803 and abandoned during resettlement in 1966 (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018).




Source: S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018.

**Figure 4.69. Newfoundland and Labrador archaeological site records near the coasts of western, northern and northeastern Placentia Bay.**

Three archaeological sites are within the Red Island BMA, and two sites are immediately north of the BMA. Within the Red Island BMA is the location of a probable Dorset sealing station, featuring artifacts such as a Dorset triangular endblade and retouched, reject and scatter flakes; shipwreck remains of what was probably a ca. 1945 Norwegian or Newfoundlander whaling ship; and building and machinery remains from a Newfoundlander whaling station ca. 1902–1949. North of the Red Island BMA are two sites where Dorset artifacts were found, including white stoneware sherds, gray/green chert flakes and a stone adze, among other unnamed artifacts (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018).

One probable Little Passage complex archaeological site is near Crawleys Island in the Long Harbour BMA. Artifacts found at the site include a projectile point and ceramic fragment (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018).

Otherwise, archaeological sites along the western, northern and northeastern coasts of Placentia Bay include (S. Hull, Archaeologist, PAO, TECII, pers. comm., 12 February 2018):

- Canadian aircraft wreck;
- Dorset hunting camp from ~290 BC;
- probable Dorset lithic manufacture/retouch and hunting camp site from ~220 AD;
- possible Dorset camp from ~860 AD (NL Archaeological Society examination of the Bordeaux Head Dorset Site during September 2017 is described in the most recent PAO Annual Review, including site testing methodology, a photo of surface finds, and test pit/surface find locations [Erwin 2018]);
- 18th to 20th century English, French or otherwise European habitation, fishing premises and fortification remains and/or artifacts;
- late-19th to early-20th century Newfoundlander garden, root cellar and habitation remains and/or artifacts;
- 19th to 20th century Mi'kmaq habitation remains and artifacts;
- remains of a European pulp mill and associated river mouth dam ca. 1897–1903;
- late-19th to early-20th century Newfoundlander sawmill remains;
- 15th to 16th century Basque (possibly) and ca. 1857 and 1940s Euro-American/European shipwreck remains;
- European cannons found underwater; and
- surface collection of artifacts, including possible Dorset or otherwise pre-contact or Maritime Archaic bifaces (prehistoric stone implements flaked on both faces), late-19th to early-20th century Newfoundlander ceramics, and a 1773 European halfpenny of George III.

***Military Fort Remains and Markers***

The Fort Frederick Municipal Heritage Site (see Figure 4.67) reveals archaeological information about 18th century military life in the Placentia area (Parks Canada n.d. [b]). Archaeological work completed on site during 2000–2002 revealed numerous artifacts, including barrel staves, cannons, musket balls, flints, Dutch tobacco pies, coins and pieces of pottery and tableware (Parks Canada n.d. [b]). One of the coins dated to 1630, confirming that Placentia was occupied before the French colony of Plaisance was established there in 1660 (Parks Canada n.d. [b]).

## 4.5.2 Palaeontological Resources

### 4.5.2.1 Newfoundland and Labrador Archaeological Site Records

Bone material was found at a minimum of two Newfoundland and Labrador archaeological sites within the Study Area (see Figure 4.72). Human bones were found by archaeologists at a Beothuk burial site within the Merasheen BMA. An archaeological site near Swift Current featured remains of a 19th and 20th century Mi'kmaq habitation, including calcined bone (burned bone reduced to white or blue mineral constituents), along with remains of a root cellar, potato beds and wharf, earthenware sherds, a cast iron stove part and bottle fragment (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018).

### 4.5.2.2 Fossil Record

Trilobite fossils from the early-Cambrian period (i.e., ~521 million years ago) have been found in the Placentia Bay region, including at Redland on the Cape St. Mary's Peninsula (Bengtson and Fletcher 1983). Within the geological layers below those containing the oldest known trilobite fossils in the Placentia Bay region, a high diversity of fossils of metazoan (i.e., multicellular) fauna have been located by palaeontologists, likely originating no earlier than ~543–519 million years ago and

representing the ~24 million year-long "pre-trilobitic Placentian Epoch on the Avalon microcontinent" (Landing and Westrop 2004). Pre-trilobitic fossilized species that have been found within the Study Area are provided in Table 4.39.

**Table 4.39. Fossilized pre-trilobitic metazoan fauna (ca. ~543–519 million years ago) found in the Study Area.**

| Location | Fossil Species or Group | Species/Group Type | Source |
|---|---|---|---|
| Redland, Cape St. Mary's Peninsula | *Aldanella attleborensis* | Mollusc | 1, 2, 3 |
| | *Latouchella* sp. | Mollusc | |
| | *Halkieria* sp. | Mollusc | |
| | *Fomitchella* cf. *acinaciformis* | Shelly fossil | |
| | Orthothecid hyoliths | Shelly fossil[a] | |
| Perch Cove (near Cuslett; north of St. Bride's) | *Coleoloides typicalis* | Conoidal Problematica[b] | 1, 2, 4 |
| | *Halkieria* sp. | Mollusc | |
| | *Eccentrotheca kanesia* | Lamp shell | |
| | *Sunnaginia* cf. *imbricate* | Lamp shell | |
| | Unidentified brachiopods | Lamp shell | |
| | *Hyolithellus* sp. (possibly) | Shelly fossil | |
| Duck Point (near Lawn; southwestern Placentia Bay) | *Cryptozoon* sp. | Filamentous calcareous algae | 1, 2, 3, 5, 6 |
| | *Coleoloides typicalis* | Conoidal Problematica | |
| | *Sabellidites* sp. | Problematica | |
| | *Fordilla* cf. *troyensis* | Clam | |
| | *Aldanella attleborensis* | Mollusc | |
| | *Aldanella* sp. (possibly) | Mollusc | |
| | *Halkieria* sp. | Mollusc | |
| | Helcionellidae | Mollusc | |
| | *Camenella* cf. *baltica* | Lamp shell | |
| | *Chancelloria* sp. | Shelly fossil | |
| | *Hyolithellus micans* | Shelly fossil | |
| | *Hyolithellus* sp. (possibly) | Shelly fossil | |
| | *Hyolithes excellens* | Shelly fossil | |
| | *Hyolithes strettonensis brevis* | Shelly fossil | |
| | *Orthotheca pugio* | Shelly fossil | |
| | Orthotecids | Shelly fossil | |
| Road between Placentia and Long Harbour | *Didymaulichnus* sp. | Ichnofossil[c] | 2, 7 |
| Come by Chance | *Arenicolites* sp. | Ichnofossil | 2, 7 |
| | *Monomorphichnus bilinearis* | Ichnofossil | |
| | *Neonereites uniserialis* | Ichnofossil | |
| | *Planolites beverleyensis* | Ichnofossil | |
| | *Rusophycus bonnarensis* | Ichnofossil | |
| Lewin's Cove (north of Salmonier; southwest Placentia Bay) | *Buthotrephis* sp. | Algae | 2, 7 |
| | *Cochlichnus* sp. | Ichnofossil | |
| | *Didymaulichnus* sp. | Ichnofossil | |
| | *Hormosiroidea canadensis* | Ichnofossil | |
| | *Monomorphichnus* sp. | Ichnofossil | |
| | *Neonereites uniserialis* | Ichnofossil | |
| | *Planolites beverleyensis* | Ichnofossil | |

Sources: [1] Bengtson and Fletcher (1983); [2] Fossilworks (2018); [3] Moysiuk et al. (2017); [4] Wotte and Sundberg (2017); [5] Merriam-Webster (2018); [6] Brasier (2010); [7] Crimes and Anderson (1985); [8] White (1901).

[a] Shelly fossils are soft-bodied organisms, typically with a conical shell (Moysiuk et al. 2017).

[b] In palaeontology, Problematica have no known living analogs, and are known only by "adult incompletely preserved skeletal morphology" (Nitecki et al. 1999).

[C] Ichnofossils are trace fossils, such as of an animal's track or burrow (YD 2018).

### 4.5.3 Architectural Resources

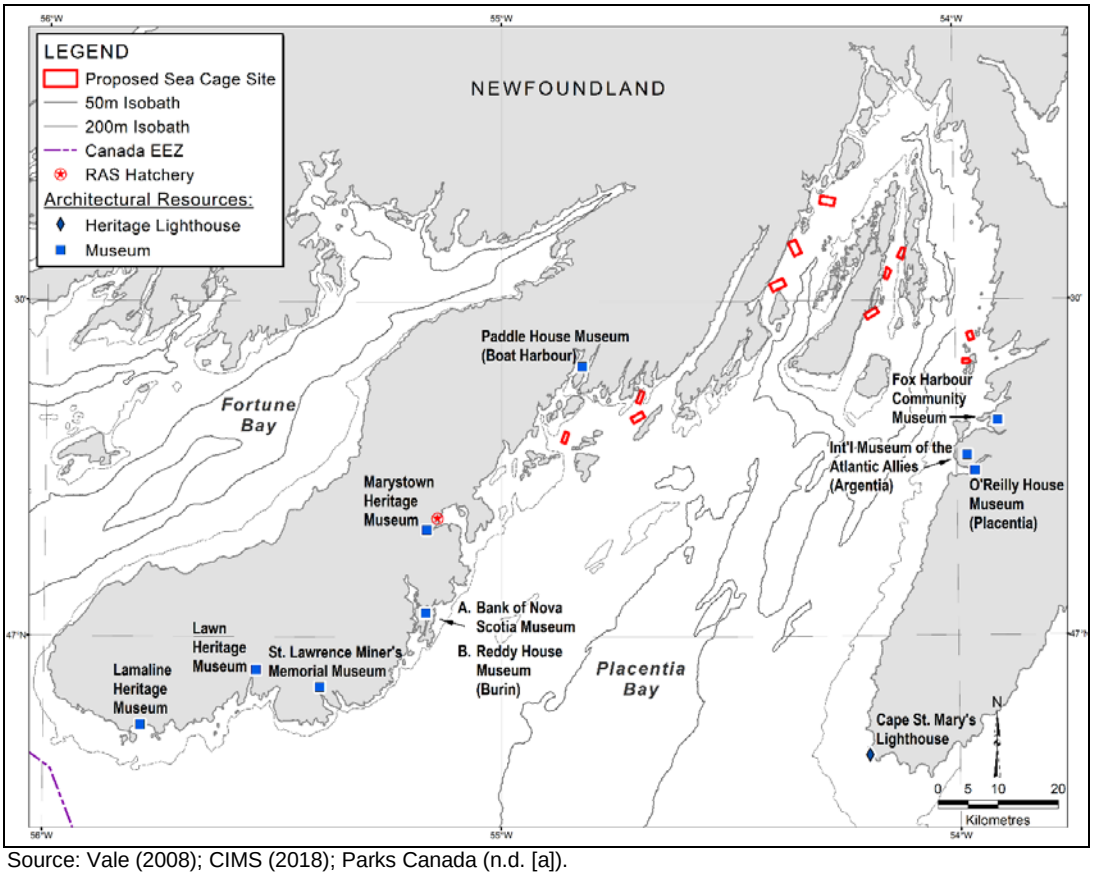
Architectural resources reflecting the heritage of communities within Placentia Bay include the Cape St. Mary's Heritage Lighthouse and public museums. These architectural resources are described below (see Figure 4.70; see also Section 4.5.4.4, Heritage Sites).

### 4.5.3.1 Heritage Lighthouses

Lighthouses are designated as Heritage Lighthouses due to important historical, architectural and community values (Parks Canada n.d. [a]). The Cape St. Mary's lighthouse was designated as a Heritage Lighthouse in 2015 in accordance with the *Heritage Lighthouse Protection Act* (2008) (Parks Canada n.d. [a]). The Cape St. Mary's lighthouse was originally built as a brick tower in 1859/1860, covered with concrete and encased in cast-iron sheets in 1885, and then covered in poured concrete in the mid-1950s, giving its current form (Parks Canada n.d. [a]). The Cape St. Mary's Heritage Lighthouse is a prime example of excellent craftsmanship utilizing standard techniques available over time (Parks Canada n.d. [a]). The concrete octagonal tower construction projects an impression of "weight and impenetrability" as a result of the addition of various construction layers throughout the lighthouse's life (Parks Canada n.d. [a]). Through efforts over time to determine the best construction solutions to ensure the lighthouse endures the extreme weather conditions at Cape St. Mary's, the lighthouse's structural modifications have lent it a unique visual appearance unlike any other extant lighthouses (Parks Canada n.d. [a]). The final construction solutions, iron and concrete, provided a secure and weather-resistant base as foundation for its lantern (Parks Canada n.d. [a]).

### 4.5.3.2 Museums

There are at least ten museums in the Study Area, presented in Figure 4.70 and described in Table 4.40.




Source: Vale (2008); CIMS (2018); Parks Canada (n.d. [a]).

**Figure 4.70. Architectural resources in the Study Area.**

**Table 4.40. Museums in the Study Area.**

| Museum Name | Community | Open Season | Key Features |
|---|---|---|---|
| Lamaline Heritage Museum | Lamaline | 1 Jun-30 Sep | • Artifacts depicting life in the late-1800s & early-1900s<br>• Handcrafted model dory collection by former resident, author & songwriter Otto Kelland<br>• World War I and II, genealogy & inshore fishery displays<br>• Scientific / local data on the 1929 tidal wave |
| Lawn Heritage Museum | Lawn | | • Local artifacts (e.g., items from the shipwreck disasters of the USS *Pollux* and USS *Truxtun*, & traditional domestic woodstoves, radios, pump organ, spinning wheel, etc.)<br>• 1929 tidal wave & resident cod fishery displays<br>• Sports section, including displays about the town's soccer heritage |
| St. Lawrence Miner's Memorial Museum | St. Lawrence | | • Artifacts, photos & displays documenting the town's fluorspar mining past |
| Burin Heritage Tourism Association:<br><br>Bank of Nova Scotia Museum & Reddy House Museum | Burin | Museums:<br>30 Mar-25 Sep<br><br>By D Rock Café:<br>11 Jun-13 Sep<br><br>Oldest Colony Trust Building:<br>Jun-Sep | • Bank of Nova Scotia Museum: Craft Shop, Bank Vault, tidal wave display, & Rooms: Mariners, War, School, Typewriter, Tool & Sports<br>• Reddy [Heritage] House Museum: once owned by Reddy Family; outport kitchen, parlor, dining room, sewing room, bedrooms, & the Cottage Hospital exhibit<br>• Also on premises: By D Rock Café (traditional Newfoundland cuisine); & Oldest Colony Trust Building (was cold storage facility; now exhibits 19th-century art work of Burin & hosts entertainment) |
| Marystown Heritage Museum Corporation | Marystown | Seasonally or by appointment | • Town history exhibits, including artifacts used in daily life & tools used to earn a living<br>• Shipbuilding display |
| Paddle House Museum | Boat Harbour | 1 Jun-31 Oct<br><br>Off-season tours upon request | • At Livyer's Lot Heritage Site<br>• Housed in home constructed in 1911 on Port Elizabeth Island, Placentia Bay, transported to Red Harbour during 1969 resettlement, & later moved to current location<br>• House restored to represent lifestyles of 1900–1950 western Placentia Bay communities; includes furnishings & domestic artifacts in kitchen, pantry, sitting room, & bedrooms; other themes: inshore fishery, carpentry & resettlement<br>• Also on site: gift shop & tea house (traditional Newfoundland cuisine & beverages) |
| Fox Harbour Community Museum | Fox Harbour | By appointment only, Monday-Friday | • Showcases community's 300-year old heritage<br>• American military presence at Argentia naval base (1941–1994) exhibit, including photos & artifacts<br>• Domestic themes: dish wares, canvas & hooked mats, wedding dresses, & other early-20th century household items<br>• Maritime history display, including the fishing schooner *Annie Haley*, which sank with seven men in 1927 outside Fox Harbour<br>• Other exhibits: education, presence of Catholicism in the community, & sports history |
| O'Reilly House Museum | Placentia | Monday-Friday until end of November | • Built in 1902 as residence for William O'Reilly; became government-owned residence for local magistrate during 1940s-1984; turned over to Placentia Area Historical Society for museum development in 1986<br>• Museum reflects >450 years of Placentia area history<br>• Basque, French, English, Irish & American historical displays, including furniture, early-style kitchen, & photos<br>• Models of former community buildings<br>• Numerous artifacts, including tipstaff presented by King George II (1772), silver tea set used by Prince William |

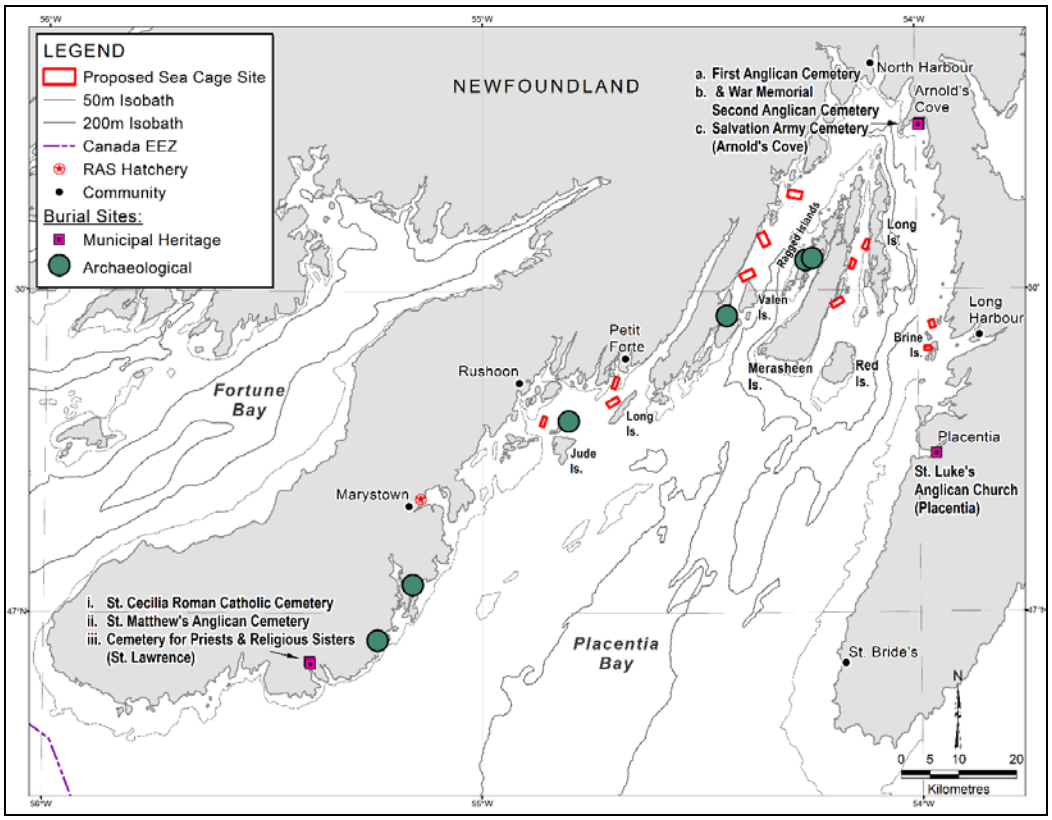
| Museum Name | Community | Open Season | Key Features |
|---|---|---|---|
| | | | Henry while visiting Placentia (1786), & Basque will (oldest original civil document from Canada) |
| International Museum of the Atlantic Allies | Argentia | | • Within Argentia Visitor Information Centre<br>• Argentia at War exhibit<br>• Demonstrates prominent role of the town while an American naval and army base was in operation there<br>• Photo, film and print displays |

Source: Vale (2008); MANL (2013); WWT (2017); CIMS (2018).

## 4.5.4 Burial, Cultural, Spiritual and Heritage Sites

### 4.5.4.1 Burial Sites

Cemeteries are present within the majority of the larger communities throughout the Study Area. In addition to these community cemeteries, within the western, northern and northeastern portions of the Study Area, there are various burial sites noted in the Newfoundland and Labrador Archaeological site records, and several Municipal Heritage cemetery sites (Figure 4.71). Gravesites previously existed within Argentia and St. Lawrence for American servicemen who perished during concurrent shipwrecks during the Second World War. Excluding non-historically designated community cemeteries, the abovementioned burial sites are described below.




Source: S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018; Parks Canada (n.d. [b]).

**Figure 4.71. Archaeological and Municipal Heritage burial sites in the western, northern and northeastern portions of Placentia Bay, NL.**

### *Newfoundland and Labrador Archaeological Site Records*

On the calm and somewhat foggy night of 21 July 1857, an American barque (i.e., a sailing ship with at least three masts, with the foremast and mainmast square-rigged and the mizzenmast rigged fore-and-aft), the *Monasco*, carrying a cargo of iron and passengers from Sweden to New York, was shipwrecked near Silver's Cove (near the town of Corbin) (Brinston and Piercey 2002). The captain, his wife and crew and five passengers survived, while 55 passengers perished, locked within their cabins. Conflicting accounts of the tragedy described the event as either the 55 passengers refused to leave their locked cabins despite urging to the contrary by the captain and crew, or the captain ordered the doors closed and called for the remaining personnel to abandon ship to a life boat (Brinston and Piercey 2002). The bodies of those who perished were taken ashore the following day and buried, supposedly with neither inquest nor investigation having occurred (Brinston and Piercey 2002). The *Monasco* Cemetery site near the town of Corbin was examined by archaeologists during August 2000 and 2001, and found to include 55 graves (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018).

Two Beothuk burial sites are located near the town of Davis Cove (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018). The first grave was situated under a cave roof overhang and completely protected from the weather, ~7.6 m distant from and ~3 m above the high water mark. The roof overhang is now collapsed. The second burial site contained human bones, a wooden stick, an arrow head, small beads, large flat beads on a stick, a feather and a birch rind with stitched holes.

A grave marked with a headstone is located on private property near Burin (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018). This is the burial site of Joshua Nicolle, a native of Jersey (the largest of the Channel Islands between England and France) who passed away in ~1856. A fisheries-based trade existed between Jersey and Newfoundland at this time (Seary 1970).

An 18$^{th}$ century Anglo-Newfoundlander graveyard likely disturbed an earlier French residential site on Oderin Island (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018). Archaeologists noted a single fallen headstone on site in 2012, and were informed by locals that the graveyard was disturbed years earlier with the excavation of human remains by a former resident of Oderin Island.

A cemetery with standing headstones is located in the area of the former stone church known as The Church of the Assumption, which was located on a pathway between the abandoned communities of St. Leonards and St. Kyrans, near Monkstown (S. Hull, Archaeologist, PAO, TCII, pers. comm., 12 February 2018). The Church was consecrated in 1859, after the settlement of St. Leonards in 1803 and St. Kyrans in 1857. Both communities were abandoned during resettlement in 1966.

### *Municipal Heritage Cemetery Sites*

A historic place is a "structure, building, group of buildings, district, landscape, archaeological site or other place in Canada that has been formally recognized for its heritage value by an appropriate authority within a jurisdiction" (Parks Canada n.d. [b]). Federal, Provincial and Territorial governments recognize the important contribution of historic places to Canadian communities, and maintain the Canadian Register of Historic Places (CRHP) as an information source for all "historic places recognized for their heritage value at the local, provincial, territorial and national levels throughout Canada" (Parks Canada n.d. [b]). As a component of the CRHP, Municipal Heritage sites are recognized in accordance with the *Municipalities Act*, maintained by the municipality in which they are located, and may include municipal heritage buildings, structures or land (Parks Canada n.d. [b]). There are seven Municipal Heritage cemetery sites within the Study Area, including three in St. Lawrence, three in Arnold's Cove and one in Placentia. These sites are described below.

The St. Cecilia Roman Catholic Cemetery in St. Lawrence was formally recognized as a Municipal Heritage site in 2005. The Municipal Heritage designation encompasses the entire fenced cemetery area, containing over 600 grave plots. This cemetery has been in use since the 19th century, during which time Roman Catholicism was the predominant religion of St. Lawrence's settler population. The Roman Catholic Episcopal Corporation temporarily transferred a portion of this cemetery to the US government to inter the bodies of 51 sailors who perished when the USS *Pollux* and USS *Truxtun* shipwrecked, with ownership returned to the Corporation after the US servicemen's bodies were transported to the US after World War II. The St. Lawrence fluorspar mining industry was a mainstay of the local economy during the 1930s to the 1970s, and the bodies of ~200 miners whose deaths were linked to industrial disease contracted in the fluorspar mines are interred at this cemetery. Grave markers in this cemetery are variably inscribed with genealogical information, such as familial relationships and dates of birth and death, religious iconography associated with the Catholic faith, soccer motifs, and local history, including information about tragedies such as shipwrecks. At least one of the grave markers is made of limestone, while most of the older markers are white marble tablets or columns (representative of their time) and many of the newer ones are granite (Parks Canada n.d. [b]).

The St. Matthew's Anglican Cemetery in St. Lawrence was formally recognized in 2005. This cemetery has been in use since the 19th century, and the Municipal Heritage designation includes the entire fenced cemetery area and the St. Matthew's Anglican Church building. As in St. Cecilia's, the St. Matthew's Cemetery reflects the unfortunate occupational disease aspect of the area's fluorspar mining industry, with the remains of miners interred there. The older grave markers at St. Matthew's are predominantly white marble, representative of the time in which they were produced, featuring designs and carved motifs typical of the 19th and early-20th centuries. The grave markers are also inscribed with genealogical information, including dates of birth and death, and familial relationships, recording over 30 local surnames (Parks Canada n.d. [b]).

The Cemetery for Priests and Religious Sisters was recognized as a Municipal Heritage site in St. Lawrence in 2005. This small cemetery is located near the town's Roman Catholic Church, and includes the cemetery area surrounded by a modern fence. This cemetery holds the remains of three priests and six nuns, who were essentially responsible for the establishment and perpetuation of the town's Roman Catholic presence. The nuns were members of the Congregation of the Sisters of Mercy of Newfoundland, established in 1842 in St. John's by sisters from Dublin, Ireland, and known for its care for the sick, education of youth, and pastoral presence. The service of the priests began in 1883. The priests and sisters provided assistance and care to those in need, including during the Great Depression, 1929 tidal wave, 1942 USS *Pollux* and USS *Truxtun* disaster and loss of miners through industrial disease. One of the priests organized the first competitive soccer game between St. Lawrence and Lawn in 1922, a game for which St. Lawrence has become renowned (Parks Canada n.d. [b]).

The First Anglican Cemetery and War Memorial in Arnold's Cove was formally recognized in 2008. The cemetery adjoins the Arnold's Cove war memorial site, which features a white marble monument. The Municipal Heritage designation includes all fenced land surrounding the cemetery and the footprint and wooden platform of the adjoining war memorial. The oldest known cemetery in the town, this graveyard was part of the first community infrastructure at Arnold's Cove ca. 1888. The tablet or columnar marble monuments and headstones of the cemetery feature historic and genealogical information, typical of the early-20th century. The war memorial stands on the former site of the town's first Church of England, and is the focal point of the town's annual Remembrance Day ceremony (Parks Canada n.d. [b]).

The Second Anglican Cemetery in Arnold's Cove was formally recognized in 2008, with the fenced cemetery containing >50 grave markers predominantly composed of marble or granite. The town's second-oldest Anglican cemetery, this site was established in 1915, consecrated in 1919 and used for

burials into the 1970s. The traditional tablet or column-style grave markers contain historic and genealogical information, serving as a community record (Parks Canada n.d. [b]).

The Salvation Army Cemetery in Arnold's Cove was formally recognized in 2008. The fenced Municipal Heritage site contains over a dozen markers, mostly of white marble, with some wooden crosses and at least one granite headstone. There are likely unmarked graves within the cemetery. The cemetery was established in the 20th century, with the earliest and latest legible dates of death recorded on headstones of 1911 and 1973, respectively. Most of the surviving grave markers are tablet or column white marble, featuring historical and genealogical information, representative of typical headstones during the 20th century (Parks Canada n.d. [b]).

The St. Luke's Anglican Church Municipal Heritage site was formally designated in Placentia in 2000. The Municipal Heritage designation includes the church building and surrounding graveyard. This wooden church was built in 1906 by the church's congregation in the Gothic Revival style, including pointed arch windows and stained glass, and was preceded by at least two other churches on the same site, one of which was Catholic. There may also have been an earlier church on this site with Basque roots. This church is "representative of the religious struggle that accompanied the military struggle that occurred in Placentia during its history" (Parks Canada n.d. [b]). The church grounds include a Basque gravesite dating to the 17th century, indicative of a Basque presence in Placentia >300 years ago (Parks Canada n.d. [b]). The Basque tombstones have since been removed for preservation (NL Heritage 2018).

***Military Burials – American Servicemen of the USS Pollux and USS Truxtun***

Gravesites were located at Argentia and St. Lawrence for the >200 American servicemen who died ~64 km south of the Argentia military base present during World War II, when a supply ship, USS *Pollux*, and destroyer, USS *Truxtun*, both ran aground off St. Lawrence Harbour in late-winter 1942 (Higgins 2007; MHA 2010). When the Second World War ended in 1945, the US Navy exhumed the bodies and returned them to the United States (MHA 2010). An undetermined number of servicemen who perished during the wrecks were never found (MHA 2010).

### 4.5.4.2 Cultural Sites

Landscape features of the Castle Hill NHS (see Figure 4.67) are culturally valued as having been an integral component of the defence function of the military installations, connecting the defence elements to the town below (Parks Canada 2007). The Castle Hill NHS cultural landscape features were partially obscured by encroaching vegetation prior to excavation for archaeological studies in the 1960s (Parks Canada 2007). Vegetation has since been selectively removed in the "glacis areas and around the breastworks", and will be monitored to ensure archaeological resources are not threatened or impaired (Parks Canada 2007).

### 4.5.4.3 Spiritual Sites

The St. Cecilia Roman Catholic and St. Matthew's Anglican Municipal Heritage Cemeteries have spiritual value as consecrated burial grounds in use for over a century (Parks Canada n.d. [b]). During the early 19th century, Roman Catholicism was the predominant religion of the settler inhabitants of St. Lawrence, and the local parish was established in 1849. The oldest extant headstone at St. Matthew's indicates that it was established by at least the early-1860s. The Cemetery for Priests and Religious Sisters Municipal Heritage site is spiritually valued because the nuns and priests buried there "were members of a religious Congregation who were active members of the Roman Catholic Parish of the

town", with their guidance and care serving as an "on-going symbol of how their ministry of compassion and mercy permeated the lives of the people of St. Lawrence" (Parks Canada n.d. [b]). The First Anglican Cemetery and War Memorial Municipal Heritage site in Arnold's Cove holds spiritual value in association with the town's Anglican religion, with the Memorial serving as tribute to the town's "war dead" (Parks Canada n.d. [b]). The Second Anglican Cemetery Municipal Heritage was consecrated in 1919 and represents the religious beliefs of the Anglican community of Arnold's Cove (Parks Canada n.d. [b]). The Salvation Army Cemetery Municipal Heritage site is spiritually important as the first and only cemetery associated specifically with the Salvation Army religion and charitable group in Arnold's Cove, and as one of the oldest cemeteries in the town (Parks Canada n.d. [b]).

#### 4.5.4.4 Heritage Sites

***Heritage Lighthouses***

Three associated buildings on the site contribute to the heritage character of the Cape St. Mary's Heritage Lighthouse (see Figure 4.70): (1) the Lightkeeper's Dwelling (circa 1965); (2) the Assistant Lightkeeper's Dwelling (1965); and (3) the Office/Equipment Building (1970) (Parks Canada n.d. [a]). The Cape St. Mary's lighthouse is a prime example of efforts by colonial governments to improve marine navigation, providing guidance to fishing and supply boats entering Placentia and St. Mary's Bays, and to international marine traffic transiting from through the Atlantic Ocean to the Gulf of St. Lawrence (Parks Canada n.d [a]). The construction of the lighthouse was considered a critical event that enabled the establishment of communities along the Avalon Peninsula's southern coast (Parks Canada n.d. [a]).

***Municipal Heritage Sites***

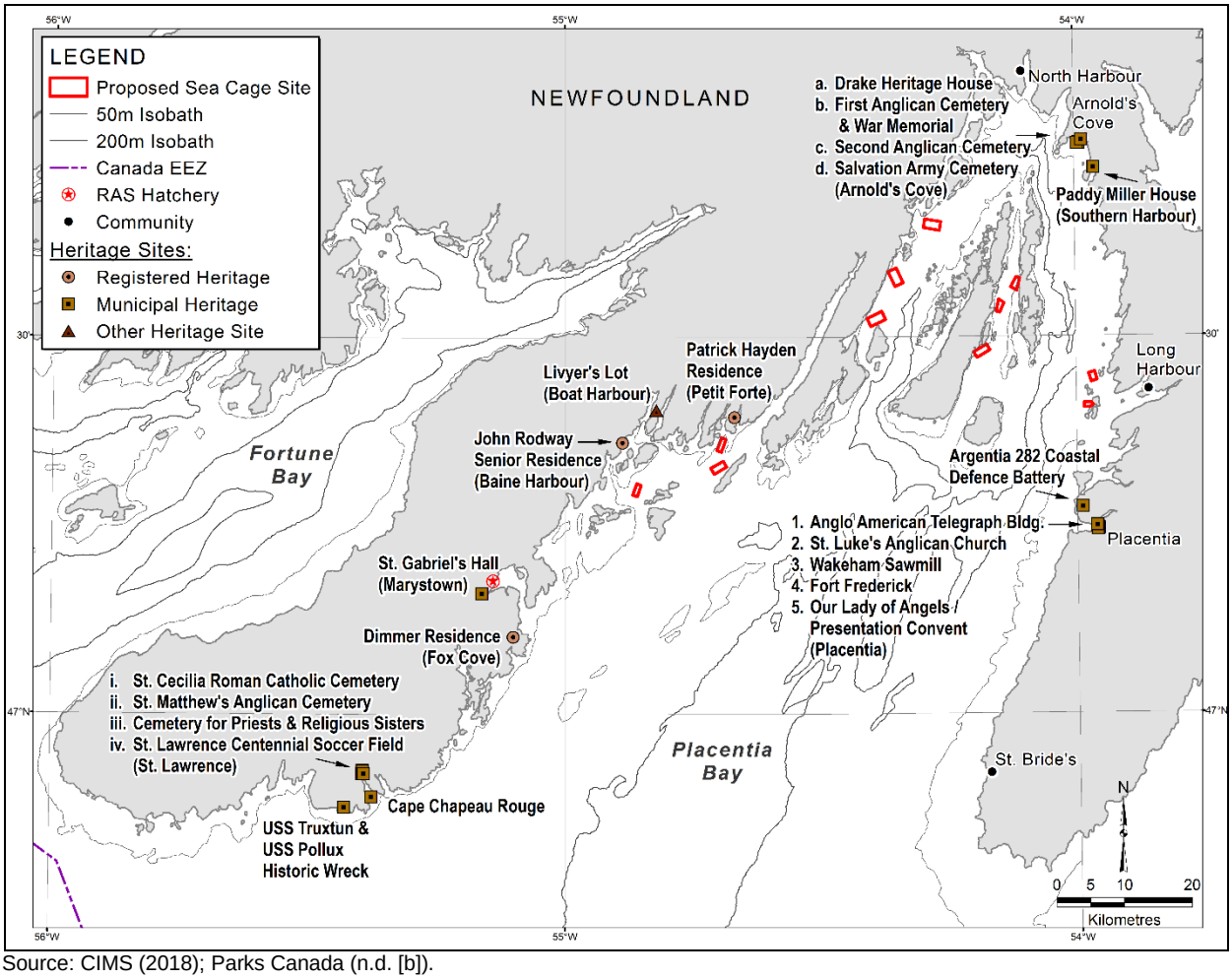
Municipal Heritage cemetery sites and the Fort Frederick marker are described above. These and ten additional Municipal Heritage sites in the western, northern and northeastern portions of Placentia Bay are presented in Figure 4.72. Excluding previously described cemetery sites and the Fort Frederick marker, key features of these Municipal Heritage sites are provided in Table 4.41.

***Registered Heritage Structures***

The Heritage Foundation of Newfoundland and Labrador (HFNL) designates examples of heritage structures in the province deemed worthy of commemoration and protection (HFNL 2018). Designations by the HFNL is commemorative only, and does not place any restrictions on the owner; however, a building must retain its heritage character in order to maintain its heritage status. Registered Heritage Structures designated by the HFNL include "heritage buildings or engineering works that are good examples of their type in a good state of preservation and that help to tell the story of Newfoundland and Labrador" (HFNL 2018). Registered Heritage Structures in the Study Area are shown in Figure 4.72.

The Dimmer Residence is the oldest dwelling in Fox Cove (ca. 1859), and one of the few that survived the 1929 tidal wave that hit the Burin Peninsula (Heritage NL 2018). The Residence served as the Dimmer family household for over a century, including for Mary Antle, who married into the Dimmer family and served as midwife for the community and surrounding area. Mary assisted the delivery of hundreds of babies in the Dimmer Residence, and became an unofficial community doctor as the Residence became a drop-in clinic for the community (Heritage NL 2018). The Dimmer Residence served as shelter for those rendered homeless after a 130 km/h, 5–15 m tidal wave struck the Burin Peninsula on 18 November 1929, destroying many houses along the coast and killing 27 people. Few examples of the Dimmer Residence's architecture remain in Newfoundland today. The house is currently a private residence, owned by Ray Whitten (Heritage NL 2018). The Newfoundland and Labrador

Heritage Website indicates the Dimmer Residence became a Registered Heritage Structure in 1995 (Heritage NL 2018); however, it is not currently listed on the HFNL Website (HFNL 2018).




Source: CIMS (2018); Parks Canada (n.d. [b]).

**Figure 4.72. Heritage sites in the western, northern and northeastern portions of Placentia Bay, NL.**

The Patrick Hayden Residence is a 2.5-storey wooden "third-generation saltbox home" with a front peak gable roof, built in the mid-1880s in Petit Forte (HFNL 2018). This Residence received the Newfoundland Historic Trust Award in 2003 for the preservation of a building representative of the "great Western boat fishery" (HFNL 2018). Petit Forte was slated for resettlement during the NL Government's Resettlement Program, but was not moved due to the resident's resistance to abandon the community. The Patrick Hayden Residence is reminiscent of this perseverance, and may be the oldest standing structure in Petit Forte (HFNL 2018).

The John Rodway Senior Residence features a steeply-pitched gable roof, shed and forge, and is located at the mouth of the harbour on Rodway's Point, Baine Harbour (HFNL 2018). This Residence was designated as a Registered Heritage Structure in 2002 as what may be the oldest cluster of buildings in the community area, built during the 1890s by the prosperous merchant, John Rodway Senior. The Rodway Family operated a successful dry goods and fish buying business for several decades, serving the entire

Placentia Bay region and leading the region's thriving economy during the late-19th and early-20th centuries (HFNL 2018).

**Table 4.41. Key features of Municipal Heritage sites in the western, northern and northeastern portions of Placentia Bay, NL (excluding cemetery sites and the Fort Frederick marker, previously described).**

| Site Name | Location | Key Features |
|---|---|---|
| USS *Pollux* and USS *Truxtun* Historic Wreck Site | St. Lawrence | • Recognized: 2005<br>• US destroyer ship (*Truxtun*) & supply ship (*Pollux*) ran aground during a winter storm in 1942, en route from Maine to Argentia during World War II<br>• Locals saved 186 men, and 203 sailors perished<br>• Many artifacts have been recovered from the wrecks; some materials (e.g., cannon & ammunition) remain at wreck site |
| Cape Chapeau Rouge | St. Lawrence | • Recognized: 2005<br>• Coastal landmark fronting Placentia Bay<br>• Highest point of land on south coast (226 m above sea level)<br>• Mariner's Guide: signal to early fishers that safe harbour was near (found on "rutters" [sets of sailing directions] as early as 1579)<br>• Beaches were useful for cod fishers; Norman and Basque fishers fished here since ~1500; set up Basque summer rooms (fishing premises) at base of Cape, but no permanent settlement occurred<br>• French set up year-round settlements during 17th century |
| St. Lawrence Centennial Soccer Field | St. Lawrence | • Recognized: 2005; Constructed: early-1960s<br>• Regulation-sized soccer field with chalet (replaced previous smaller soccer field)<br>• Designed to attract national & international events (e.g., 1977 National Challenge Cup Championships, & games by teams from Ireland & St. Pierre et Miquelon)<br>• Soccer in St. Lawrence dates to first settlers of community (from England, Scotland & Ireland); first recorded game in 1904 (Laurentians vs. St. John's)<br>• St. Lawrence earned "Soccer Capital of Canada" title from Canadian Soccer Association; & Laurentians named "Team of the Decade" during 1970s<br>• Chalet houses St. Lawrence Soccer Hall of Fame & Wall of Honour |
| St. Gabriel's Hall | Marystown | • Recognized: 2006; Constructed: 1915–1919<br>• Built in Second Empire Style (2.5-storey with hipped-roof)<br>• Was one of largest structures on Burin peninsula at time of construction<br>• Earlier way of life once commonplace in small communities: Community effort to fell timber & build Hall, at request of Reverend of ca. 1909 Sacred Hearth Parish<br>• Social function: hosted cultural events & ceremonies (events announced by raising flag on Hall's clock tower, before introduction of telephones in 1950s) |
| Drake Heritage House | Arnold's Cove | • Recognized: 2004<br>• Two-storey house with low-pitched gable roof<br>  o Typical outport architecture, built using local, traditional materials of the late-19th century in a small fishing village<br>• Representative of Newfoundland Government (Gov.) Fisheries Household Resettlement Program<br>  o Built in small fishing community, Haystack, northeast coast of Long Island, north of Harbour Buffett (Long Island settlements depended on Harbour Buffett for supplies & sales of their fish)<br>  o Resettlement Program by Newfoundland Gov. during 1954–1975 to centralize population & bring residents of small, isolated communities to larger "growth centres"<br>  o Harbour Buffett agreed to resettle & Haystack soon followed; Drake House was floated to nearby community of Arnold's Cove in 1970s to its present location<br>  o Visual reminder of controversial & highly emotional Resettlement Program |

| Site Name | Location | Key Features |
|---|---|---|
| Paddy Miller House | Southern Harbour | • Recognized: 2004; also known as “Paddy’s House” or “Ingram/Miller House”<br>• Two-storey, wooden structure with rear-slanting roof, typical of houses during early- to mid-20th century in rural Newfoundland<br>• One of oldest extant houses in Southern Harbour<br>• Representative of Newfoundland Gov. Fisheries Household Resettlement Program era<br>o House built ~1920 by Walter Ingram in Harbour Buffett, Long Island<br>o Patrick (Paddy) Miller, fisherman from Prowseton (another community which participated in Resettlement Program) purchased & floated house by barge to Southern Harbour |
| Argentia 282 Coastal Defence Battery | Argentia | • Recognized: 2006; Constructed: 1941 (World War II)<br>• Located on hill overlooking Placentia Bay & former American base of Fort McAndrew, Argentia<br>• “200 Series” bunker: Concrete construction covered in earth (to blend with landscape), with above-ground fortification; likely only of its kind remaining with original artillery guns in place (two 6” Seacoast M1903A2 Guns with shields remain in-situ, mounted outside bunker)<br>• Argentia was chosen as naval base due to its strategic proximity to N. Atlantic convoy routes & deep-water access of Placentia Bay<br>• Fort McAndrew was most expensive overseas American base built during the period; at its peak, 20,000 US servicemen were stationed in Argentia<br>• Base played key role in Battle of the Atlantic: anti-submarine patrols originated there, & transatlantic convoys rendezvoused in waters off Argentia<br>• Argentia was communications centre during the Cold War, one of numerous early warning systems instigated by US to monitor Soviet activity<br>• Reminder of positive & negative cultural, societal & economic changes that resulted from the establishment of US military bases in NL<br>o Job boom (~5,000 civilians employed at base)<br>o Forced relocation for residents of Argentia & Marquise (~800 people resettled to neighbouring communities, while their homes were demolished & their ancestor’s graves were exhumed & relocated at community’s insistence)<br>o Degree of financial independence not previously attainable under predominant credit system of traditional inshore fishery<br>o Americans introduced contemporary US pop culture to region, including leisure activities, music & fashions, broadening cultural sphere of wartime & post-war NL |
| Anglo American Telegraph Building | Placentia | • Recognized: 2006; Constructed: 1876<br>• Two-storey, wooden building with 1940s wartime addition<br>• Provided transatlantic communications support for ~60 years<br>• Was vital link between Hearts Content Cable Station & Nova Scotia<br>• Representative of simple style & design typical of construction of company-owned structures in outport Newfoundland<br>• Wartime addition representative of tradition of remodelling homes to meet evolving needs of residents<br>o Expansion space was made available to US servicemen & their families during 1940s-1950s while they awaited housing on base in Argentia<br>o Space later converted into convenience store |
| Wakeham Sawmill | Placentia | • Recognized: 2005; Constructed: 1912<br>• Two-storey, wooden building originally built as a fishing stage in Petit Forte; partially dismantled & transported on board schooner across Placentia Bay to current location in 1942, & adapted to house carpentry business<br>• Building interior retains sawmill infrastructure (benches, machinery, hardware) & unfinished exposed beams, rafters, timber walls & wood floors<br>• Orcan River flowed under the building when re-constructed in Placentia, with logs flowing from neighbouring Southeast to the Sawmill (River |

| Site Name | Location | Key Features |
|---|---|---|
| | | boundaries since altered to protect low-lying Placentia, so Sawmill now stands on dry land)<br>• Played strong economical role at its current location, as site for processing natural resource for commercial purpose, & producing wood products for local market<br>• Only building of its type remaining in Placentia proper |
| Our Lady of Angels / Presentation Convent | Placentia | • Recognized: 2006; Constructed: 1864<br>• Two and a half-storey stone building (mainly of locally quarried stone), with steep gable roof & cupola; built in French colonial style<br>• Only remaining stone building in Placentia; last standing structure in a five building ecclesiastical complex located in the Town Square<br>• Irish Presentation Sisters of the Roman Catholic Church arrived in Placentia in 1864, & established first teacher training school outside building attached to convent; Sisters left in 1989, ending 125 years of education<br>• Representative of longstanding relationship between the convent & the education & religion of the community<br>• Convent's name, "Our Lady of Angels", stands as memorial to Franciscan friars of Quebec, who established first monastery in Newfoundland in 1689 |

Source: Parks Canada (n.d. [b]).

### *Other Heritage Sites*

The Livyer's Lot Heritage Site, principally overseen by the volunteer-based Placentia West Heritage Committee, is located near the community of Boat Harbour, in western Placentia Bay (Figure 4.6; NL Tourism 2018b). Featuring traditional food at the Tea Rose restaurant, the Paddle House Museum (see Table 4.2), and craft demonstrations and the sale of heritage crafts and artwork at the economuseum, the Livyer's Lot Heritage Site educates guests in traditional living in outport Newfoundland during the early- to mid-20th century (NL Tourism 2018b). Textile crafts are a speciality in the area, with traditional skills imparted to young students during classes held at the Site's economuseum (see Section 4.4.3, Tourism, for further detail). During 2004, an environmental assessment decision was taken to permit the enhancement of tourism infrastructure at the Heritage Site, including the restoration of the Paddle Heritage House, renovation of an existing structure to create a fishermen's museum, construction of a walking trail and footbridge at a nearby pond, upgrading existing footpaths, and installation of new signage (CEAA 2012).

## 4.6 Communities

### 4.6.1 Communities, Industries, and Population Demographics

#### 4.6.1.1 Communities of the Burin Peninsula

They are 19 towns and 11 Local Service Districts on the Burin Peninsula (Table 4.42). Towns, or municipalities, are governed in accordance with the provincial *Municipalities Act, 1999*, which specifies rules for financial management. Towns must set an annual budget and tax schedule and operate within a sound financial administration. Many towns take on additional responsibilities for services and economic development, and supporting communities and families. Local service districts are less structured, community committees that may charge fees for the services they organize. Their services are legally limited to water supply, fire services, garbage collection, street lighting, animal control and maintenance of some of the community roads (GNL 2018c).

**Table 4.42. Towns and Local Service Districts on Burin Peninsula.**

| Community Type | Community Name |
|---|---|
| Towns / Municipalities | Baine's Harbour, Burin, Fortune, Frenchman's Cove, Garnish, Grand Bank, Lamaline, Lawn, Lewin's Cove, Lord's Cove, Marystown, Parkers Cove, Point Au Gaul, Point May, Red Harbour, Rushoon, St. Lawrence, Terrenceville, Winterland |
| Local Service Districts | Beau Bois, Garden Cove, Goobies, Petit Forte, Rock Harbour, Jean de Baie, Little St. Lawrence, South East Bight, Spanish Room, Swift Current |

The five largest communities on the Burin Peninsula are Marystown, Burin, St. Lawrence, Fortune and Grand Bank. Both Grand Bank and Fortune are on the western side of the peninsula, and the other three are on the Placentia Bay side. All towns on the Peninsula dedicate varying levels of resources to their programs and services, are attuned to their population, and take particular pride in their distinctive histories, locations, and industries, with a pleasant competitive rivalry in sport. Their councils are active partners and/or volunteers for running most of programs, from fire departments to recreation and economic development. Each of the larger towns are involved in direct economic development, marketing, strategic planning, and applications for funding for infrastructure and programs.

There are several regional or peninsula-wide associations and organizations that provide a level of regional cooperation and support for all communities on the peninsula, such as the Burin Peninsula Joint Council, Burin Peninsula Chamber of Commerce, Burin Peninsula Regional Waste Management Council, Burin Peninsula Regional Service Board, Primary Healthcare Advisory Committee, Coalition for Mental Health & Wellness and Heritage Run Tourism Association. In some ways, 'the Burin' operates as an entity.

The Burin Peninsula Joint Council was formed in 2012, operates voluntarily without core staff, and now has 18 towns and three Local Service Districts as members. The council unites in advocating for regional economic development and infrastructure, such as the South East Bight ferry schedule, ferry construction contracts that could be directed to the Marystown shipyard, highway cell phone coverage, support for the Fortune fish plant operation and hosting an economic development conference on the Peninsula (Macvicar 2017).

### 4.6.1.2 Integrated Community Sustainability Plans (ICSPs)

Over the last several years, many communities in the province have developed Integrated Community Sustainability Plans (ICSPs). An ICSP is a requirement of the Gas Tax Agreement between the provincial government and communities. In order to qualify for revenue from the Gasoline Gas Tax Fund, a community must prepare an ICSP (Infrastructure Canada 2014). Many of the communities on the Burin Peninsula have developed ICSPs within the last ten years. For example, the Grand Bank ICSP "…provides a framework for sustainable decision making that will help the Community move towards sustainability over the next 10 years and beyond. The ICSP fulfils the federal criteria per the Gas Tax Agreement with the inclusion of:

- A coordinated approach to community sustainability (e.g., linkages to various plans, planning and financial tools that contribute to sustainability objectives);
- Reflected and integrated social, cultural, environmental and economic sustainability objectives in community planning (governance added by Government of Newfoundland and Labrador);

- Collaboration with other municipalities, where appropriate, to achieve sustainability objectives; and
- Engaged residents in determining the long-term vision of the municipality" (Edwards & Associates 2010a).

An ICSP does not have the legal implications of a Municipal Plan, but encourages multi-disciplinary discussion about a given community and its future, and enhances strategic planning by and for a community. Marystown, for example, is working to actively integrate their ICSP and the Municipal Plan. ICSPs are developed using a process which engages all facets and sectors of a community, including volunteers through community-based organizations, churches, educators, business, council members and staff. Recreation is a clear interest and focus, as is supporting and increasing the celebration of culture and heritage, and economic development.

***Community Values (ICSP)***

A key step in the ICSP process is to define Community Values and a Community Vision. The primary values of community, social connection and family were identified within the ICSPs for the larger communities on the Burin, and are summarized below.

*Marystown*

Marystown, the largest community on the Burin Peninsula, is integrating their ICSP into their Municipal Plan, with a focus on practical matters to enhance recreational opportunities for all ages, and "…become more age friendly as a community, addressing seniors' needs, pursuing youth engagement programming and family friendly facilities..." (Tract 2017).

*Burin*

Burin is "…committed to ensuring the safety and protection of our community for the wholesome enjoyment of residents of all ages. Moreover, we are a generous and supportive community, always there to lend a hand and come forward to assist those in need" (Edwards & Associates 2010b).

*St. Lawrence*

"The residents of the town of St. Lawrence value their cohesive community networks, which integrate strong family commitments, an extraordinary charitable mindset and an active volunteer sector, attributes that normally evolve from small town atmosphere" (Edwards & Associates 2010c).

*Fortune*

Within its Vision Statement, the "Town of Fortune values its sense of community, historic and cultural resources. Most of all we value our citizens and the safe and caring atmosphere in our rural area of Newfoundland and Labrador" (HMJ 2015).

*Grand Bank*

Grand Bank "…is a caring community, in that many in the public sector and volunteers do what they can to alleviate distressing conditions and promote healthy lifestyles through actions such as a food bank and staffing recreation programs" (TGB 2012).

### 4.6.1.3 Industries

Traditionally nearly all shoreline communities on the Burin Peninsula and around Placentia Bay were sustained by inshore fishing, where a number of independent, self-employed fishers used their own vessels and enterprise licenses to harvest cod, lobster, crab, and other seasonal species. While the primary sources of employment have shifted during the last ~50 years to a wage labour economy, there are still close to 600 fish harvesters in Placentia Bay (FFAW 2016). Fishers' incomes have been threatened in recent years by declining resources. The amount of lobster available to fishers on the west side of the Bay has declined over the last few years (see Appendix D), but severe declines in the commercial cod and crab fisheries over the past five years have had a more serious impact. Most of the cod from NAFO Division 3Ps is landed by Placentia Bay fishers, and the amount of cod they caught declined by half, from 10,600 mt in 2008 to 5,200 mt in 2012 (FFAW 2016). In 2016, the harvest levels remained low, at only half of the available quota (FFAW 2016). By 2017, only 20% (1,800 mt) of the quota available to fishers in the under 65' vessels category were landed (FFAW 2016).

A strong snow crab fishery with high crab prices offset the declining cod fishery until 2014. In 2015, the 2,500 mt of crab landed was less than a third of what was landed in 2013, and in 2016 declined to only 662 mt (FFAW 2016). The FFAW estimates there was a 90% drop in crab landings over those three years. They appealed for help for the fishers, noting that the disappearance of snow crab resources, "the primary economic driver for harvesters in Placentia Bay for close to two decades", had a serious impact on fishers' enterprise and household incomes (FFAW 2016). The FFAW estimated annual enterprise crab fishery incomes for fishers in boats under 40' decreased from $53,000 between 2011 and 2014 to $35,000 in 2015, and $10,000 in 2016. The cod fishery income from 2011–2014 was only $10,000 a year (FFAW 2016). The union was concerned that the impact of declining resources would be devastating without some form of fleet rationalization or retirement plan, as debt leveraged for the fishing enterprises could cause bankruptcies (FFAW 2016).

The largest employer on the Burin Peninsula is the Eastern Health Authority (EHA), employing over 500 people at 11 facilities, including hospitals, clinics and offices. The English School District employs over 350 people at 18 schools and related offices in communities around Placentia Bay. Franchise private sector employers, including Walmart, Sobeys, McDonalds and Canadian Tire, employ about 325 personnel among their enterprises. Clearwater Seafoods employs ~200 people at its processing plant in Grand Bank.

The largest workforces on the Peninsula varied over an eighteen-month period during 2017 and 2018, depending on seasonality and demand. At times during 2017, the number of people employed at select locations included Eastern Regional Integrated Health Authority Burin, Bluecrest and US Memorial health centres (420 employees), Canada Fluorspar mine in St. Lawrence (227), OCI seafood processing plant in St. Lawrence (208), Clearwater Seafoods processing plant in Grand Bank (200), Walmart in Marystown (135), Kiewit Offshore Services in Marystown (100), Motel Mortier in Marystown (80), two English School Board District Schools in Marystown (139 combined), and Dynamic Air Shelters Ltd. in Grand Bank (70) (J. Bradley, Business Development Officer, Canada Business Network, pers. comm., 9 March 2018; Canada Fluorspar Human Resources Department, pers. comm., 24 April 2018; P. Keiley, OCI, pers. comm., 24 April 2018).

Publicly-funded industry is predominant throughout the Peninsula, including hospitals, schools, clinics, colleges, libraries, provincial and federal agencies, municipalities and non-profit organizations. The private sector includes a number of large enterprises, such as seafood processors, manufacturers, department, grocery and hardware stores, accommodations and banking. The total volume of registered

businesses predominantly includes small- and medium-sized enterprises, such as shops and stores, and self-employed medical professionals and tradespeople throughout the communities.

Table 4.43 indicates that the number of businesses and employers varies from public to private sector among communities. Some of these values reflect multiple individual businesses registered to the same business holder. Enterprises of individual fishers harvesting cod, crab, lobster and other species are not included in the numbers of registered businesses.

**Table 4.43. Businesses within Burin Peninsula communities.**

| Community | No. | Largest Business | No. Private | No. Public | No. Employed |
|---|---|---|---|---|---|
| Baine Harbour | 1 | Canada Post | 0 | 1 | 1 |
| Boat Harbour | 2 | Midway Gas Bar | 1 | 1 | 13 |
| Burin | 39 | Eastern Health | 18 | 21 | 400 |
| Burin Bay Arm | 26 | College North Atlantic | 18 | 8 | 224 |
| Burns Cove | 1 | Haye's Carpentry | 1 | | 3 |
| Creston (North) | 16 | Data Enterprises | 12 | 4 | 64 |
| Fortune | 40 | English School District | 27 | 13 | 48 |
| Frenchmans Cove | 4 | Grand Meadows Golf | 3 | 1 | 20 |
| Garnish | 6 | Town of Garnish | 2 | 4 | 11 |
| Grand Bank | 74 | Clearwater Seafoods | 50 | 24 | 768 |
| Lamaline | 13 | English School District | 4 | 8 | 71 |
| Lawn | 11 | English School District | 8 | 3 | 39 |
| Lewins Cove | 2 | Just For You | 2 | 0 | 3 |
| Marystown | 211 | Walmart | 172 | 39 | 1,957 |
| North Harbour (PB) | 4 | Slade Enterprises | 4 | 0 | 7 |
| Parkers Cove | 2 | Canada Post | 0 | 2 | 3 |
| Petit Forte | 1 | Canada Post | 0 | 1 | 2 |
| Red Harbour | 1 | Canada Post | 0 | 1 | 2 |
| Rushoon | 4 | English School District | 1 | 3 | 31 |
| South East Bight | 2 | English School District | 1 | 1 | 5 |
| St Bernards Jacques | 10 | Peninsula Pharmacy | 6 | 4 | 33 |
| St. Lawrence | 23 | US Memorial Hospital | 12 | 11 | 258 |
| Swift Current | 4 | Kilmory Ventures | 2 | 2 | 27 |
| Terrenceville | 7 | English School District | 6 | 2 | 53 |
| Winterland | 3 | Winterland Town | 2 | 1 | 7 |
| **Total** | **507** | | **372** | **124** | **4,050** |

Source: J. Bradley, Business Development Officer, Canada Business Network, pers. comm., 9 March 2018.

Over a third of the labour force (3,313 people out of the total labour force 8,911 in 2016) on the Burin Peninsula work in trades, transport and equipment-related jobs (Statistics Canada 2018a). Many of these workers are part of a mobile workforce, and travel to locations off the Peninsula and out of the Province.

Since the declaration of the moratorium on cod fishing in 1992, long distance commuting for work in western Canada, primarily Alberta, has supported many families on the Burin Peninsula as well as elsewhere in the Province. Effects of this practice have been studied by sociology and health researchers in the Province, including by Dr. Keith Storey (Storey 2016; Storey and Hall *in press*), and Dr. Barbara Neis and Dr. Stephen Bornstein, Co-Directors of a seven year study, On The Move Partnership, investigating employment-related geographical mobility and its consequences for workers, families, employers, communities, and municipal, provincial and federal governments (OMP 2018).

The ICSPs and municipal plans for the larger communities on the Burin highlight the importance of community, social connection and family, and some address the impact of its residents being part of a

mobile workforce. The Municipal Plan for the Town of Fortune recognizes that this practice, as essential as it might be, can be detrimental (HMJ 2015):

"Finally, and very importantly, a substantial number of people work away from their home communities, commuting on a longer work cycle to opportunities outside the province and in the capital region. Although the incomes brought to the home communities is very important, an unfortunate side effect is that the social fabric of the community is weakened, as some adults who travel away become naturally not much connected to the events and organizations at home."

### 4.6.1.4 Demographics

The population of the Burin Peninsula has been declining for the past 15 years. Reflecting a province-wide rural trend, there were 5,000 fewer people on the Peninsula in 2016 than in 2001. The 4.6% decline in the Burin Peninsula's population is in contrast to the Province's overall increase of +1.0 % (Statistics Canada 2018a). Population demographics for the Burin Peninsula and the Province are provided in Table 4.44.

**Table 4.44. Population Demographics for the Burin Peninsula and the Province.**

| Community | Population Demographics | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2011 | 2016 | % Change | Average Age | Average Total Income of Households in 2015 | Average Household Size | No. Private Dwellings |
| Province | 514,536 | 519,716 | +1.0 | 48 | $87,392 | 2.3 | 265,739 |
| Burin Peninsula | 21,351 | 20,372 | - 4.6 | 46.7 | 80,949 | 2.3 | 11,497 |
| St. Lawrence | 1,244 | 1,192 | - 4.2 | 46.4 | 73,192 | 2.4 | 601 |
| Marystown | 5,508 | 5,316 | - 3.5 | 42.6 | 83,765 | 2.3 | 1,270 |
| Grand Bank | 2,415 | 2,310 | - 4.3 | 41 | 92,764 | 2.4 | 1,158 |
| Garnish | 545 | 568 | + 4.2 | 48 | 85,195 | 2.3 | 292 |
| Burin | 2,424 | 2,315 | - 4.5 | 44.4 | 89,162 | 2.3 | 1,145 |
| Fortune | 1,050 | 1,007 | - 4.1 | 46.9 | 63,453 | 2.2 | 510 |
| Petit Forte | 85 | 57 | - 32.9 | 50.5 | N/A* | 2.2 | 25 |
| Baine Harbour | 137 | 124 | - 9.5 | 46 | N/A | 2.3 | 61 |
| Parkers Cove | 301 | 248 | - 17.6 | 46.3 | N/A | 2.3 | 127 |
| Red Harbour | 191 | 189 | - 1.0 | 44.6 | N/A | 2.3 | 83 |
| Rushoon | 288 | 245 | - 14.9 | 48.9 | N/A | 2.2 | 127 |
| Terrenceville | 530 | 482 | - 9.1 | 44.8 | 87,128 | 2.4 | 239 |
| Winterland | 363 | 390 | + 7.4 | 43.1 | 116,648 | 2.4 | 191 |
| Long Harbour | 298 | 185 | - 37.9 | 49.3 | N/A | 2.2 | 163 |
| Placentia | 3,643 | 3,496 | - 4.0 | 48.8 | 79,659 | 2.2 | 1,852 |

Source: Statistics Canada (2018a).

* Denotes data suppressed (i.e., the volume of responses was too low to utilize without potentially revealing private information).

## 4.6.2 Health Services and Social Programs

### 4.6.2.1 Department of Children, Seniors and Social Development (CSSD)

The provincial Department of Children, Seniors and Social Development (CSSD) supports individuals, families and communities in Newfoundland and Labrador in achieving improved health and social well-being and reduced poverty. The CSSD also ensures the protection of children, youth and adults from abuse or neglect. The CSSD offers programs for financial help (e.g., income support, home heating rebate, child benefit, parental support, child care subsidy and financial help for seniors and persons with

disabilities); housing, shelter and home support (e.g., rental housing, home repair and support for victims of violence); education and learning (e.g., education incentives, adult basic education and student loans); employment support (e.g., job creation partnerships, employment centres, self-employment services and wage subsidies); medical, health and wellness (e.g., prescription drug program, dental and vision care, medical transportation assistance, the medical care plan [MCP], helplines for problem gambling and smoking and community programs in association with healthcare authorities); and justice and legal programs (e.g., child protection, victim services, legal aid and family justice services). Other services include consumer protection and child and youth advocate.

In Economic Zone 16, which encompasses the Burin Peninsula, there were 1,535 individuals receiving income support (7.3% of the population of 21,027) in 2016 (Community Accounts 2017a). As of February 2018, there were 33,007 people receiving income support in the entire province, and 22,889 income support cases (DF 2018). In 2016, just over 40,000 people (7.8% of population) received income supports benefits. This was the lowest number in the province since 1991, when the number of recipients peaked at over 100,000 in the mid-nineties and represented 18% of the population (Community Accounts 2017a).

#### 4.6.2.2 Department of Health and Community Services

The Provincial Department of Health and Community Services leads health and community services programs and policy development for the Province, working in partnership with regional health authorities, community organizations, professional associations, post-secondary educational institutions, unions, consumers and other government departments. The provincial government's focused approach on primary health care for individuals encompasses community-based services essential to maintaining and improving health and well-being throughout an individual's entire lifespan. Primary health care is expected to support individuals, families, communities, and the health sector to prevent illness and maintain health. This includes recognizing and working to improve social conditions that have a significant impact on health such as income, housing, education, and environment (GNL 2015a).

Population health refers to the health of a population as measured by health status indicators and as influenced by social, economic, and physical environments, personal health practices, individual capacity and coping skills, human biology, early childhood development, and health services. As an approach, population health focuses on the interrelated conditions and factors that influence the health of populations over the life course, identifies systematic variations in their patterns of occurrence, and applies the resulting knowledge to develop and implement policies and actions to improve the health and well-being of those populations (GC 2013).

#### 4.6.2.3 Eastern Health Authority (EHA)

Publicly funded health and community services are delivered throughout the province by four regional health authorities. The EHA is the largest of the four health authorities in the Province, and its jurisdiction includes the Burin Peninsula and Placentia Bay communities. The EHA provides a full continuum of health and community services, including public health, long-term care, and acute (hospital) care. It serves a population of just over 300,000. With a budget of approximately $1.45 billion (the highest portion of the overall provincial budget), the EHA has ~13,000 employees and works with 745 physicians, including 270 on salary (Eastern Health 2017a). The EHA operates all health care facilities on the Avalon, Burin and Bonavista Peninsulas, and manages 925 acute care beds, including 87 critical care beds, in 17 facilities. It provides tertiary-level programs and 36 individual programs through 78 physical sites.

Population Health is a priority focus, and Eastern Health has been involved in collaborative partnerships committed to rural health. Three initiatives include the Bonavista Primary Health Care and Burin Peninsula Primary Health Care initiatives, and Downtown Collaborative in St. John's.

***Primary Healthcare System on the Burin Peninsula***

Eastern Health partnered with the Government of Newfoundland and Labrador Office of Communication and Public Engagement on 1–3 May 2017 to host a series of Primary Health Care community consultations on the Burin Peninsula. A total of four sessions were held in Grand Bank, St. Lawrence, Burin and St. Bernard's, attended by 144 residents. The purpose of the sessions was to share information about the health status of residents in the area, engage participants in a discussion regarding health and together search for concrete solutions to help transform primary health care on the Burin Peninsula. An additional online survey included people from the Burin and Placentia West Clinic area. Individuals participating in the sessions included representatives from community groups and organizations such as schools, ambulance operators, municipalities, churches and clergy, fire departments, youth groups, seniors' groups, sports and recreation committees and Eastern Health employees (Eastern Health 2017b).

The top three concerns in the community or region identified by participants during polling questions as part of the abovementioned consultation process were mental health, cancer and addictions. Aspects of the Primary Healthcare System found to be working well included people and groups working together, lots of community resources, dedicated and excellent volunteers, public education sessions and the variety of Eastern Health programs and services offered throughout the region. On the other hand, there were aspects of the Primary Healthcare System considered to be not working so well, lacking resources and requiring stronger focus. Mental Health and Addictions Services stood out, as did the need for better communication and collaboration among all stakeholders, and better efforts to recruit and retain health professionals. Concerns were also expressed about difficulty accessing Eastern Health programs and services (Eastern Health 2017b).

Of particular concern to the region was a spate of suicides in 2016 that led many community leaders to ask for more resources to address addiction and mental health. There were more suicides in some communities, such as in Grand Bank, where six suicides were noted over a period of 14 months (Smellie 2017). Other communities like Parkers Cove were affected as well (Smellie 2017; E. Murphy, Chair, Placentia West Development Association, pers. comm., 20 February 2018; H. Murphy, Mayor, Parkers Cove, Chair, BPWMC, and Member, Burin Peninsula Joint Council, pers. comm., 20 February 2018; see also Appendix D).

The EHA consultations revealed a repeated and urgent need for support groups for individuals, families and health care providers. There was a demand for family programs, counselling, psychiatrists and a local detox centre or treatment facility, along with increased availability of methadone prescriptions and programs to help reduce stigmas, improve communication regarding available services, and address high rates of anxiety among youth. As a result of the consultations, the EHA accepted recommendations for changing or improving the Primary Healthcare system on the Burin Peninsula, and is actively working on ways to enhance infrastructure, resources and education as well as communication and collaboration between all stakeholders. The team dedicated to the Burin Primary Healthcare is also working to break down barriers, work better together and improve engagement with specific target groups (Eastern Health 2017b). To date, this effort has resulted in the establishment of the Burin Peninsula Initiative (Eastern Health 2018a), which provides services at several facilities, training and increased health care access, including:

- The Grand Bank Mental Health and Addictions Wellness and Resources Drop-In Service, which provides added access to counselling services, other members of the primary health-care team, and information and resources on Wednesdays and Thursdays at the Dr. S. Beckley Health Centre;
- St. Lawrence DoorWays Walk-In Sessions, which are offered on Mondays at the U.S. Memorial Health Centre in St. Lawrence;
- Marystown Walk-In Mental Health and Addictions Clinics, with DoorWays single-session counselling and other services, offered Monday to Friday at the Marystown Community Services Building;
- Applied Suicide Intervention Skills Training (ASIST) provided by Eastern Health in partnership with the Richard's Legacy Foundation for Survivors of Suicide Loss, Inc. to health-care professionals and community groups on the Burin Peninsula in December, February and March 2018; and
- Terrenceville Primary Health Care has increased access to primary health care in 2018 with a new nurse practitioner at the Terrenceville Medical Clinic for two days per week.

In August 2017, Eastern Health partnered with town councils and community agencies on the Burin Peninsula to form a Coalition for Mental Health & Wellness. The new coalition is intended to foster a healthy community for all citizens, encompassing positive mental health and wellness with a specific focus on suicide awareness, prevention and intervention and post-suicide support. Community partners include representatives of the five largest towns, victim and ambulance services, police, government agencies, school and healthcare employees, and the ministerial association and joint community council. The coalition will be aligned with a Community Advisory Council to guide the recently-established Burin Peninsula Primary Health-Care Initiative (Eastern Health 2017c).

***Burin Peninsula Primary Health Care Initiative***

Overall, Eastern Health programs and initiatives for residents of the Burin Peninsula and Placentia Bay communities include a Provincial Home First program and Regional Wellness Coalitions, focused on prevention and early intervention through partnerships and engaging the public. Outreach services are offered with selected clinical care throughout the region for cancer care, mental health and selected children's services such as physiotherapy (Eastern Health 2017c).

Primary Healthcare planning continues for the Burin Peninsula. Primary Healthcare is a philosophy for organizing and delivering a comprehensive and realistic range of coordinated and collaborative community-based services to empower individuals, families and communities to take responsibility for their health and wellbeing, prevent illness, treat health issues or injuries, and to seek diagnoses and manage chronic health conditions (Eastern Health 2017c).

There is a philosophy that essential healthcare can be made accessible at a cost which the country and community can afford, with methods that are practical, scientifically sound, and socially acceptable. Primary healthcare providers, including those on the Burin Peninsula, include chiropractors, counsellors, diabetes educators, dietitians, family doctors, mental health and addictions counsellors, nurse practitioners, occupational therapists, pharmacists, dentists, physiotherapists, registered nurses, psychologists, public health nurses, social workers, speech language pathologists, health educators, paramedics, self-management leaders, community volunteers, and educators (Eastern Health 2017c).

### *Social Determinants of Health*

Social determinants of health refer to the social and economic conditions that impact the health and well-being of individuals, families and communities. These determinants include education, socio-economic status, employment, housing, early life experiences, access to social supports and food security. Eastern Health is integrating the consideration of these social determinants of health in its models for primary healthcare on the Burin Peninsula (Eastern Health 2017c).

### *Socio-economic Indicators*

Current socio-economic indicators considered by Eastern Health in determining Burin population health status are presented in Table 4.45.

**Table 4.45. Socio-economic indicators considered by Eastern Health for the health status of the Burin population.**

| Indicator | Burin Peninsula | Eastern Health | Province |
|---|---|---|---|
| Population >65 | 21.9% | 16.9% | 18.4% |
| | 22.7% north of Marystown area | | |
| | 18.9% Burin area | | |
| | 21.2% St. Lawrence area | | |
| | 28.1 % Grand Bank area | | |
| Median Age (years) | 49 | 42 | 44 |
| Employment Rate | 42.8% | 55.0% | 50.7% |
| Completed High School | 69.1% | 84.1% | 79.7% |

Source: Eastern Health (2017c).

### *Eastern Health Authority Facilities*

Eastern Health distinguishes its facilities in five categories: (1) hospitals and health care centres; (2) clinics and health offices; (3) long-term care; (4) community services; and (5) administrative offices (Table 4.46).

**Table 4.46. Healthcare facilities on the Burin Peninsula and around Placentia Bay.**

| Facility | Hospitals & Health care Centres | Clinics and Health Offices | Long Term Care | Community Services | Administration Offices |
|---|---|---|---|---|---|
| Burin Peninsula Health Care Centre | ✓ | | | | |
| U. S Memorial Health Centre | ✓ | | ✓ | | |
| Placentia Health Centre | ✓ | ✓ | | ✓ | |
| South East Bight Clinic | | ✓ | | | |
| Terrenceville Clinic | | ✓ | | | |
| Grand Bank Health Centre | | ✓ | | ✓ | ✓ |
| Marystown Community Services | | ✓ | | | ✓ |
| Blue Crest Nursing Home | | | ✓ | | |
| Placentia West Medical Clinic, Boat Harbour | | | | ✓ | |
| St. Bride's District Office | | | | ✓ | |
| Placentia District Office | | | | ✓ | |

Source: Eastern Health (2016).

***Facility and Service Descriptions***

The Burin Peninsula Health Care Centre in Burin has 41 acute care beds and provides 24-hour emergency, outpatient clinics, day surgery, dialysis, diagnostic imaging and x-ray, blood collection, chemotherapy and laboratory services. Inpatient services include a suite of services from medicine/surgery, pediatrics, intensive care, to palliative care, and gynecology and obstetrics (Eastern Health 2013a). Physicians with private practices are located in the Burin Pharmacy Building next door to the Burin Peninsula Health Care Centre, and are available for emergency care, shifts, special procedures, chemotherapy, prenatal and postnatal care and house calls/ personal care home visits as needed (Avery 2014).

The U.S Memorial Health Centre in St. Lawrence has 40 beds, including 30 long-term care beds and 10 protective care beds to provide nursing care for Level 3 residents and dementia residents who are dependent on the support of nurses and other health-care professionals for most activities of daily living. The Centre accepts admissions for palliative care, respite and convalescence care, and offers a Family Practice Clinic with family physician and nurse practitioner clinics along with emergency services, diagnostic imaging and x-ray, laboratory services and blood collection (Eastern Health 2017d).

The Placentia Health Centre in the town of Placentia has 10 inpatient beds, including a palliative care room, along with three beds for 24-hour emergency care and a quiet room available for family. Services include emergency, diagnostic imaging and x-ray, laboratory and blood collection, outpatient clinics and inpatient services (Eastern Health 2013b).

The South East Bight Clinic is housed in St. Anne's School, which has 16 students and two teachers in its multi-grade classes and is also used as a community centre. Clinics are offered twice a month as required with family physicians and nurse practitioners (Eastern Health 2011a).

The Terrenceville Clinic is located on the western side of the Burin Peninsula and provides access to primary healthcare with a nurse practitioner available two day a week (Eastern Health 2017c).

The Grand Bank Health Centre, also known as the Dr. S. Beckley Health Centre, provides primary health care and emergency services, such as continuing care, public health, community health, a district administration office and an emergency department. Family physician clinics are open from 8:30 a.m. to 4:30 p.m. The emergency department offers 24-hour service. Laboratory and diagnostic services are also available (Eastern Health 2018b).

The Marystown Community Services Clinic provides primary health care with services for public health, community health, mental health and addictions, community supports programs, speech and language programs, child, youth and family, community corrections, finance and human resources (Eastern Health 2015).

The Blue Crest Nursing Home in Grand Bank provides nursing care for Level 3 and 4 residents who need moderate to total assistance with daily functioning. The facility has 61 beds, including 58 for long-term care and one bed each for palliative, respite and convalescent care (Eastern Health 2017e).

The Placentia West Medical Clinic in Boat Harbour is a relatively new clinic that opened in 2015 to serve northern Burin Peninsula communities from Monkstown to Parker’s Cove, with primary care services and programs in community health nursing (e.g., public health, home and community care), family medicine outpatient clinics, blood collection, and access to mental health professionals. The clinic was opened as a result of a unique community partnership among the Placentia West Development Committee, Eastern

Health and Provincial Government to replace older medical clinics in Parker's Cove, Petit Forte and St. Bernard's. Community-based services are offered at the clinic five days a week, with physician hours scheduled three days per week (GNL 2015b).

The St. Bride's District Office provides a clinic for Public Health and Home and Community Care, and operates Monday–Friday from 8:30 a.m. to 4:30 p.m. (Eastern Health 2012).

The Placentia District Office provide a clinic for public health, ambulatory care, mental health, and community health and support, and operates Monday–Friday from 8:30 a.m. to 4:30 p.m. (Eastern Health 2011b).

### 4.6.3 Family Life, Recreation and Culture

#### 4.6.3.1 Family Life

Families form a large portion of the population in the region. There were 6,718 families among the nearly 20,000 people living on the Burin Peninsula in 2016, with an average family size of 2.4. Of these, 75% were married couples, 11% were common-law couples and 13% were lone parent families. Among these categories, ~41% were families with children at home (Table 4.47) (Statistics Canada 2018a).

**Table 4.47. Number of families and persons per family on the Burin Peninsula as per a 2016 Statistics Canada Census.**

| Census Family Category | No. Families or Persons | % of Total |
|---|---|---|
| 2016 Census Families in Private Households | **6,718** | - |
| Married couples | **5,063** | **75** |
| With no children at home | 2,761 | 41 |
| With children at home | 2,301 | 34 |
| Common-law couples | **750** | **11** |
| With no children at home | 324 | 5 |
| With children at home | 426 | 6 |
| Lone-parent families | **905** | **13** |
| Number of Census Family Persons | 17,753 | - |
| Persons per Census Family (Average) | 2.4 | - |

Source: Statistics Canada (2018a).

***Community Leadership***

Communities have set clear visions to care for families and lifestyles in the development of ICSPs, strategic plans and Municipal Plans. For example, with respect to recognizing one of the community's values in keeping its 'small rural identity', the Town of Burin Strategic Plan states that "Burin has no interest in being something it is not" (JW 2018).

Burin's Plan's Vision and Mission statements show the balance between optimism and reality:

- **Vision:** "We are a proud family-friendly community that strives to provide effective local government built on good planning and wise investment. We enjoy growth and prosperity that continue to sustain us as a strong and independent rural community. Come visit. Experience the difference. You may even want to stay" (JW 2018).

- **Mission:** "The Town Council of the Town of Burin strives to provide affordable, quality programs and services to residents, and to be accountable to taxpayers as a means to providing sustainable local government services that are within our means" (JW 2018).

The municipal leaders consulted in February 2018 (see Appendix D) were cautiously optimistic that there would be an economic turnaround on the Burin Peninsula with the Canadian Fluorspar Inc. project, the proposed Grieg NL salmon aquaculture Project, and possible re-opening of the Marystown shipyard, and increased tourism associated with the new ferries for St. Pierre et Miquelon.

***Volunteers***

There are numerous active community-based organizations on the Burin Peninsula. They are staffed largely by volunteers and play an important role in social programs, such as youth programs, recreation leagues, safety training and emergency response, food banks and health outreach. Marystown alone lists more than 50 volunteer groups, and the essential role of volunteers is widely acknowledged and recognized throughout the Province. Communities are aware of the aging of their residents and most have active seniors' associations or Fifty + clubs. Housing and health/recreation needs of seniors are also frequent issues in communities' ICSPs (e.g., Tract 2017).

***Religion***

Faith-based community and affiliation is important for many residents, with many church organizations providing spiritual and community support. Only 1% of the population self-identified in 2016 as having no religious affiliation (Statistics Canada 2018a), with 99% identifying as Christian. Close to half (48%) of census respondents indicated being Catholic, followed by Anglican (23%), United Church (17%), affiliated other Christian faith (10%), and Pentecostal (1%).

### 4.6.3.2 Recreation

People living on the Burin Peninsula predominantly enjoy a rural Newfoundland outdoor lifestyle of boating for fishing and trips on the bay, cabins and camping, back country snowmobiling and trail biking and hiking. Many enjoy organized sports and indoor programs for recreation, entertainment and fitness, as well as community and school-based arts and performances (Statistics Canada 2018; J. Bradley, Business Development Officer, Canada Business Network, pers. comm., 6/9 March 2018). Recreation is discussed in detail in Section 4.4. Land and Resource Use.

Residents spent about $34 million, or 6% of their income (after tax, pensions and charitable causes) on recreation during 2016. Nearly $8 million was spent on buying recreational vehicles, including all-terrain vehicles or ATVs (23%), boats (15%), snowmobiles (14%), motorcycles (7%) and travel trailers (6%). An additional ~$3.5 million was spent on operating recreational vehicles, mostly for gas, supplies and parts. About $8 million was spent on recreational equipment for sports, games, computers, photography and music. Of the remaining $10 million spent on recreation services, $7.5 million (~75%), was spent on other forms of entertainment, including $6.4 million on cable and satellite services; $460,000 in movie theatres; $390,000 on performing arts; and $175,000 at live sporting events. An additional $2 million was spent on package travel tours. Nearly $655,000 was spent on single use or membership fees and dues for sports and recreational facilities (Statistics Canada 2018; J. Bradley, Business Development Officer, Canada Business Network, pers. comm., 6/9 March 2018).

Several towns around Placentia Bay have active recreation facilities and programs for residents of all ages. The facilities in the larger towns are typically used by neighbouring communities. Marystown is a

regional hub for recreation and sport, with both indoor and outdoor facilities. The new sports complex, which opened two years ago, is owned by the Town and operated by the YMCA of Newfoundland and Labrador. It offers a 6-lane swimming pool, fitness centre, indoor track, gymnasium and other modern healthy lifestyle features and facilities. The Katelyn Osmond arena in Marystown has active skating, hockey and figure skating, stimulated in part by the arena's namesake Olympian medalist and gold World Figure skater. League soccer on the Burin Peninsula is highly competitive with an annual Challenge Cup (TSL 2015; P. Pike, Mayor, Town of St. Lawrence, pers. comm., 21 February 2018).

St. Lawrence is celebrated as the Soccer Capital of Canada (TSL 2015). The Town's men's team, the Laurentians, was established in 1904. Two regulation-size soccer pitches owned by the Town of Burin are used by the Burin Minor Soccer Association and young players (under 9 years of age) for recreational play. Table 4.48 demonstrates that recreational facilities are core investments in Burin Peninsula communities.

**Table 4.48. Recreational facilities on the Burin Peninsula.**

| Community | Facility | Features / Purposes |
|---|---|---|
| Marystown | YMCA Sports Complex | 25 m 6-lane pool; play pool and waterslide; conditioning fitness centre; walking/running track; gymnasium |
| | Kaetlyn Osmond Arena | Ice surface, dry floor, figure skating; ice and ball hockey; Marystown Minor Hockey; Marystown Ice Crystal Figure Skating Club |
| | Town Soccer Pitch | Marystown Minor Soccer |
| | Town Softball Fields (2) | |
| | Landing Place Pond | 1.8 km trail and swimming area |
| | Jane's Pond | Scenic walking trail |
| | Town Track and Field Complex | Mariners Athletic Club |
| Grand Bank | Town Playgrounds | |
| | Tennis Courts (4) | |
| | Soccer Field | Men's, ladies' and junior soccer leagues |
| | Basketball Centre | |
| | Swimming Pool | |
| | Fitness Centre | |
| | Gymnasiums | Senior men's and women's floor hockey Leagues; |
| | Grand Bank Nature Trail | 5 km trail; view salmon ladder |
| | Grand Bank Marine Hike | 7 km to Grand Bank Cape |
| St. Lawrence | Soccer Fields (2) | Regulation |
| | Curling Rink (2 sheets) | |
| | Multi-purpose Recreation Centre | |
| | Tennis Courts (2) | |
| | Softball Field | |
| | Cape Chapeau Rouge View Park and Trail | Centre town lookout and storyboards; trail to highest point |
| | Chamber Cove Heritage Walk | 5 km trail tracing rescue route of *USS Truxton* and *USS Pollux* ship disasters; old mine |
| | St. Lawrence Nature Walk | 16 km trails on old mine roads |
| Fortune | Fortune Arena | Ice surface; dry surface for floor hockey; indoor soccer |
| | Multi-purpose Field | |
| | Horse Brook Walking Trail | Ecological park view |
| Frenchman's Cove | Grand Meadows Golf Course | 9-hole golf course next to Frenchman's Cove Park |
| Burin | Town Playgrounds (5) | |
| | College of North Atlantic | Gymnasium |
| | Schools (2) | Gymnasiums; soccer fields; basketball courts |
| | Town Soccer Field | Regulation soccer field (split in two for minor leagues); Burin Minor Soccer Association; Burin Minor Softball |
| | Town Softball Field | Regulation softball field |
| | Cooks Lookout Trail | 6 km gravel and boardwalk trail |
| | Salt Pond Walking Trail | Trail around pond |

Source: M. Healey, Director, Healthy Living, Sport and Recreation, Department of Children, Seniors and Social Development, pers. comm., 17 April 2018.

#### 4.6.3.3 Culture

Culture and heritage are often the focus of local festivals and events, including Come Home Years, a clear demonstration of community attachment. There are theatres and auditoriums in several locations, such as in Marystown, Burin and Grand Bank. Heritage associations reach out to both adults and youth to pass on traditional activities, tools, materials and 'way of life' (E. Murphy, Chair, Placentia West Development Association, pers. comm., 21 February 2018).

Frequently identified in the ICSPs is the interest of the community in incorporating culture into tourism. Two reports (HNL 2013; BT and TC 2014) have frequently been mentioned during ICSP reviews, and the influence of culture is present in community web sites, funding applications and strategic plans. Major revitalization projects are in the planning stage for the towns of Burin and Grand Bank that draw on the advice and information in HNL (2013) and BT and TC (2014). Grand Bank is interested in the development of their waterfront, while Burin focuses on developing an area in Old Burin called Heritage Square (MLS 2017a,b).

Marystown promotes its historic and cultural facilities to residents and to visitors via the Marystown Heritage Museum, St. Gabriel's Hall, Little Bay Heritage Centre, Marystown Firefighters Heritage Room, and Jerome Walsh's Museum, Little Bay (TM 2011).

### 4.6.4 Education and Training Facilities and Programs

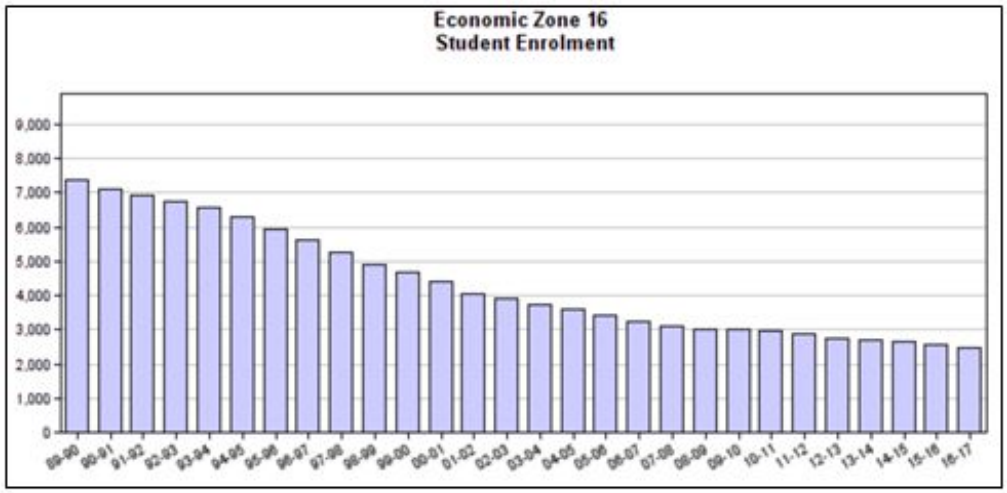
The Department of Education and Early Childhood Development is responsible for early childhood learning and development, the K-12 school system and public libraries, with the objective of building an educational community in Newfoundland and Labrador that fosters safe, caring and inclusive learning environments for all children and youth in early childhood settings, regulated child care and family resources centres, and pre-school to grade 12 (GNL 2018d).

In addition to the programs offered through the Division of Early Childhood Learning, there are many others that also serve children from birth to age six and their families. These include regulated full-time or part-time child care centres, family childcare homes, family resource centre programs, school-sponsored pre-Kindergarten programs, and early literacy programs such as those affiliated with public libraries, schools and community centres. There is a child care centre in Marystown. Child health clinics are available in Grand Bank, St. Lawrence, Marystown, Boat Harbour, Come By Chance, Placentia and St. Brides. There are family resources centres in Marystown and Placentia (GNL 2018e).

The Newfoundland and Labrador English School District (NLESD) represents all English-speaking students and schools in Newfoundland and Labrador. The District includes approximately 65,300 students; 252 schools and six alternate sites; and over 8,000 employees (NLESD 2018). Governed by 17 elected school board trustees, the district is managed by a CEO/Director of Education, an Associate Director of Education (Programs & Operations) and two Assistant Directors for Human Resources and Finance. There are four regional offices in the province, located in Happy Valley-Goose Bay, Corner Brook, Gander and St. John's. Each office has an Assistant Director of Education (Programs) and a variety of support staff for programing, human resources, finance, facilities and information technology. Senior Education Officers, program specialists, itinerant personnel, and support staff are located throughout the District, and work with the administrators and school communities to ensure the goals of community strategic plans are met, and, most importantly, that students are provided the opportunity for academic and personal achievement (NLESD 2018). During 2016–2017, the NLESD had a varied school population, with school enrolments ranging from two students (Raymond Ward Memorial, Norman Bay) to 972 students (Holy Heart of Mary High School, St. John's). The number of students in each region

served by the NLESD during this period include: Labrador (3,643), Western (11,506), Central (15,342) and Avalon (35,691), for a total of 66,182 (NLESD 2017).

Schools on the Burin Peninsula are governed within the Central Regional office, whereas schools in the remaining Placentia Bay communities are governed within the Avalon region. Student enrolment from Kindergarten to grade 12 (or level three) has declined steadily on the Burin Peninsula during the past three decades, from ~7,500 students during the 1989–1990 school year to 2,500 students in 2017 (Figure 4.73; Table 4.49; GNL 2017a).




Source: Community Accounts (2017b).

**Figure 4.73. Economic Zone 16 student enrolment, 1989/1990 to 2016/2017. Vertical axis is the number of students enrolled, and horizontal axis is the school year.**

**Table 4.49. Student enrolment in Burin Peninsula / Placentia Bay schools.**

| School | Community | Total No. Students | No. High School Students | Grades |
|---|---|---|---|---|
| Pearce Junior High School | Burin Bay Arm, NL | 229 | 229 | 8–9 |
| Lake Academy | Fortune, NL | 234 | 30 | K to 7 |
| John Burke High School | Grand Bank, NL | 185 | 185 | 8–12 |
| St. Joseph's Academy | Lamaline, NL | 77 | 36 | K to 12 |
| Marystown Central High School | Marystown, NL | 364 | 364 | 10–12 |
| Sacred Heart Academy | Marystown, NL | 469 | 63 | K to 7 |
| Christ the King School | Rushoon, NL | 98 | 54 | K to 12 |
| Donald C. Jamieson Academy | Burin Bay Arm, NL | 336 | 56 | K to 7 |
| St. Anne's School | South East Bight, NL | 16 | 3 | K to 5, 8–10 |
| Fortune Bay Academy | St. Bernard's - Jacques Font | 85 | 45 | K to 12 |
| St. Lawrence Academy | St. Lawrence, NL | 165 | 75 | K to 12 |
| St. Joseph's All Grade | Terrenceville, NL | 103 | 53 | K to 12 |
| Swift Current Academy | Swift Current, NL | 24 | 7 | mix |
| Holy Name of Mary Academy | Lawn, NL | 80 | 42 | K to 12 |
| Tricentia Academy | Arnold's Cove, NL | 222 | 107 | K to 12 |
| Laval High School | Placentia, NL | 216 | 216 | 7–12 |
| Fatima Academy | St. Bride's, NL | 54 | 31 | 1–12 |
| St. Anne's Academy | Dunville, NL | 236 | 0 | K to 6 |
| **Total** | **-** | **3,193** | **1,596** | **-** |

Source: GNL (2018f).

### 4.6.4.1 Training and Education Approach

All core education and training for Project occupations and positions (see Section 2.6, Personnel Requirements) is available at facilities and institutions within the Province. Additional orientation, and equipment and site-specific training and orientation will be provided upon employment. The Project workforce onboarding approach will be a combination of training and education provided by instructors at institutions and facilities within the Province, with added technical orientation and training tied to equipment, operational and safety specifications and standards. Customized training will be provided for operating equipment and systems unique to this Project in accordance with Grieg's operating standards, which are proprietary to Grieg NL's contractors' equipment manufacturers and suppliers (P. Power, Human Resources Manager, Grieg NL, pers. comm., March 2018).

Grieg NL has initiated working relationships with Memorial University and its Fisheries and Marine Institute, as well as the College of the North Atlantic and private colleges on the Burin Peninsula to develop a multi-year training plan that is tied to the schedules and plans for operation of the hatchery and sea farms. Customized training plans and programs will incorporate the participation and equipment of the contracted suppliers with the Project's technology and equipment. This will include the assembly and operations of the Aqualine Midgard Sea Cages, the AquaMaof Hatchery Recirculating Aquaculture System, marine service vessels and barges, and all other related operational and maintenance equipment and systems. Orientation and training will be provided in multiple ways, using classrooms, e-learning and virtual reality technologies, operating manuals, on-site and on-equipment demonstrations, and other tools and technology supplied by Grieg NL's contractors. Grieg NL intends for training and orientation to be provided on the Burin Peninsula, on-site or site-adjacent, with the inclusion of local institutions and facilities wherever possible. In select situations, to comply with standards and to ensure direct learning and experience, orientation and training will be provided at out-of-Province operating aquaculture sites and original equipment manufacturers plants in Norway, Israel, America, Canada and other sites as determined (P. Power, Human Resources Manager, Grieg NL, pers. comm., March 2018).

### 4.6.4.2 Private and Public Education and Training

The core skills and knoweldge required for the RAS Hatchery and sea cage sites are available via programs provided by public and private education and training insitutions in the Province. The Department of Advanced Education, Skills and Labour (AESL) and its Literacy and Institutional Services Division are responsible for postsecondary education and training in the Province, which involves direct support to Memorial University and its Fisheries and Marine Institute and Grenfell Campus, as well as the College of the North Atlantic. The Department is responsible for regulating and monitoring 23 private training institutions and international education, and has offices throughout the province, including Marystown (GNL 2018g).

The AESL supports adult learning and training for employment, and plans and advances adult literacy through the provincial Adult Literacy Grants program and the provincial Adult Basic Education (ABE) program. Post-secondary education is factored into community strategies for healthcare, literacy and economic development. Employment and training assessments are offered to individuals to determine necessary financial and training support and provide an employment plan. The Community Partnership Program, along with community agencies, helps individuals prepare for, find and maintain initial employment and transition to new jobs. The Program supports youth, women, persons with disabilities and older workers, and provides enhanced employment, career and workplace services to support participation in the labour force. The Program also responds to indetified labour market needs, addressing gaps in current services. The AESL oversees employment services in apprenticeships and trades

certifications, employment services, immigration and multiculturalism, student aid and income support (GNL 2018h).

### *Private Institutions*

The AESL requires the registration of all private training institutions in the Province that offer courses with 50 or more hours of instruction. Private institutions are governed by the *Private Training Institutions Act* and associated regulations, in accordance with standard operating procedures (GNL 2018i). There are several private training institutions located on the Burin Peninsula and in eastern Newfoundland (from Clarenville to St. John's) offering programs with the core skills and knowledge required by Grieg NL and its suppliers and contractors (Table 4.50).

**Table 4.50. Private training institutions in eastern Newfoundland.**

| Institution | Relevant Training Programs |
|---|---|
| Keyin College<br>Marystown<br>Burin<br>Carbonear<br>St. John's | Business (accounting, office and business administration, computer applications, management, human resources and office); Adult Basic Education; Career Preparation; Customized Corporate Training; Industrial Trades (carpenter, commercial driver, construction electrician, heavy equipment operator, insulator, plumber, steamfitter pipefitter); Information Technology (business, computer, graphic arts, network, information systems) |
| Academy Canada<br>St. John's | Construction; Trades; Business; Adult Basic Education |
| Canadian Training Institute<br>Bay Roberts | Heavy Equipment Driver |
| Carpenter Millwright College<br>Paradise | Carpenter; Millwright; Scaffolding; Interior Mechanical Systems; Safety; Construction Health and Safety Advisor |
| Operating Engineers College<br>Holyrood | Mobile Crane; Heavy Equipment and Boom Truck |
| U.A. Training Centre<br>Mount Pearl | Pipe and Welding Trades |

Source: GNL (2018e).

In prepration for the Project, Grieg NL has initated discussions with Keyin College in Burin/Marystown regarding its core curriculum and availability for potential customized on-site and site-adjacent orientation and training. Keyin College has outlined its interest in providing customized training for unique applications, as it had done for the St. Lawrence Fluorspar Mine, with an adaptation of its heavy equipment operator course for haul truck operators at the mine, and safety training on work sites in St. Lawrence. (L. Lewis, Career Counselor, Keyin College, pers. comm., 13 April 2018). Keyin College has proposed an Aquaculture Program to Grieg NL.

### *Public Education*

Public education and training is available at two provncial organizations: (1) Memorial University of Newfoundland, which includes the Fisheries and Marine Institute; and (2) College of the North Atlantic. Both organizations offer programs relevant to the aquaculture industry and to core industry operations. The main campus of Memorial University is in St. John's, with its Grenfell Campus in Corner Brook, a residential campus in Harlow, England, and its Institut Frecker in Saint Pierre et Miquelon. Table 4.51 provides a selection of Memorial University's programs, including those available at the Marine Institute, which could provide employment opportunities for graduates in the aquaculture industry and be considered as relevant in Grieg NL's recruitment program.

**Table 4.51. Selection of Memorial University programs relevent to the aquaculture industry. Campuses include the main campus (St. John's), Fisheries and Marine Institstute (St. John's), Sir Wilfred Grenfell (Corner Brook), residential campus (Harlow, England), and Institut Frecker (Saint Pierre et Miquelon).**

| Program Level | Programs |
|---|---|
| Ph.D. | Biochemistry; Biology; Chemistry; Computer Science; Earth Sciences; Environmental Science; Environmental Systems Engineering and Management; Fisheries Science; Food Science; Marine Biology; Ocean and Naval Architectural Engineering; Process Engineering |
| Master's | Science (Aquaculture); Business Administration; Employment Relations; Environmental Policy; Marine Studies (Fisheries Resource Management, Spatial Planning and Management); Maritime Management; Aquaculture Technology Management |
| Bachelor's | Food Technology; International Business Administration; Maritime Atudies; Nutrition; Ocean Mapping; Ocean Sciences and Environmental Systems; Sustainable Resource Management; Technology |
| Diploma | Advanced Diploma Food Safety; Marine Engineering; Marine Engineering Systems Design; Marine Environment Technology Diploma; Nautical Science; Nautical Architecture; Naval Architecture; Remotely Operated Vehicles; Underwater Vehicles; Water Quality; Safety and Risk Engineering; Sustainable Aquaculture Advanced Diploma |
| Post-graduate Certificate | Quality Management |

Source: MUN (2018).

The main campus of Memorial University's Fisheries and Marine Institute is in St. John's. The Marine Institute operates the Safety and Emergency Response Training Centre (SERT) in Stephenville. The Marine Institute also has off-site operations throughout the Province and globally through industry partnerships (MI 2018a). Programs and courses offered by the Marine Institute that may be relevant to the Project are provided in Table 4.52.

**Table 4.52. Project-relevant Fisheries and Marine Institute programs and courses.**

| Level of Achievement | Program | Location |
|---|---|---|
| Diploma of Technology | Marine Engineering | Main Campus St. John's |
| | Marine Engineering Systems Design | Main Campus St. John's |
| | Nautical Science | Main Campus St. John's |
| | Naval Architecture | Main Campus St. John's |
| Diploma of Technology / Bachelor of Technology | Marine Environmental Technology | Main Campus St. John's |
| | Ocean Mapping | Main Campus St. John's |
| | Underwater Vehicles | Main Campus St. John's |
| Technician Diploma | Remotely Operated Vehicles (ROV Operator) | Main Campus St. John's |
| Technical Certificate | Bridge Watch | Main Campus St. John's |
| | Fire Rescue | Safety and Emergency Response Training Centre (SERT) Centre, Stephenville |
| | Marine Diesel Mechanics | Main Campus St. John's |
| Advanced Diploma | Food Safety | Main Campus St. John's |
| | Sustainable Aquaculture | Main Campus St. John's |
| | Water Quality | Main Campus St. John's |
| Degree | Maritime Studies | Online & Main Campus |
| | Technology | Online & Main Campus |
| Post-Graduate Certificate | Food Safety - Post Graduate Certificate | Online only |
| | Quality Management | Online only |
| Master's Degree | Fisheries Science (Stock Assessment) Master of Science (M.Sc.) Degree | Main Campus & Fieldwork |
| | Fisheries Science (Fisheries Science and Technology) Master of Science Degree | Main Campus & Fieldwork |
| | Marine Studies (Marine Spatial Planning and Management) | Main Campus & Online |
| | Marine Studies (Fisheries Resource Management) | Online only |

| Level of Achievement | Program | Location |
|---|---|---|
| | Technology Management (Engineering/Applied Science Technology) | Online only |
| | Technology Management (Aquaculture Technology) | Online only |
| | Maritime Management | Online only |
| Ph.D. | Fisheries Science Doctor of Philosophy (Ph.D.) | Main Campus & Fieldwork |

Source: MI (2018a).

The Marine Institute focuses on innovation and collaboration with oceans industries and offers customized industrial training and applied research through ten specialized centres, all of which have applications for aquaculture and the Project. The centres include the following (MI 2018b):

- Centre for Applied Ocean Technology (CTec): conducts applied research and development in ocean mapping, observing systems and instrumentation as well as underwater intervention, working to apply the evolving technology needs of key ocean industries, such as aquaculture;
- Centre for Aquaculture and Seafood Development (CASD): offers a complete range of services for aquatic health, food and seafood processing, fishery by-products and aquaculture industries, including applied research, product and process development, technology transfer, advisory services and industrial training. The centre hosts a modern aquaculture research facility, quarantine and histopathology laboratories, two food pilot plant facilities and has an approved Quality Management Program (QMP) in place;
- Centre for Fisheries Ecosystems Research (CFER): focuses on capacity in fisheries science research and federal and international fisheries management decision making processes;
- Centre for Marine Simulation (CMS): has a suite of computer-based simulators for training, education and applied research in partial or large and complex applications;
- Centre for Sustainable Aquatic Resources (CSAR): conducts applied research and development, technology transfer, at-sea testing and education in fisheries development, emerging fisheries, by-catch and selectivity, hydrodynamics testing and industrial training and educational workshops. The centre operates the world's largest flume tank, a primary testing facility for demonstrating and testing fishing gear and marine structures;
- Community Based Education Delivery (CBED): offers training in communities and response, in partnership with industry and government to support training priorities. Along with the main office in St. John’s, there are regional offices in Lewisporte and Iqaluit, Nunavut. The centre organizes, facilitates, and leads training in aquaculture, environmental practices, fish harvesting and food processing;
- Lewisporte Regional Fisheries and Marine Centre: works closely with the professional marine community of the northeast coast of Newfoundland to develop needed courses and programs;
- MI International: an active international partner providing contract training and consultant services, deploying a large multi-disciplinary team of experienced professionals to provide training and applied research. Since 2008, MI International has delivered more than 120 projects in over 50 countries;

- Offshore Safety and Survival Centre (OSSC): delivers customized safety, survival and emergency response training for offshore petroleum, marine transportation, fishing and land-based industries, and reinforces aviation and firefighting emergency response training provided in Stephenville; and
- Safety and Emergency Response Training Centre (SERT): a fire training facility for aircraft rescue and firefighting, and structural, marine and industrial firefighting training, and delivers the Marine Institute's Fire Rescue Technical Certificate program.

The College of the North Atlantic has campuses throughout the Province and offers a suite of programs applicable to the Project (Table 4.53).

**Table 4.53. Project-relevant programs offered by the College of the North Atlantic.**

| Campus Locations | Programs |
|---|---|
| Burin<br>St. John's (2)<br>Seal Cove<br>Clarenville<br>Gander<br>Grand Falls-Windsor<br>Corner Brook<br>Bay St. George | Business Administration (Accounting, General, Human Resource Management, Marketing); Carpenter; Chemical Process Engineer; Civil Engineering Technology; Comprehensive Arts & Science Transition; Computing Systems and Networking; Construction/Industrial Technician; Cook; Digital Animation; Digital Filmmaking; Electrical Engineering Technology; Electronic Systems Engineering; Environmental Engineering Technology; Fish and Wildlife Technician; Geomatics/Surveying Engineering Technology; GIA Applications Specialist; Graphic Communications; Graphic Design; Heavy Duty Equipment Technician/Truck and Transport Mechanic; Heavy Equipment Operator; Industrial Engineering Technology; Millwright; Information Management; Instrumentation and Controls Technology; Machinist; Mechanical Engineering Technology; Mobile Crane Operator; Office Administration; Plumber; Process Operations Engineering Technology; Programmer Analyst; Refrigeration & Air Conditioning Mechanic; Steamfitter/Pipefitter; Web Development; Welder |

Source: CNA (2018).

The Burin Campus of the College of the North Atlantic offers full-time credit courses (Table 4.54). Registration is approximately 400 students per semester, with another 75 who are registered part-time. Approximately 500 students participate in Continuing Education evening courses (CNA 2018).

**Table 4.54. Programs offered at the Burin Campus of the College of the North Atlantic.**

| Level of Achievement | Program | Duration |
|---|---|---|
| Certificate | Comprehensive Arts & Science Transfer: College-University | 1 year |
| Certificate | Construction / Industrial Electrician | 37 weeks |
| Certificate | Cook | 34 weeks |
| Certificate | Instrumentation and Control Technician | 34 weeks |
| Certificate | Metal Fabricator (Fitter) | 37 weeks |
| Certificate | Office Administration | 1 year |
| Diploma | Office Administration (Executive) | 2 years |
| Certificate | Sheet Metal Worker | 34 weeks |
| Certificate | Welder | 36 weeks |
| Diploma | Welding Engineering Technician | 2 years |

Source: CNA (2018).

### 4.6.5 Housing, Accommodations and Property Values

The communities and residents of the Burin Peninsula, Marystown in particular, have experienced the 'boom and bust' effects of many previous projects, which have frequently required large, temporary work forces, such as a shortage of accommodation and increased rental rates. The proposed Grieg NL aquaculture Project anticipates the bulk of the workforce will be from the Burin Peninsula and while there

is a start-up construction phase, the work will be done at an existing industrial site, utilizing many of the traditional building skill available on the Peninsula.

The population demographics reveal average household size and the number of private dwellings owned on the Burin Peninsula (Table 4.55).

**Table 4.55. Average household size and the number of private dwellings owned on the Burin Peninsula.**

| Community | Population Demographics | | | | | | |
|---|---|---|---|---|---|---|---|
| | Population | | | | Average Total Income of Households in 2015 | Average Household size | No. Private Dwellings |
| | 2011 | 2016 | % Change | Average Age | | | |
| Province | 514,536 | 519,716 | +1.0 | 48 | 87,392 | 2.3 | 265,739 |
| Burin Peninsula | 21,351 | 20,372 | - 4.6 | 46.7 | 80,949 | 2.3 | 11,497 |
| St. Lawrence | 1,244 | 1,192 | - 4.2 | 46.4 | 73,192 | 2.4 | 601 |
| Marystown | 5,508 | 5,316 | - 3.5 | 42.6 | 83,765 | 2.3 | 1,270 |
| Grand Bank | 2,415 | 2,310 | - 4.3 | 41 | 92,764 | 2.4 | 1,158 |
| Garnish | 545 | 568 | + 4.2 | 48 | 85,195 | 2.3 | 292 |
| Burin | 2,424 | 2,315 | - 4.5 | 44.4 | 89,162 | 2.3 | 1,145 |
| Fortune | 1,050 | 1,007 | - 4.1 | 46.9 | 63,453 | 2.2 | 510 |
| Petit Forte | 85 | 57 | - 32.9 | 50.5 | N/A* | 2.2 | 25 |
| Baine Harbour | 137 | 124 | - 9.5 | 46 | N/A | 2.3 | 61 |
| Parkers Cove | 301 | 248 | - 17.6 | 46.3 | N/A | 2.3 | 127 |
| Red Harbour | 191 | 189 | - 1.0 | 44.6 | N/A | 2.3 | 83 |
| Rushoon | 288 | 245 | - 14.9 | 48.9 | N/A | 2.2 | 127 |
| Terrenceville | 530 | 482 | - 9.1 | 44.8 | 87,128 | 2.4 | 239 |
| Winterland | 363 | 390 | + 7.4 | 43.1 | 116,648 | 2.4 | 191 |
| Long Harbour | 298 | 185 | - 37.9 | 49.3 | N/A | 2.2 | 163 |
| Placentia | 3,643 | 3,496 | - 4.0 | 48.8 | 79,659 | 2.2 | 1,852 |

Source: Statistics Canada (2018a).
* Denotes data suppressed (i.e., the volume of responses was too low to utilize without potentially revealing private information).

Of the 8,375 households and dwellings reported in Statistics Canada 2016 Census estimates and projections, 86% were owned, and 14% rented (Table 4.56; Statistics Canada 2018). Most (89%) were single detached houses. Row houses comprised only 3% of the total reported dwellings, as did apartment duplexes.

**Table 4.56. Estimated number of households and dwellings on the Burin Peninsula, 2016.**

| Household / Dwelling Type | Burin Area | |
|---|---|---|
| | Number | % of Total |
| Households by Size of Household | **8,375** | - |
| 1 person | 1,956 | 23 |
| 2 persons | 3,478 | 42 |
| 3 persons | 1,504 | 18 |
| 4 persons | 992 | 12 |
| 5 persons | 337 | 4 |
| 6 or more persons | 108 | 1 |
| Persons in Households | **19,730** | - |
| Persons per Household | **2.36** | - |
| Owner Occupied Private Dwellings by Tenure | **8,375** | - |
| Owner | 7,240 | 86 |
| Renter | 1,135 | 14 |
| Occupied Private Dwellings by Structure Type | **8,375** | - |
| Single-detached house | 7,474 | 89 |
| Semi-detached house | 118 | 1 |
| Row house | 226 | 3 |

| Household / Dwelling Type | Burin Area | |
|---|---|---|
| | Number | % of Total |
| Apartment; building with fewer than five stories | 169 | 2 |
| Apartment; building with more than five stories | 5 | 0 |
| Apartment; duplex | 287 | 3 |
| Other single-detached home | 40 | 0 |
| Movable dwelling | 56 | 1 |
| Households by Age of Maintainer | **8,375** | - |
| Under 25 years | 165 | 2 |
| 25 to 34 years | 651 | 8 |
| 35 to 44 years | 1,086 | 13 |
| 45 to 54 years | 1,723 | 21 |
| 55 to 64 years | 2,110 | 25 |
| 65 to 74 years | 1,724 | 21 |
| 75 years and older | 916 | 11 |

Source: Statistics Canada (2018a).

The primary housing demand in Marystown is for affordable, single-family homes, which in 2017 cost in the range of $150–200,000 (Table 4.57; C. Janes, Senior Market Analyst, Market Analysis [Atlantic], Canada Mortgage and Housing Corporation, pers. comm., 15 February 2018). There was evidence from consultations during the planning phase (Tract 2017) that these homes are attractive to out-of-Province buyers looking to sell their homes in more expensive housing markets and retire to homes of the same style in the less expensive Marystown market (P. Power, Human Resources Manager, Grieg NL, pers. comm., 20 February 2018).

**Table 4.57. Cost of housing on the Burin Peninsula, 2013–2017.**

| Community | Year | Average Sale Price ($CAD) | No. of Sales | Average No. Monthly Active Listings |
|---|---|---|---|---|
| Burin Peninsula | 2013 | $143,070 | 20 | 19 |
| | 2014 | $170,527 | 45 | 26 |
| | 2015 | $160,074 | 42 | 35 |
| | 2016 | $164,494 | 50 | 78 |
| | 2017 | $136,604 | 63 | 106 |
| Goobies-Terrenceville | 2013 | $85,000 | 1 | N/A |
| | 2014 | $44,500 | 2 | N/A |
| | 2015 | $69,000 | 1 | N/A |
| | 2016 | $175,000 | 1 | N/A |
| | 2017 | - | 0 | N/A |
| Little Harbour East-Red Harbour | 2013 | $35,000 | 1 | N/A |
| | 2014 | - | 0 | N/A |
| | 2015 | $113,500 | 2 | N/A |
| | 2016 | - | 0 | N/A |
| | 2017 | - | 0 | N/A |
| Marystown-Burin Area-Winterland | 2013 | $176,300 | 13 | 10 |
| | 2014 | $206,752 | 29 | 16 |
| | 2015 | $195,230 | 27 | 25 |
| | 2016 | $193,664 | 36 | 55 |
| | 2017 | $162,231 | 43 | 77 |
| St. Lawrence-Point May | 2013 | - | 0 | N/A |
| | 2014 | $155,000 | 1 | N/A |
| | 2015 | - | 0 | N/A |
| | 2016 | $134,500 | 1 | N/A |
| | 2017 | $114,000 | 2 | N/A |
| Garnish-Grand Bank-Fortune | 2013 | $89,900 | 5 | 7 |
| | 2014 | $110,300 | 13 | 7 |
| | 2015 | $96,325 | 12 | 6 |
| | 2016 | $78,608 | 12 | 17 |
| | 2017 | $77,894 | 18 | 23 |

Source: C. Janes, Senior Market Analyst, Market Analysis (Atlantic), Office of the VP, Housing Markets and Indicators, Canada Mortgage and Housing Corporation, pers. comm., 15 February 2018.

### 4.6.5.1 Need and Availability

Some detailed information on housing is available for the Town of Marystown through the Town's public consultation toward integration of the ICSP with the Municipal Plan (Tract 2017). The Town of Marystown is planning for diverse housing and land development (Tract 2017). According to 2011 census data, the single detached residential home is the predominant residential housing type in Marystown (Tract 2017). The 2011 census data indicated that there were 2,210 private households, an increase of 8% from 2006. Of these, 73% were privately owned and 27% rented, a similar pattern for 2006 but quite different than the provincial ratio of 78% ownership/22% rental (Tract 2017). Of these owned homes, 41% of the housing structures were over 37 years of age (i.e., built before 1980), and 37% were built during 1981–2000 (Tract 2017). For planning purposes, it was noted that 27% of the homes were owned by people in the pre-retirement age group, and 19% by seniors over the age of 65. The analysis suggested there could be an increase in demand for alternative housing for seniors choosing not to stay in their own home, and indicated the need to consider demand for senior housing for people living in Marystown and for those looking to move to Marystown (Tract 2017).

It was determined that there was no demand for apartment buildings in Marystown. At the time of the Town of Marystown's public consultation towards integration of the ICSP with the Municipal Plan (Tract 2017), there were two vacant 16-unit, three-story apartment buildings near Pittman's Hill (on Marine Drive past the Marystown Retirement Centre). These apartment buildings had been used during construction peaks by contractor employees. At the same time, it was noted that many transient employees prefer basement apartments. Since the 2016 construction project peak of the offshore Hebron oil platform modules at the shipyard subsided, home owners began applying to the Town to decommission their basement apartments.

During 2017, there were 466 homes with some form of public support on the Burin Peninsula, half of which were in Marystown (NLHC 2017). The rental housing portfolio for the Peninsula, as reported by the Newfoundland and Labrador Housing Corporation (NLHC), included 307 NLHC houses, one house that was provided with a rent supplement, 20 units provided through partner managed housing in affordable housing approved units, 101 provided by the private sector and another 40 by a nonprofit organization (Table 4.58; NLHC 2017). The NLHC indicated there is low demand for publicly funded housing in Marystown. Most NLHC units in Marystown are located on Smallwood Crescent and Atlantic Crescent, where there is a Community Centre run by a private Board (P. Power, Human Resources Manager, Grieg NL, pers. comm., 20 February 2018). In consultation with the Town, the NLHC has been selling properties that have been vacant, many of which are 30–40 years old and require considerable repairs. Many of the houses were built and configured for large families, and with changing demographics to smaller family size and single people, the housing stock is no longer relevant. It is noted that much of the existing housing stock is not suitable for seniors, having too many stairs or being too large for a single widow/er (Tract 2017).

The Town of Marystown is also considering options to make more economically efficient use of the limited serviced area land supply, through infill residential development, well-designed smaller lot size homes, provision for compact lot zone categories within the development regulations, and the strategic siting of higher density two-unit and other apartment residential forms. The Town is considering seniors' desire to age in place, with options for residential care backyard cottage style dwelling units. However, it was noted during planning consultations (Tract 2017) that there was some resistance to the concept of small homes and higher density development, without establishing development controls to protect the rural atmosphere of Marystown neighbourhoods.

**Table 4.58. Newfoundland and Labrador Housing Corporation rental housing portfolio on the Burin Peninsula, as of 31 March 2017.**

| Community | NL Housing Total | Rent Supplement | Affordable Housing Approved Units | | Partner Managed Housing | Co-op | Federal Portfolio | Community Total |
|---|---|---|---|---|---|---|---|---|
| | | | Private Sector | Non-profit | | | | |
| Bay L'Argent | 6 | - | - | - | - | - | - | **6** |
| Burin | 52 | - | 37 | - | - | - | - | **89** |
| Creston | - | - | 6 | - | - | - | - | **6** |
| Creston South | - | 1 | - | - | - | - | - | **0** |
| Fortune | 35 | - | 10 | - | - | - | - | **45** |
| Garnish | - | - | - | - | 8 | - | - | **8** |
| Grand Bank | 37 | - | 10 | - | - | - | 23 | **70** |
| Lawn | 4 | - | - | - | - | - | - | **0** |
| Marystown | 148 | - | 30 | 12 | 12 | - | 32 | **234** |
| St. Lawrence | 25 | - | - | - | - | - | - | **0** |
| Winterland | - | - | 8 | - | - | - | - | **8** |
| **Total** | **307** | **1** | **101** | **12** | | **0** | **55** | **466** |

Source: NLHC (2017).

### 4.6.5.2 Home Rental Rates

The home rental market in the Marystown area was described as being similar to urban centres on the Avalon, with rental rates ranging from $650 to $1,000 per month for an apartment and $1,200 to $1,500 per month for a bungalow-styled house (P. Power, Human Resources Manager, Grieg NL, pers. comm., 13 April 2018). In April 2018, a review of advertisements on listing websites (NL Buy Sell 2018; NL Classifieds 2018) reflected a similar range, with the exception of an executive home available for $4,000.00 (Table 4.59).

**Table 4.59. Rental rates in the Marystown area as of April 2018.**

| Rental Unit Type | Features | No. Bedrooms | Location | Price per Month ($CAD) |
|---|---|---|---|---|
| Basement apartment | Furnished | 1 | Marystown | $550 |
| Basement apartment | Furnished | 1 | Marystown | $800 |
| Main floor apartment | Unfurnished | 2 | Marystown | $1,000 |
| Main floor apartment | Partially furnished | 3 | Marystown | $1,200 |
| Efficiency apartment | Camp-style | 1.5 | Marystown | $700 |
| Duplex | Unfurnished | 3 | Marystown | $775 |
| Townhouse | Furnished | 2 | Marystown | $995 |
| House | Executive Furnished | 3 | Marystown | $4,000 |
| House | Unfurnished | 3 | Marystown | $1,300 |
| House | Partially furnished | 3 | Marystown | $1,400 |
| House | Partially furnished | 3 | Grand Bank | $700 |
| House | Unfurnished | 3 | Grand Bank | $650 |
| Main floor apartment | Furnished | 1 | Swift Current | $650 |

Source: NL Buy Sell (2018); NL Classifieds (2018).

## 4.7 Economy, Employment and Business

### 4.7.1 Economy of the Burin Peninsula and of the Province

#### 4.7.1.1 Provincial Economy

For many decades, Newfoundland and Labrador struggled with a slow-growing economy that relied heavily on traditional resource industries, including the fishery, mining and forestry. Unemployment was high, and so was reliance on government transfer payments. The early 1990s saw a major economic shift in the Province as the historic cod fishery was shut down, and the newly emerged oil and gas industry began to take shape. This new industry would lead an unprecedented level of growth and prosperity for more than two decades.

From 1995–2015, the Province became one of the fastest growing economies in Canada, with real Gross Domestic Product (GDP) growth reaching a high of 11% in 2007 (GNL 2018j). Major oil projects were constructed or came online during this period, including Hibernia, Terra Nova, White Rose and Hebron. The mining industry saw the development of Voisey's Bay nickel mine and its processing facility in Long Harbour, which strengthened mining revenues long led by iron ore in Labrador West. The province's GDP grew by an average of 3% per year over this 20-year period. Average household incomes doubled, and retail sales reached nearly $10 billion by 2016. The provincial unemployment rate went from a high of 18.9% in 1996 to a low of 11.6% in 2013 (GNL 2017b). Provincial economic indicators for the period 2007–2017 are provided in Table 4.60.

It is important to note that the abovementioned provincial average was not reflected in all regions of the Province, but was largely concentrated on the Avalon Peninsula, where new challenges came with the economic boom, like increased traffic and crime, and less affordable housing as prices soared. Meanwhile, many rural areas of the Province without connection to offshore oil, mining or energy projects struggled to keep young families from leaving, and to provide access to services to an aging population (M. Butland, Owner, Butland Communications, pers. comm., 30 April 2018).

In 2018, the Province's economy has slowed once again. This shift was long foreseen as the new oil and gas and mining projects transitioned from construction to production phases, most recently the Hebron oil field and the Long Harbour nickel smelter. Despite the slowing of capital investment, the economy remains fairly robust with positive and new developments underway. Further details are provided below (Section 4.7.1.3).

#### 4.7.1.2 Overview of Key Industry Sectors

The following subsection describes the current status of key goods-producing sectors of the provincial economy, based on 2016 and 2017 data (GNL 2017b). GDP by industry sector is briefly profiled in Table 4.61for all sectors of the economy, including the many private and public services that support the production of goods and the well-being of people in the Province.

***Oil and Gas***

The oil and gas industry contributed $4.3 billion or 15% of the Province's GDP in 2016. It provided ~5,300 person years of employment in 2017, 2.3% of total employment in the province (GNL 2018l). There are currently four projects producing oil in the province's offshore: (1) Hibernia; (2) Terra Nova; (3) White Rose; and (4) Hebron. Total production increased by 5.0% in 2017 to reach 80.6 million barrels, in part due to the Hebron project producing first oil late in the year. As a result of increased

production volumes and crude oil prices, the estimated value of production grew by nearly 30% to reach $5.7 billion (GNL 2018l).

**Table 4.60. Selected economic indicators, Newfoundland and Labrador, 2007–2017.**

| Indicator | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017f |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Population (000s) | 509.0 | 511.5 | 516.7 | 522.0 | 525.0 | 526.5 | 527.4 | 528.4 | 528.8 | 530.3 | 528.8 |
| % change | -0.3 | 0.5 | 1.0 | 1.0 | 0.6 | 0.3 | 0.2 | 0.2 | 0.1 | 0.3 | -0.3 |
| GDP ($m) | 29,065 | 31,572 | 25,001 | 29,085 | 33,539 | 32,033 | 34,459 | 34,277 | 30,332 | 31,112 | 32,233 |
| % change | 18.3 | 8.6 | -20.8 | 16.3 | 15.3 | -4.5 | 7.6 | -0.5 | -11.5 | 2.6 | 3.6 |
| % change, real | 11.2 | -1.5 | -10.1 | 5.5 | 2.7 | -4.4 | 5.2 | -0.9 | -1.7 | 1.9 | -3.2 |
| Household Disposable Income ($m, NL total) | 10,905 | 11,824 | 12,712 | 13,402 | 14,319 | 15,287 | 16,025 | 16,543 | 17,017 | 17,267 | 17,576 |
| % change | 9.0 | 8.4 | 7.5 | 5.4 | 6.8 | 6.8 | 4.8 | 3.2 | 2.9 | 1.5 | 1.8 |
| % change, real | 7.4 | 5.4 | 7.2 | 2.9 | 3.3 | 4.6 | 3.1 | 1.3 | 2.4 | -1.2 | -0.8 |
| Retail Sales ($m) | 6,528 | 7,009 | 7,121 | 7,453 | 7,833 | 8,187 | 8,606 | 8,919 | 8,972 | 8,988 | 9,075 |
| % change | 8.6 | 7.4 | 1.6 | 4.7 | 5.1 | 4.5 | 5.1 | 3.6 | 0.6 | 0.2 | 1.0 |
| % change, real | 7.6 | 7.2 | 2.5 | 3.0 | 3.2 | 3.6 | 4.4 | 1.7 | -0.3 | -2.3 | -0.4 |
| Consumer Price Index (2002=100) | 111.1 | 114.3 | 114.6 | 117.4 | 121.4 | 123.9 | 126.0 | 128.4 | 129.0 | 132.5 | 136.0 |
| % change (inflation) | 1.5 | 2.9 | 0.3 | 2.4 | 3.4 | 2.1 | 1.7 | 1.9 | 0.5 | 2.7 | 2.6 |
| Capital Investment ($m) | 4,425 | 5,306 | 5,293 | 6,341 | 7,952 | 9,825 | 11,566 | 12,035 | 12,325 | 14,200 | 12,678 |
| % change | -4.0 | 19.9 | -0.2 | 19.8 | 25.4 | 23.6 | 17.7 | 4.1 | 2.4 | 15.2 | -10.7 |
| % change, real | -4.4 | 13.8 | -3.2 | 19.1 | 24.8 | 20.6 | 16.4 | 1.8 | -0.9 | 9.6 | -11.9 |
| Housing Starts | 2,649 | 3,261 | 3,057 | 3,606 | 3,488 | 3,885 | 2,862 | 2,119 | 1,697 | 1,398 | 1,158 |
| % change | 18.6 | 23.1 | -6.3 | 18.0 | -3.3 | 11.4 | -26.3 | -26.0 | -19.9 | -17.6 | -17.1 |
| Employment (000s) | 217.0 | 221.1 | 215.1 | 222.8 | 231.9 | 240.8 | 242.7 | 238.6 | 236.2 | 232.6 | 223.1 |
| % change | 1.2 | 1.9 | -2.7 | 3.6 | 4.1 | 3.8 | 0.8 | -1.7 | -1.0 | -1.5 | -4.1 |
| Labour Force (000s) | 251.0 | 255.2 | 254.6 | 261.2 | 265.3 | 274.5 | 274.5 | 270.9 | 270.8 | 268.7 | 262.6 |
| % change | -0.2 | 1.7 | -0.2 | 2.6 | 1.6 | 3.5 | 0.0 | -1.3 | 0.0 | -0.8 | -2.3 |
| Participation Rate (%) | 59.0 | 59.6 | 58.9 | 59.7 | 60.2 | 62.0 | 61.7 | 61.0 | 61.1 | 60.5 | 59.3 |
| Unemployment Rate (%) | 13.5 | 13.4 | 15.5 | 14.7 | 12.6 | 12.3 | 11.6 | 11.9 | 12.8 | 13.4 | 15.1 |

Source: GNL (2018k).
Note: f = forecast.

### *Mining*

The mining industry accounted for $1.8 billion or 6.4% of the Province's GDP in 2016. The 2017 value of mineral shipments was estimated at $3.6 billion, an increase of 25% over the previous year, largely due to increased iron ore production and prices, which offset lower prices for nickel (GNL 2018l). Jobs declined in 2017, but the industry still provided ~5,300 person years of employment (GNL 2018l). The decline mainly reflects the loss of construction jobs as the Long Harbour nickel processing facility entered its production phase (GNL 2018l).

**Table 4.61. GDP by industry sector, Newfoundland and Labrador, 2016.**

| Industry | GDP (2016e) | |
|---|---|---|
| | $ Millions | % of Total |
| **Goods-Producing Sector** | **11,854.7** | **41.5** |
| Agriculture, Forestry & Logging | 193.9 | 0.7 |
| Fishing, Hunting & Trapping | 340.8 | 1.2 |
| Mining | 1,828.5 | 6.4 |
| Oil Extraction | 3,776.2 | 13.2 |
| Support Activities for Oil and Mining | 542.8 | 1.9 |
| Manufacturing | 1,129.4 | 4.0 |
| Fish Products | 352.2 | 1.2 |
| Other | 777.3 | 2.7 |
| Construction | 3,431.2 | 12.0 |
| Other | 611.9 | 2.1 |
| **Services-Producing Sector** | **16,738.3** | **58.5** |
| Wholesale Trade | 674.8 | 2.4 |
| Retail Trade | 1,687.0 | 5.9 |
| Transporting & Warehousing | 897.8 | 3.1 |
| Finance, Insurance, Real Estate & Business Support Services | 4,471.9 | 15.6 |
| Professional, Scientific & Technical Services | 743.4 | 2.6 |
| Educational Services | 1,669.8 | 5.8 |
| Health Care & Social Assistance | 2,447.6 | 8.6 |
| Information, Culture & Recreation | 803.5 | 2.8 |
| Accommodation & Food Services | 577.6 | 2.0 |
| Public Administration | 2,238.8 | 7.8 |
| Other Services | 526.1 | 1.8 |
| **Total: All Industries** | **28,593.0** | **100.0** |

Source: GNL (2018l).
Note: e = estimate; GDP is expressed at basic prices (market prices minus taxes and subsidies on products).

### *Manufacturing*

The Province's manufacturers produce a wide range of exports for the international market, from fish and newsprint to refined petroleum and nickel. In 2016, the sector contributed $1.1 billion or 4% of the Province's GDP, of which fish products accounted for $352 million (1.2% of total GDP) (GNL 2018l). In 2017, the manufacturing industry provided 9,100 person years of employment, or 4% of total employment in the Province, a decrease from the previous year owing to job losses in fish processing (GNL 2018l). The 2017 value of manufacturing shipments totalled nearly $6 billion, up 25% from 2016 (GNL 2018l). This increase was largely due to increased value of refined petroleum products. The United States remained the largest export market for Newfoundland and Labrador products, accounting for 65.7% of international exports in 2017 (GNL 2018l).

### *Fishery & Aquaculture*

An important industry for more than 400 rural communities in the Province, the seafood sector continued to perform well into 2017. Overall production was valued at $1.3 billion, near the historic high of 2016, and the Province exported seafood products to more than 40 countries around the globe (GNL 2018l). More than 16,000 people were employed in the capture fishery in 2017, including over 9,000 harvesters and nearly 7,000 plant workers (GNL 2018l). The relatively new aquaculture industry employed just 424 people, but provincial plans are underway to double production levels and grow that sector considerably (GNL 2018l). Recent DFO surveys have many people concerned about the 2018 fishing year. The lucrative crab fishery continues to see quotas decline, and the newly rebounded cod fishery may be off limits again due to very poor stock counts (ASP 2018).

### *Forestry*

The Province's key forest products are newsprint and lumber for export. The newsprint industry continues to face global market decline, largely because of the shift from paper to digital media. Tariffs imposed by the new U.S. government add further constraint. The province has one remaining pulp and paper facility, located in Corner Brook. In 2017, it employed 550 people throughout its operations, and shipped 250,000 tonnes of newsprint valued at $192 million (GNL 2018l). Newfoundland and Labrador exported $88 million of newsprint into the U.S. during 2017 (GNL 2018l). Meanwhile, the Province's lumber industry experienced high prices in 2017 due to increased housing starts throughout Canada and the U.S and reduced supply in the marketplace, and exported 84 million board feet of lumber (GNL 2018l). Provincial lumber production is expected to increase to ~87 million board feet in 2018 (GNL 2018l).

### *Agriculture*

Agricultural activity in the Province is diverse and ranges from small organic farms to large dairy and poultry operations. Combined, the Province's farmers reported income of $105.6 million for the first three quarters of 2017 (latest data available), an increase from 2016 (GNL 2018l). Crops accounted for $12.8 million and livestock for $89.2 million (GNL 2018l). The Province has 500 farms, most of which are small operations, with only 11% reporting annual income of $500,000 or more (GNL 2018l). The sector continues to grow and diversify, especially as more young people gain interest in food production. The provincial government recently helped encourage new entrants and expansion by setting aside 44,700 hectares of Crown Land for agricultural development (GNL 2018l).

### *Construction*

Until 2016, the Province's construction industry experienced the largest boom in its history, with 15 years of recorded growth as the energy and mining sectors undertook major construction projects (GNL 2018l). Other commercial and residential construction also peaked during the same period (GNL 2018l). Even with the Hebron and Vale Inco projects now complete, the sector still benefited from $9 billion in construction investment in 2017, providing 28,000 person years of employment and 9% of the Province's total employment that year (GNL 2018l). Looking ahead, the Muskrat Falls project is still in its construction phase, and the Province has launched a five-year infrastructure development plan that will see new hospitals, roads and other facilities constructed (GNL 2018l). In 2018 and beyond, the level of construction activity is expected to decline but remain healthy (GNL 2018l).

### *Tourism*

The tourism industry continues to grow and diversify in all regions of the Province. In 2016, the sector generated $1.13 billion in revenue, and efforts are underway to increase that amount to $1.6 billion by 2020 (GNL 2018l). As the Province invests in new product development, rural and urban communities are creating ever more unique tourism experiences. Visitors are drawn to the rich landscape and character of the Province, and their numbers grow each year. The number of non-resident automobile visitors travelling to the Province reached 101,881 by the end of December 2017, an increase of 0.9% compared to the same time period of the previous year (TCII 2018). The number of non-resident air visitors reached 412,901 by the end of December 2017, decreased by 0.4% compared to the previous year (TCII 2018). The Province received 38,321 unique non-resident cruise visitors during the 2017 cruise season, an increase of 62.8% compared to the 2015 cruise season (TCII 2018). The potential for tourism growth remains strong, especially in many rural areas that have just begun to share their wealth of history and natural heritage.

### 4.7.1.3 Economic Outlook – 2018 and Beyond

Relative to the prosperity of recent years, the short-term view of the road ahead appears to be rocky. But the medium to long-term view shows many signs of a healthy economy.

As major construction projects wind down in the energy and mining sectors, capital investment in the Province will diminish in 2018, and this will impact employment, incomes and consumption in most areas of the economy. Real GDP is expected to fall by 0.8% and employment by 1.0 % in 2018. See Table 4.62 for economic indicators for the forecast period 2018–2021.

**Table 4.62. Economic forecast for Newfoundland and Labrador, 2018–2021 using select economic indicators.**

| Indicator | 2018f | 2019f | 2020f | 2021f |
|---|---|---|---|---|
| GDP ($m) | 32,350 | 33,454 | 33,864 | 35,060 |
| % change | 1.3 | 1.8 | 1.2 | 3.5 |
| % change, real | -0.8 | 1.1 | -0.3 | 1.0 |
| Household Disposable Income ($m) | 17.712 | 17,801 | 18,048 | 18,444 |
| % change | 0.7 | 0.5 | 1.4 | 2.2 |
| % change, real | -1.3 | -1.6 | -0.7 | -0.4 |
| Retail Sales ($m) | 9,310 | 9,259 | 9,284 | 9,379 |
| % change | 0.7 | -0.5 | 0.3 | 1.0 |
| % change, real | -0.5 | -1.9 | -1.1 | -0.4 |
| Consumer Price Index (2002=100) | 138.4 | 141.4 | 144.4 | 148.2 |
| % change | 2.0 | 2.2 | 2.1 | 2.6 |
| Capital Investment ($m) | 9,703 | 8.872 | 8,735 | 8.458 |
| % change | -9.3 | -8.6 | -1.5 | -3.2 |
| % change, real | -10.8 | -10.4 | -3.6 | -5.1 |
| Housing Starts | 1,259 | 1,159 | 1,199 | 1,262 |
| % change | -10.1 | -8.0 | 3.5 | 5.2 |
| Employment (000s) | 221.9 | 218 | 215.8 | 215.4 |
| % change | -1.0 | -1.8 | -1.0 | -0.2 |
| Labour Force (000s) | 260.6 | 257.9 | 255.7 | 254.2 |
| % change | -0.9 | -1.1 | -0.8 | -0.6 |
| Unemployment Rate (%) | 14.8 | 15.4 | 15.6 | 15.3 |
| Participation Rate (%) | 57.8 | 57.4 | 57.1 | 57 |
| Population (000s) | 525.9 | 523.4 | 521.1 | 518.1 |
| % change | -0.6 | -0.5 | -0.4 | -0.6 |

Source: Statistics Canada (2018a); CMHC; Economic and Project Analysis Division, Department of Finance (Nov 2017) GNL (2018m).
Note: f = forecast; GDP = Gross Domestic Product at market prices.

The expectations for the Newfoundland and Labrador economy during 2018 are as follows (GNL 2018m):

- Real GDP is forecast to decrease by 0.8%, reflecting further declines in major project investment and weaker consumer spending;
- Capital investment is expected to decline by 9.3% to $9.7 billion, reflecting the completion of Hebron in 2017 and the advanced stage of the Muskrat Falls development;
- Real exports are expected to increase by 2.8%, mainly due to a full year of Hebron production;
- Oil production is expected to increase by 6.4% to 85.7 million barrels with higher production at Hebron offsetting declines at Hibernia, Terra Nova and White Rose;
- Brent crude prices are projected to average US$63.70 per barrel on a calendar year basis (US$63.00 per barrel for fiscal year 2018/19);
- Employment is expected to average 221,900, down 1.0% from 2017;

- The unemployment rate is expected to remain unchanged (averaging 14.8%) as the decrease in employment is offset by a similar decline in the labour force;
- Household income is expected to increase by a modest 0.7%;
- Retail sales are expected to total $9.3 billion, up 0.7% from the previous year;
- Consumer prices are expected to increase by 2.0%;
- The Province's population is projected to decline by 0.6% to 525,900;
- Development and construction of the West White Rose project will continue with fabrication activities taking place throughout the Province;
- Several Calls for Bids are expected. Two Calls for Bids (Jeanne d'Arc and Eastern Newfoundland) were opened in March 2018 and close in November 2018. Two other Calls for Bids (South Eastern Newfoundland and Labrador South) are expected to open in August 2018 and close in November 2019;
- The value of mineral shipments is expected to decline as iron ore production increases are offset by lower average iron ore prices;
- Iron ore production is expected from Tacora and IOC's Wabush 3 open pit mine, and fluorspar production is expected at CFI's mine;
- Ramp-up of Vale's nickel processing plant at Long Harbour will continue as the company moves toward nameplate capacity;
- Mineral exploration expenditures are expected to increase to about $38 million;
- The value of provincial manufacturing shipments is expected to increase because of higher production at Vale Newfoundland and Labrador's nickel processing facility;
- Newsprint shipments are expected to be around 245,000 tonnes, down slightly from 2017, but consistent with steady-state production levels. Like many Canadian producers, Corner Brook Pulp and Paper will be subject to the imposition of U.S. newsprint duties;
- Newsprint prices are expected to average US$603/tonne, up from US$575/tonne in 2017;
- Lumber production is anticipated to increase to approximately 87 million board feet;
- Farm cash receipts are expected to grow across all sectors. The increase in Crown land available for agricultural development bodes well for the agriculture industry;
- The fishing and aquaculture industries are expected to be positively impacted by strong global demand for fish and seafood products;
- Fish landings will be similar to 2017. Declines in shellfish landings may be offset by a rise in groundfish and pelagic landings;
- Aquaculture volume and value are expected to increase, largely reflecting higher salmonid production;
- Housing starts are forecast to decrease by 10.1% to 1,259;
- The Canadian Real Estate Association forecasts sales in the Province to rise 0.1% and the average resale price to fall 2.7%;
- The continued strength in the Canadian and United States economies bodes well for non-resident travel to the Province;
- Cruise activity is expected to be solid, with 98 port calls tentatively booked (as of March) for 20 ports in the 2018 cruise season;
- Work will continue on expansion and improvements at St. John's International Airport. The first of a two-phase expansion for the terminal building will be completed mid-2018, followed by the commencement of the second phase;
- Work will continue to advance the Province's five-year, nearly $3 billion infrastructure plan for new and existing public infrastructure. Approximately $619.7 million is expected to be spent during fiscal 2018/19;

- Work will continue to advance the Muskrat Falls Project. Following the completion of the transmission assets in mid-2018, power from Churchill Falls will be delivered to the island;
- About $21 billion in project spending is planned or underway in the Province according to the Inventory of Major Capital Projects;
- Long-term exploration programs submitted by Statoil, Husky, ExxonMobil, Nexen Energy and BP Canada for areas in the Jeanne d'Arc, Flemish Pass and Orphan Basins bode well for the future of the oil industry in the province; and
- The Provincial Government will continue to progress initiatives outlined in The Way Forward to support private sector employment and economic growth.

#### 4.7.1.4 Economy of the Burin Peninsula

The 2016 census for the Burin Peninsula recorded a population of just under 20,000 (Table 4.63), with the majority of residents living within five municipalities – Marystown, Burin, Grand Bank, St. Lawrence and Fortune (Statistics Canada 2018a). Marystown is the geographic hub and service center for the region, with a population of 5,318 (Statistics Canada 2018a). It has a wide range of services and retail outlets, and until recently it was an industrial engine for the region.

**Table 4.63. Burin Peninsula, selected population demographics, 2016.**

| Population Demographic | 2016e |
|---|---|
| Population | 19,880 |
| % population change since 2011 | -5.5% |
| Median Age | 50 |
| Dominant Age Group | 60–64 |
| Average Household Income | $70,502 |
| Sources of Income (% based on 2014 data) | |
| Market Sources | 78.9% |
| Transfer Payments (EI, public pensions, etc.) | 21.1% |

Source: Statistics Canada (2018a); GNL (n.d.).
Note: e = estimate.

Marystown had a long history of shipbuilding, which was a major source of employment for skilled tradespersons in the area. Between 1967 and early 2000s, nearly 60 ships were built in Marystown, including offshore fishing boats, ferries, and coast guard vessels (TM 2018). The Town is home to Mortier Bay, which is one of the deepest, most sheltered ice-free ports in the world, and a prized site for ocean industries. When Keweit Offshore Services purchased the shipyard in 2002, a new branch of industry was born in Marystown. Keweit added a second and larger facility at Cow Head in Mortier Bay to serve the offshore oil industry. Between 2012 and 2015, employment there peaked at 1,500 people, mostly for skilled trades, of which 1,100 people were employed for the construction of the drilling support module for the topside facility for the White Rose oil project (TM 2018). Numerous local service businesses also benefited from this activity.

Marystown has become accustomed to a boom and bust cycle. Activity at the shipyard rose and fell throughout its lifetime, and it has been dormant since 2015 (S. Synard, Mayor, Town of Marystown, pers. comm., 14 March 2018). After the White Rose project was complete in 2015, skilled workers went two years without employment (S. Synard, Mayor, Town of Marystown, pers. comm., 14 March 2018). A new, but smaller, project began at Cow Head in late-2017, employing 90 people (TM 2018). That number will increase to 150, with work continuing until the end of 2019 (Mayor and Councillors, Town of Marystown, pers. comm., 14 March 2018). Overall, fewer construction jobs, and the loss of 140 jobs with the 2011 closure of the local fish plant, have been a blow to all sectors of the Marystown economy,

and this has been felt throughout the peninsula (Mayor and Councillors, Town of Marystown, pers. comm., 14 March 2018).

Nonetheless, there are mainstays of the economy and some encouraging developments in the region. The fishery continues to play a significant role in the regional economy, despite the reduction in processing capacity with plant closures in Marystown and Burin. The largest plants on the peninsula are now Clearwater Seafoods in Grand Bank and Ocean Choice International in St. Lawrence.

The mining industry is on the rise, with Canada Flourspar Inc. redeveloping the St. Lawrence mine. Construction began in 2016 and the mine is already in early-stage production (GNL 2018m). When fully operational, the mine is expected to provide 200 year-round jobs for at least 10 years, with recent drilling surveys estimating fluorspar resources in excess of 22 million tonnes (CFI 2018a,b). In Point May, at the southern tip of the peninsula, a local mineral exploration company is determining the mining feasibility of the Heritage Gold and Silver deposit in the area. They have spent nearly $3 million to date and had a confirmed inventory of 76,000 ounces by late 2017 (PPR 2017). Exploration work continues, and with gold currently trading at $1,300 per ounce, investor interest in the project is high (PPR 2017).

Tourism has always been an economic benefactor for the peninsula. The peninsula is the gateway to the French islands of St. Pierre et Miquelon, which attracts thousands of national and international visitors each year (D. Amb, Tourism Development Officer, Eastern Destination Marketing Organization, pers. comm., 7 February 2018). The EDMO, operating under the tourism brand of Legendary Coasts, includes the Burin Peninsula in its product and market development initiatives. The EDMO has a cooperative arrangement in partnership with the Government of France to increase the number of visitors to the French islands and Burin Peninsula (D. Amb, Tourism Development Officer, Eastern Destination Marketing Organization, pers. comm., 7 February 2018). The Peninsula offers a diverse range of attractions, excellent museums, spectacular trails and scenery, and fossils of some of the earth's earliest life forms (GNL 2018b).

The public service sector on the peninsula includes all levels of government and every type of public service, from policing and the courts to health care, education, social assistance and municipal services. Nearly 1,200 people work in public service on the peninsula, providing a healthy contribution to the economy (see Section 4.6.1.3, Industries).

Altogether, more than 500 businesses and organizations serve the peninsula, with the majority operating in the five major facets described in this subsection (see also Sections 4.6.1.3, Industries, and 4.7.4.1, Current Businesses).

### 4.7.2 Employment on the Burin Peninsula and in the Province

The recent period of expansion and growth on the Burin Peninsula and in the Province is the result of major developments in oil and gas, mining, hydroelectric development and manufacturing (see Section 4.7.1.4). Effects of this growth have diffused into other facets of the economy, creating a positive effect on employment and income levels (e.g., see Table 4.64), particularly on the Avalon Peninsula. Overall, provincial employment grew by an average of 1.6 % per year from 1997–2013, mostly in full-time jobs (GNL 2015a). The lowest provincial unemployment rate in 40 years occurred in 2013, with an annual average of 11.6 percent (NLSA 2018b). Strong labour demand triggered an increase in wages over the same period. Newfoundland was second to Alberta for average weekly earnings of $1,033 in January 2018 (Statistics Canada 2018b). Employment growth occurred in both the private and public sectors during the period of February 2017–February 2018. Major private sector growth occurred in construction, mining, oil and gas, professional and scientific services, trade and business services

(Statistics Canada 2018c). In the public sector, health care and social assistance recorded the greatest increase in employment, followed by education and public administration (Statistics Canada 2018c).

**Table 4.64. Newfoundland and Labrador, Selected Demographics.**

| Characteristic | Total | Male | Female |
|---|---|---|---|
| Population, 2016 | 519,716 | - | - |
| Population, 2011 | 514,536 | - | - |
| Average age | 43.7 | 42.9 | 44.4 |
| Median age | 46.0 | 45.4 | 46.6 |
| Average market income in 2015 ($) | 45,500 | 56,985 | 33,617 |
| Average government transfers in 2015 ($) | 9,823 | 10,636 | 9,166 |
| Average after-tax income of households in 2015 ($) | 87,392 | - | - |

Source: Statistics Canada (2018a).

During 2018, the completion of several large industrial projects, combined with lower oil and nickel prices, has slowed the Province's economy, and employment numbers reflect the change. Table 4.65 below shows labour force statistics over four selected years within a 16-year period, with averages for the Province and two key regions, the Avalon and Burin Peninsulas. Note that the Burin Peninsula lies within a larger district for Statistics Canada's labour force surveys. The average provincial unemployment rate in 2017 was 14.8%, an improvement from 16% in 2001, which at that time was the lowest rate in 12 years (NLSA 2018c). When the Avalon Peninsula reached an unemployment low of 7.9% in 2013, the Burin region was at 16.7% and has increased consistently since then, with rates of 11% and 21.5% during 2017 for the Province and Burin region, respectively (NLSA 2018c).

**Table 4.65. Labour force characteristics for Newfoundland and Labrador and key regions, annual averages, 2001, 2007, 2012 and 2017.**

| Region | No. of People ('000s) | | % | | |
|---|---|---|---|---|---|
| | Pop. Aged 15+ | Labour Force | Participation Rate | Employment Rate | Unemployment Rate |
| **2001** | | | | | |
| Province | 426.6 | 242.5 | 56.8 | 47.7 | 16.0 |
| R 01 – Avalon | 202.6 | 123.6 | 61.0 | 53.5 | 12.4 |
| R 02 – Burin+ | 133.8 | 66.6 | 49.8 | 39.2 | 21.3 |
| **2007** | | | | | |
| Province | 425.5 | 251.0 | 59.0 | 51.0 | 13.5 |
| R 01 – Avalon | 212.0 | 132.4 | 62.5 | 56.1 | 10.2 |
| R 02 – Burin + | 126.0 | 66.4 | 52.7 | 42.9 | 18.7 |
| **2012** | | | | | |
| Province | 442.9 | 274.5 | 62.0 | 54.4 | 12.3 |
| R 01 – Avalon | 228.5 | 155.5 | 68.1 | 61.9 | 9.0 |
| R 02 – Burin + | 125.9 | 67.3 | 53.5 | 44.4 | 16.9 |
| **2017** | | | | | |
| Province | 445.5 | 262.9 | 59.0 | 50.3 | 14.8 |
| R 01 – Avalon | 237.3 | 147.7 | 62.2 | 55.4 | 11.0 |
| R 02 – Burin + | 121.5 | 64.2 | 52.8 | 41.6 | 21.5 |

Sources: NLSA (2018c).

Note: R 01 = Avalon Peninsula; R 02 = South Coast-Burin Peninsula and Notre Dame-Central Bonavista Bay. The labour force is the population over the age of 15 who are working or seeking work, and labour force participation rate is a % representation of the same. Unemployment rate is the % of the labour force without work.

Employment rates in 2017 were 50.3% for the province, 55.4% for the Avalon, and 41.6% on the Burin Peninsula (see Table 4.65). Table 4.66 summarizes where those jobs were occurring, with a provincial

view of employment by industry in 2017, including all sectors of the economy, both private and public. Overall, the service sectors accounted for nearly 80% of employment in 2017. The top three service sector employers were in health care and social assistance (17.6% of total), the retail trade (16.2%) and education (6.8%), followed closely by public administration and food and accommodation services (6.7 and 6.6%, respectively). In the goods-producing sector, the top employers were the construction industry (9.2%) and other manufacturing (2.9%).

**Table 4.66. Employment by industry, Newfoundland and Labrador, 2017.**

| Industry | Employment (2017) | |
|---|---|---|
| | *Person Years ('000s) | % of Total |
| **Goods-Producing Sector** | **46.8** | **20.9** |
| Agriculture, Forestry & Logging | 3.0 | 1.3 |
| Fishing, Hunting & Trapping | 2.9 | 1.3 |
| Mining | 2.8 | 1.2 |
| Oil Extraction | 3.0 | 1.3 |
| Support Activities for Oil and Mining | 2.3 | 1.0 |
| **Manufacturing** | **9.1** | **4.1** |
| Fish Products | 2.5 | 1.1 |
| Other Manufacturing | 6.6 | 2.9 |
| Construction | 20.7 | 9.2 |
| Utilities | 2.9 | 1.3 |
| **Services-Producing Sector** | **177.4** | **79.2** |
| Wholesale Trade | 4.6 | 2.1 |
| Retail Trade | 36.2 | 16.2 |
| Transporting & Warehousing | 11.3 | 5.0 |
| Finance, Insurance, Real Estate & Business Support | 13.3 | 5.9 |
| Professional, Scientific & Technical Services | 9.8 | 4.4 |
| Educational Services | 15.2 | 6.8 |
| Health Care & Social Assistance | 39.4 | 17.6 |
| Information, Culture & Recreation | 6.5 | 2.9 |
| Accommodation & Food Services | 14.8 | 6.6 |
| Public Administration | 15.1 | 6.7 |
| Other Services | 11.3 | 5.0 |
| **Total: All Industries** | **224.1** | **100.0** |

Source: GNL (2018c).

* Employment by Person Year refers to work done by one person over one year.

### 4.7.2.1 Income Support and Employment Insurance

The number of employment insurance (EI) claims is an indicator of the state of provincial employment. Table 4.67 includes the latest data available, summarizing a demographic and regional breakdown of EI claims within the Province for the periods of January 2016 and 2017.

Nearly twice as many men as women collected EI during January 2017 (65% vs 35% for women; Table 4.67), likely a reflection of a greater proportion of men losing construction jobs and numerous members of the NL mobile work force (mainly men) no longer travelling to Alberta, given the slowdown in that region. The 60+ age group may or may not be part of the same male cohort, with more than a 12% increase in claims.

**Table 4.67. Number of EI claims by gender, age and economic region, January 2016 and 2017.**

| EI Claimant Category | | Jan 2017 | | Jan 2016 vs. Jan 2017 |
|---|---|---|---|---|
| | | ('000s) | % of total | % Change |
| **Gender** | | | | |
| Both Sexes | | 64.9 | 100.0 | 7.6 |
| Females | | 22.5 | 34.7 | 9.2 |
| Males | | 42.4 | 65.3 | 6.8 |
| **Age Distribution** | | | | |
| Less than 19 | | 0.2 | 0.3 | 61.6 |
| 19–24 | | 4.6 | 7.1 | 6.3 |
| 25–29 | | 5.0 | 7.8 | 8.6 |
| 30–39 | | 10.5 | 16.2 | 8.4 |
| 40–49 | | 13.9 | 21.4 | 4.0 |
| 50–59 | | 18.6 | 28.6 | 6.8 |
| 60+ | | 12.1 | 18.6 | 12.4 |
| *Average Age* | | 46.4 | - | 0.3 |
| **Economic Zones** | | | | |
| Zone 1 | Labrador | 0.4 | 0.7 | 7.5 |
| Zone 2 | | 0.5 | 0.8 | -16.1 |
| Zone 3 | | 0.7 | 1.1 | 8.9 |
| Zone 4 | | 0.7 | 1.1 | 2.0 |
| Zone 5 | | 0.4 | 0.6 | -3.2 |
| Zone 6 | West Coast | -1.9 | 3.0 | 3.0 |
| Zone 7 | | 2.8 | 4.3 | 1.2 |
| Zone 8 | | 5.1 | 7.9 | 13.9 |
| Zone 9 | | 3.3 | 5.0 | 7.3 |
| Zone 10 | | 1.6 | 2.5 | 7.2 |
| Zone 11 | Central – North and South | 2.9 | 4.4 | 4.1 |
| Zone 12 | | 3.4 | 5.2 | 6.7 |
| Zone 13 | | 2.0 | 3.0 | 7.1 |
| Zone 14 | | 8.7 | 13.5 | 7.8 |
| Zone 15 | | 5.5 | 8.4 | 7.8 |
| Zone 16 | Burin Peninsula | 4.0 | 6.2 | 2.1 |
| Zone 17 NW | Avalon Peninsula | 7.4 | 11.4 | 8.1 |
| Zone 18 SW | | 1.4 | 2.2 | 7.7 |
| Zone 19 NE | | 9.4 | 14.5 | 8.0 |
| Zone 20 SE | | 1.7 | 2.6 | 10.0 |

Source: NLSA (2017).

By economic zone, the Muskrat Falls/Happy Valley – Goose Bay region of Labrador experienced a 16% decrease in EI claims. Claims increased on the west coast and central portions of the island, likely due to cuts in forestry employment (see Table 4.67). The Burin Peninsula remained relatively unchanged (2.1%), with the total number of claims accounting for 6.2% of the provincial total during 2017. Not surprisingly, the number of claims was proportionally greater on Avalon Peninsula, since both the economic boom and slowdown were most dramatic there.

Employment insurance claims by occupation (Table 4.68) indicate that the greatest increase between January 2016 and 2017 occurred in education, law and government services, at ~251%, coinciding with cuts to the public service at that time. The same period of cuts likely accounts for some of the EI claims by management, administrative and health workers. The largest percentages of total claims were among workers in the trades, sales and service, and the fishery.

**Table 4.68. Number of EI Claims by Occupation. Monthly Data: January 2017, January 2016.**

| Occupation | January 2017 | | Jan 2016 vs. Jan 2017 |
|---|---|---|---|
| | ('000s) | $ of Total | % Change |
| Management | 1.7 | 2.6 | 17.9 |
| Other Business, Finance and Administration | 1.7 | 2.6 | 29.8 |
| Office Support, Distribution, Tracking and Scheduling Coordination | 1.8 | 2.8 | -13.7 |
| Natural and Applied Sciences and Related | 2.5 | 3.9 | 12.3 |
| Health | 0.8 | 1.2 | 31.6 |
| Education, Law and Social, Community and Government Services | 5.2 | 8.1 | 250.9 |
| Art, Culture, Recreation and Sport | 0.5 | 0.7 | 15.1 |
| Sales and Services | 8.6 | 13.2 | -17.2 |
| Trades, Transport and Equipment Operator and Related | 19.0 | 29.3 | 6.1 |
| Trades Helpers, Construction Labourers and Related | 6.6 | 10.2 | 3.7 |
| Fish Harvester | 7.1 | 11.0 | 7.8 |
| Other Natural Resources, Agriculture and Related Production | 2.5 | 3.9 | -1.1 |
| Fish Plant Worker | 4.5 | 6.9 | 5.3 |
| Other Occupations in Manufacturing and Utilities | 2.0 | 3.1 | 9.3 |

Source: NLSA (2017).

## 4.7.3 Availability of Skilled and Unskilled Labour on the Burin Peninsula and in the Province

### 4.7.3.1 Demographic Considerations

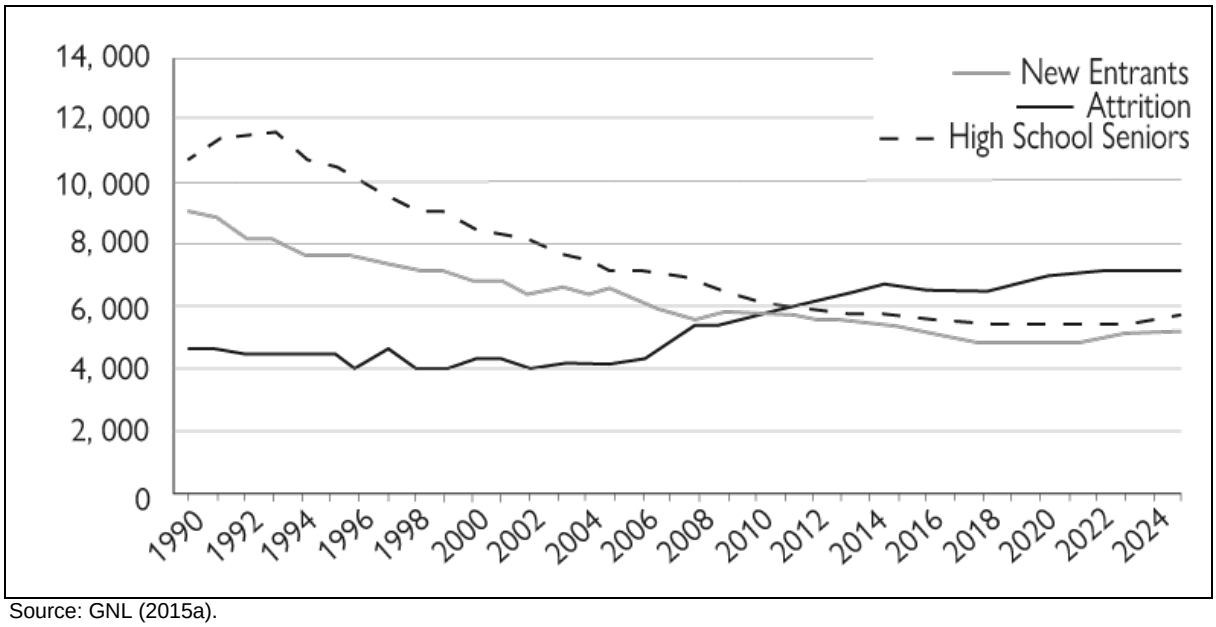
Newfoundland and Labrador faces considerable demographic challenges in relation to its labour force. An aging population, combined with a low birth rate, has resulted more people reaching retirement age than there are younger people to replace them in the work force, a trend that is worsening over time. The Province's typical working age population (15–64) is projected to decrease by 6% within the next seven years, while the population over 65 is expected to increase by 32% (Table 4.69).

**Table 4.69. Demographic indicators relative to the Newfoundland and Labrador labour force.**

| Indicator | 2016 Actual | 2025 Forecast | Projected % Change |
|---|---|---|---|
| Population | 519,715 | 530,002 | 2 |
| Males | 253,925 | 257,669 | 1 |
| Females | 265,790 | 272,333 | 2 |
| Median Age | 46 | 47.9 | 4 |
| Population 0–14 | 74,440 | 72,634 | -2 |
| Population 15–64 | 344,425 | 324,196 | -6 |
| Population 65+ | 101,025 | 133,172 | 32 |

Source: GNL (2015a); Statistics Canada (2018a).

The abovementioned trend is made clear upon examination of the projected number of new entrants and attrition in the workforce (Figure 4.74), where new entrants refer to young people at the beginning of their careers, while attrition refers to people retiring or permanently exiting the workforce for other reasons. During 2018, nearly 7,000 people are expected to depart the work force, while less than 5,000 will enter. About 25 years ago, there were 100 new entrants for every 50 people exiting the workforce. Today, it is estimated that for every 100 new entrants, there are approximately 125 people exiting (GNL 2015a). This gap is expected to widen over the 2025 forecast period, although as significant numbers of people retire from the labour market, there will be more job openings for younger people who qualify.




Source: GNL (2015a).

**Figure 4.74. New entrants and attrition for the Newfoundland and Labrador labour market, 1990–2024.**

Measures are being taken to mitigate and help balance the supply and demand of labour in the marketplace. The Province's *Population Growth Strategy* (GNL 2015b) is focused on increasing immigration, including the return of Newfoundlanders who left home to work elsewhere. Migration during 2016–2017 did not achieve a net increase in population, although international migration produced a positive result (Table 4.70). The high rate of inter-provincial outmigration was possibly due to workers from elsewhere leaving after the completion of construction projects. The population of the Province was 527,613 as of 1 January 2018, a decrease of 817 persons since 1 October 2017 as a result of losses in net interprovincial migration and international migration, and natural declines due to fewer births than deaths (GNL 2018n).

**Table 4.70. NL population change and migration, 2016–2017.**

| NL Population, 2016–2017 | |
|---|---|
| **Population 1 July 2016** | **530,305** |
| **Total Net Migration** | **-619** |
| Interprovincial net-migration | -1,954 |
| Interprovincial in-migration | 5,755 |
| Interprovincial out-migration | -7,709 |
| Net international migration | 1,335 |
| **Natural Population Change** | **-869** |
| Births | 4,411 |
| Deaths | -5,280 |
| **Population 1 July 2017** | **528,817** |

Source: GNL (2018l).

A provincial *Workforce Development Action Plan* (GNL 2015c) is helping align education and training in the Province with labour market demands, with additional measures being taken to increase the labour

market participation rate. Despite these measures, it is expected that some employers may be challenged to find local labour for certain occupations.

The provincial government analysed patterns of population changes by provincial region since 1991 to predict future populations (GNL 2018o). The population variably declined in the majority of the Province during 1991–2007 (GNL 2018o). Regions were people relied on the seasonally interdependent cycles of the fishery and employment insurance experienced greater population declines, notably within areas where the fishing population is heavily dependent on the ground fish fishery, such as the Northern Peninsula, northeast coast, south coast and portions of the Avalon Peninsula (GNL 2018o). Population increases were only experienced within Economic Zones 1 (north coast of Labrador) and 19 (northeast Avalon) (Table 4.71). There are relatively more children born and a steady economy associated with public service, Voisey's Bay and traditional seasonal employment and income support within Economic Zone 1 (GNL 2018o). The population of Economic Zone 16, which includes the Burin Peninsula, decreased by ~26% and 7.6% during 1991–2007 and 2007–2017, respectively, and is predicted to decline by 24% over the next 20 years (Table 4.71).

**Table 4.71. Provincial population change by economic zone.**

| | 1991–2007 Change | | 2007–2017 Change | | 2017–2036 Change | | Median Age 2017 |
|---|---|---|---|---|---|---|---|
| Economic Zone | Actual | % | Actual | % | Actual | % | |
| **1** | 195 | 6.4 | 383 | 11.8 | 249 | 6.9 | 29.7 |
| **2** | -2,676 | -21.5 | 274 | 2.8 | -559 | -5.6 | 36.3 |
| **3** | -1,005 | -9.8 | 1,259 | 13.6 | 536 | 5.1 | 36.0 |
| **4** | -451 | -15.0 | -510 | -20.0 | -439 | -21.5 | 46.8 |
| **5** | -437 | -19.7 | -151 | -8.5 | -372 | -22.9 | 51.5 |
| **6** | -4,404 | -33.5 | -1,234 | -14.1 | -1,886 | -25.1 | 52.3 |
| **7** | -3,277 | -26.9 | -964 | -10.8 | -1,910 | -24.0 | 53.1 |
| **8** | -5,352 | -11.5 | 1,721 | 4.2 | -2,064 | -4.8 | 47.6 |
| **9** | -6,234 | -22.3 | -938 | -4.3 | -3,784 | -18.2 | 51.2 |
| **10** | -3,682 | -29.0 | -720 | -8.0 | -1,826 | -22.0 | 53.4 |
| **11** | -5,930 | -29.5 | -912 | -6.4 | -3,062 | -23.1 | 51.9 |
| **12** | -4,783 | -15.3 | 112 | 0.4 | -2,845 | -10.7 | 50.0 |
| **13** | -2,424 | -23.7 | -790 | -10.1 | -1,433 | -20.5 | 49.6 |
| **14** | -11,332 | -19.5 | -416 | -0.9 | -6,149 | -13.2 | 50.3 |
| **15** | -7,101 | -20.0 | -1,075 | -3.8 | -4,774 | -17.5 | 50.9 |
| **16** | -7,576 | -26.1 | -1,641 | -7.6 | -4,730 | -23.8 | 50.5 |
| **17** | -5,973 | -13.0 | 648 | 1.6 | -3,437 | -8.5 | 49.7 |
| **18** | -3,455 | -32.5 | -1,159 | -16.2 | -1,797 | -29.9 | 55.0 |
| **19** | 8,055 | 4.4 | 25,783 | 13.4 | 18,418 | 8.4 | 40.1 |
| **20** | -2,751 | -24.8 | 98 | 1.2 | -654 | -7.7 | 50.8 |

Source: GNL (2018g).

The movement of people away from rural areas resulted in an increased population in urban areas (GNL 2018o). The regional population distribution is expected to change further as youth out-migrate from rural area communities, which, combined with negative natural population growth, indicates a continued downward trend in the population of rural areas (GNL 2018o). The positive and negative impacts of demographic change will be experienced throughout a broad spectrum of Newfoundland and Labrador society, including (GNL 2018o):

- Business sector (e.g., shifting spending patterns and needs);
- Health care (e.g., home support services, pharmaceuticals);
- Education (e.g., declining enrolment, life-long learning);

- Municipalities (e.g., declining revenue base in some communities);
- Justice (e.g., changing nature of criminal activity);
- Social assistance (e.g., shifting needs);
- Regional economic development (e.g., declining rural population);
- Workplace injury (e.g., higher rehabilitation costs for older workers);
- General public sector (e.g., revenue generation, expenditure pressures); and
- Labour markets (e.g., demand, supply imbalances).

### 4.7.3.2 Profile of Existing Labour Supply

A summary of the Newfoundland and Labrador labour force, inclusive of the number of people, by gender, qualified to work in occupation categories as outlined in the National Occupation Classification System, is provided in Table 4.72.

**Table 4.72. NL Population 15 years and over by Occupation, Gender and Labour Force Activity, Province and Burin Peninsula, 2016.**

| Labour Force | Newfoundland & Labrador | | | Burin Peninsula | | |
|---|---|---|---|---|---|---|
| | Total | Male | Female | Total | Male | Female |
| **Labour Force Activity** | | | | | | |
| **Total Population aged 15+** | **437,935** | **212,785** | **225,150** | **16,974** | **8,404** | **8,570** |
| In the Labour Force | 256,855 | 133,110 | 123,745 | 8,911 | 4,973 | 3,939 |
| Not in the Labour force | 181,080 | 79,675 | 101,405 | 8,062 | 3,431 | 4,631 |
| Participation rate (%) | 58.7 | 62.6 | 55.0 | 52.5 | 59.2 | 46.0 |
| **Occupation** | | | | | | |
| **All occupations** | **251,800** | **130,405** | **121,390** | **8,911** | **4,973** | **3,939** |
| Management | 20,870 | 11,930 | 8,940 | 255 | 153 | 102 |
| Business, finance and administration | 32,115 | 8,130 | 2,985 | 484 | 56 | 428 |
| Natural and applied sciences | 16,780 | 13,320 | 3,460 | 200 | 200 | 0 |
| Health | 18,865 | 3,190 | 15,675 | 353 | 4 | 349 |
| Social science, education, government and religion | 32,515 | 8,935 | 23,585 | 1,016 | 124 | 892 |
| Art, culture, recreation and sport | 4,830 | 2,045 | 2,790 | 2 | 0 | 2 |
| Sales and Service | 56,205 | 21,550 | 34,650 | 2,072 | 289 | 1,783 |
| Trades, transport and equipment operators and related | 47,890 | 45,235 | 2,655 | 3,313 | 3,297 | 16 |
| Natural resources | 11,845 | 9,800 | 2,045 | 624 | 497 | 127 |
| Processing, manufacturing and utilities | 9,885 | 6,270 | 3,615 | 580 | 350 | 230 |
| Occupation – Not applicable | 5,055 | 2,705 | 2,350 | 14 | 3 | 11 |

Source: Statistics Canada (2018).

#### *Labour Force by Education Level*

Compared to the Canadian average, the current Newfoundland and Labrador population appears more focused on skilled trades than university education, likely a reflection of the employment opportunities available in the Province (Tables 4.72 and 4.73).

The percentage of the Burin Peninsula population with trades certificates as their highest education is virtually double the national average, while the rate of university education is just over half the national average (Statistics Canada 2018d). These proportions have remained relatively unchanged since the last census profile during 2011 (Statistics Canada 2017). The percentage of people with college diplomas is equivalent to the national average (Statistics Canada 2018d). The number of workers with high school diplomas versus those without has recently increased, with 22% of the aged 25–64 provincial population now having high school as their highest level education, although nearly 16% still have less than a high

school diploma (Table 4.73). The Canadian average is 24% with a high school diploma and 9% without (Statistics Canada 2018d).

**Table 4.73. Population aged 25–64 years by highest educational attainment, Province and Burin Peninsula, 2016.**

| Highest Education Level | Newfoundland & Labrador | | | | | | Burin Peninsula | |
|---|---|---|---|---|---|---|---|---|
| | Total | | Male | | Female | | Total | |
| | Count | % | Count | % | Count | % | Count | % |
| No certificate, diploma or degree | 45,170 | 16 | 23,965 | 17 | 21,205 | 14 | 3,186 | 30 |
| High school diploma or equivalent | 65,210 | 22 | 30,300 | 21 | 34,910 | 23 | 1,989 | 19 |
| Apprenticeship or trades certificate or diploma | 36,075 | 12 | 26,475 | 19 | 9,605 | 6 | 2,589 | 24 |
| College or other non-university certificate or diploma | 81,955 | 28 | 34,175 | 24 | 47,780 | 32 | 2,180 | 20 |
| University certificate or diploma below bachelor level | 6,680 | 2 | 2,970 | 2 | 3,710 | 2 | 34 | 0.4 |
| Bachelor's degree | 34,555 | 12 | 13,960 | 10 | 20,595 | 14 | 490 | 4 |
| University certificate, diploma or degree above bachelor level | 18,230 | 6 | 7,800 | 5 | 10,430 | 7 | 160 | 1 |
| **Total (all education levels)** | **287,875** | | **139,645** | | **148,235** | | **10,628** | |

Source: Statistics Canada (2018a).

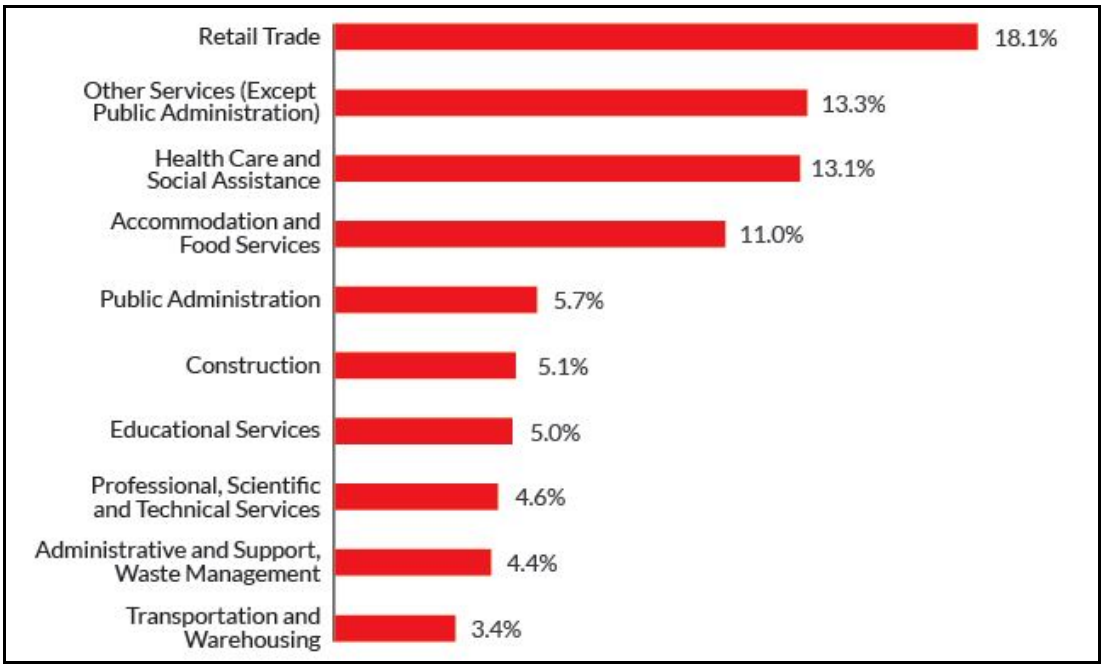
### 4.7.3.3 Labour Market Demand

The provincial government conducts regular studies of labour market trends and produces reports to guide decision making. One of its tools is the Job Vacancy Report, which, while an imperfect indicator of labour market demand, provides useful information via the analysis of job ads throughout the Province. The Job Vacancy Report for 2016 examined at all provincial job ads posted in the top print and online job boards to identify three key pieces of information: (1) the nature of industries seeking workers; (2) occupations with job openings; and (3) skill levels required for these jobs. It is assumed that advertisement frequency is partially influenced by employee turnover, skill mismatches, or changes in service demands.

By industry, the vast majority of ads were in the service sectors during 2016, with the highest percentage of job ads in retail trade (Figure 4.75). As previously noted, 80% of the Province's employment occurs in the service sector, as reflected in the majority of job ads. By occupation, jobs in the retail trade and health sector were the most frequently advertised. Occupations related to education, on the other hand, are tied to larger demands in specific areas of the Province. The percentage distribution of job ad occupations for the Burin Peninsula during 2016 is roughly equivalent to that of the Province (Table 4.74; Figure 4.75).

Using the National Occupational Classification System, the GNL (2017c) report identified the following skill and education levels being sought by employers in posted ads:

- 10.6% of job ads were management-level for the Province and 6.5% on the Burin Peninsula;
- 14.2% were on-the-job training level for the Province, and 10% on the Burin Peninsula;
- 14.6% were university level for the Province, and 16.9% on the Burin Peninsula;
- 29.9% were high school or equivalent level for the Province; and 32.9% on the Burin Peninsula; and
- 30.4% were college/apprenticeship training level for the Province, and 33.3% on the Burin Peninsula.




Source: GNL (2017c).

**Figure 4.75. Top ten job ads by industry in Newfoundland and Labrador, 2016.**

**Table 4.74. Job ads by occupation, Burin Peninsula, 2016.**

| Job Ad Category | % |
|---|---|
| Retail Salespersons | 8.7 |
| Home Support Worker, Housekeepers and Related Occupations | 7.4 |
| College and Other Vocational Instructors | 4.8 |
| Special Physicians | 3.5 |
| Retail and Wholesale Managers | 3.5 |

Source: Source: GNL (2017c).

Most job ads typically appear in higher population areas. During 2016, 1.6% of the Province's job ads appeared within the Burin Peninsula (GNL 2017c).

### 4.7.3.4 Labour Market Outlook

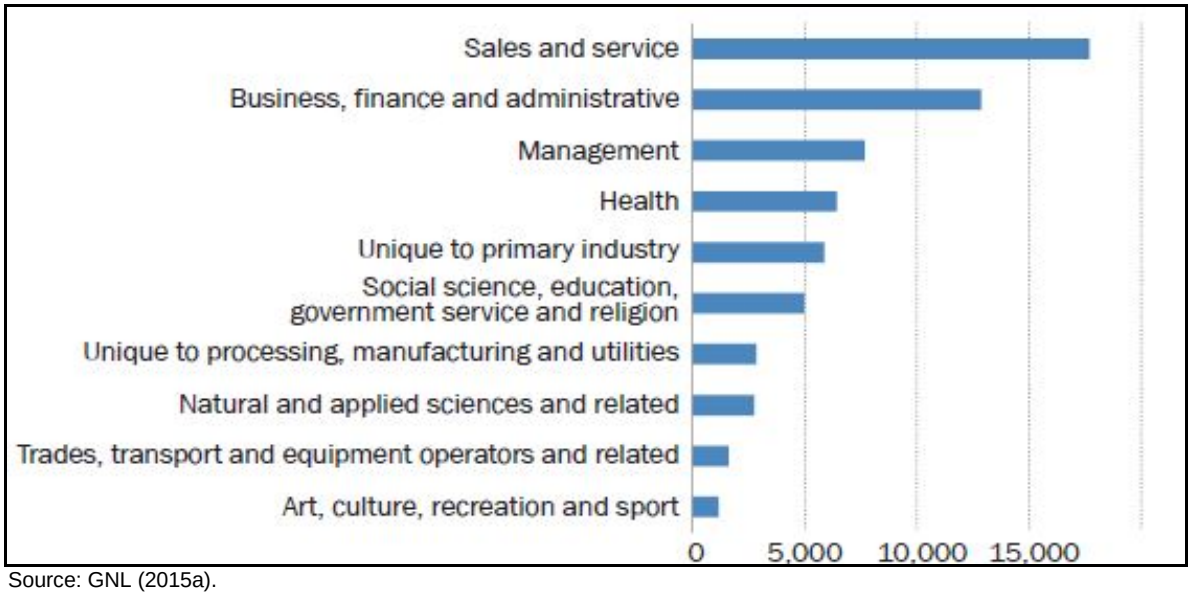
Another provincial labour report is the *NL Labour Market Outlook 2025* (GNL 2015a). It was produced in 2014 by the Departments of Finance and Advanced Education and Skills, and is an examination of job prospects for 120 occupational groups in the Province within the forecast period of 2015–2025. To date, its predictions for the 2015–2018 period have been fairly accurate. For the 2019–2025 period, GNL (2015a) predicts an increase of 4.5% in the number of employed workers, based on higher production levels from Voisey's Bay mining development and Statoil's Bay du Nord discovery, and expanding employment in the service sector to meet the needs of an aging population. Worth noting is that the Voisey's Bay underground mine project is delayed while nickel prices are low, but that may change before 2025.

Throughout the forecast period of 2018–2025, GNL (2015a) predicts a general upward trend in employment growth. By industry, the largest increases in employment are expected in the following areas:

- Health care and social assistance;
- Mining and oil and gas extraction;
- Arts, entertainment and recreation/accommodations and food services;
- Finance, insurance, real estate and leasing; and
- Wholesale and retail trade.

Increases in health care and social assistance are consistent with an aging population. Growth in mining and oil and gas extraction reflects increased production in areas like Hebron, Voisey's Bay mine and Statoil's Bay du Nord. Growth in the arts, entertainment and recreation/accommodations and food services industries is positively correlated with the growth trend in the Province's tourism industry.

Employment declines are expected during the 2018–2015 period for construction, professional and technical services, other manufacturing besides seafood processing, public administration, and educational services (GNL 2015a). In terms of education levels, it is projected that more than half of all job openings will be for management occupations or positions that require post-secondary certification (Figure 4.76). It is expected there will also be considerable openings requiring high school and on-the-job training.




Source: GNL (2015a).

**Figure 4.76. Projected number of job openings by occupation for the top ten occupational categories in Newfoundland and Labrador, 2015–2025.**

### 4.7.3.5 Meeting Labour Requirements for the Aquaculture Industry

The aquaculture industry is still relatively new in the Province and currently employs fewer than 500 people, but that is expected to change in the coming years (GNL 2017d,e). The sector is a strategic growth area for the Province and new projects are in development. The Government of Newfoundland

and Labrador released an aquaculture sector work plan on 26 September 2018, with the objective of doubling current levels of salmon production (to 50,000 mt) and tripling mussel production (to 10,750 mt), while creating new employment in rural areas (GNL 2017e). The target is 1,100 person years of employment at the stated production rates (GNL 2017e).

The Province and the Newfoundland Aquaculture Industry Association (NAIA), working in partnership with federal government and provincial education partners, are developing a work plan to grow the aquaculture industry. Human resource development is one part of that plan. NAIA is currently completing a Labour Force Strategic Review for the aquaculture industry, and it is expected this will provide a road map to meet future labour requirements of the industry under the Labour Market Partnership Program for the NAIA to assist in the development of a human resource plan for the aquaculture industry in the Province (GNL 2017f).

Grieg NL's proposed Project in Placentia Bay presented its full labour requirements, from construction of land- and marine-based facilities to the operation of both, to the Department of Advanced Education, Skills and Labour during August 2016. Overall, the construction phase will require more than 200 skilled workers, many of them technical and engineering positions, along with skilled trades (Grieg NL 2016a). With the current downturn in the construction industry, it is expected that a sufficient labour pool will be available. During the operations stage, Grieg NL expects to hire 170 workers, with additional hires by contractors and suppliers (Grieg NL 2016a). Some positions relate to administration and maintenance, but most are technical and specific to the industry (Grieg NL 2016a).

The Fisheries and Marine Institute already offers several key training programs related to aquaculture. Enrollment in the 2014 and 2015 school years show 135 potential recruits with diplomas in food technology and marine environmental technology, and advanced diplomas in areas like food safety, sustainable aquaculture and water quality (Grieg NL 2016a). It is expected that new training programs will come online as needed, possibly in concert with the College of the North Atlantic, which has facilities throughout the province.

### 4.7.4 Business Capacity Relative to Goods and Services

#### 4.7.4.1 Current Businesses

Most of the businesses in the province are located in the St. John's metropolitan area on the Avalon Peninsula, which is typically (as per regulated highway speed-limits) a three and a half hour-drive from Marystown. In 2017, just over half (53%) of businesses in the Province were located on the Avalon Peninsula, with 3.2% located on the Burin Peninsula and 5.7% in the nearby Clarenville-Bonavista region (Table 4.75).

Businesses in the Clarenville-Bonavista area are primarily located in Clarenville, within a two-hour drive from Marystown. There is another cluster of businesses in the Avalon isthmus area serving primarily oil and gas and mining industrial operations, including North Atlantic Oil Refinery at Come By Chance, Vale's Nickel Processing Plant at Long Harbour, and the Newfoundland Transshipment Terminal (offshore oil) at Whiffen Head. Businesses in this area are also prepared to work for major construction and fabrication contractors at Argentia and the Bull Arm site in Trinity Bay for future offshore developments (M. Butland, Owner, Butland Communications, pers. comm., 25 April 2018).

**Table 4.75. Number of businesses in the Newfoundland and eastern Newfoundland region, 2007 and 2017.**

| No. of Businesses | Province | | Clarenville-Bonavista | | Burin Peninsula | | Avalon Peninsula | |
|---|---|---|---|---|---|---|---|---|
| | 2007 | 2017 | 2007 | 2017 | 2007 | 2017 | 2007 | 2017 |
| No. of Businesses | 17,610 | 15,814 | 1,079 | 907 | 699 | 504 | 8,527 | 8,344 |
| % of Businesses in Province | 100 | 100 | 6.1 | 5.7 | 4.0 | 3.2 | 46.9 | 52.8 |
| Difference from 2007–2017 | -10.2% | | -15.9% | | -27.9% | | -2.1% | |
| No. of Businesses with <5 employees | 10,206 | 8,239 | 674 | 503 | 479 | 287 | 4,468 | 4,299 |
| Difference from 2007–2017 | -19.3% | | -25.3% | | -40% | | -3.8% | |

Source: GNL (2018p).

The number of businesses on the Burin Peninsula has declined over the last decade, from 699 in 2007 to 504 by the end of 2017, a decrease of ~28% (see Table 4.75). This reflects an overall declining trend in business numbers in rural areas. While Avalon Peninsula businesses only decreased by 2% over the past decade, there was a 10% decline in the number of businesses throughout the Province, from 17,610 in 2007 to 15,814 in 2017 (see Table 4.75). In the Clarenville-Bonavista region, the number of businesses decreased by ~16% (see Table 4.75).

The decrease was more drastic (40%) among small businesses on the Burin Peninsula, i.e., those with fewer than five employees. Province-wide, the decline was 19.3% for businesses with fewer than five employees, half that of the Burin Peninsula. On the Avalon, the number of small businesses decreased slightly more than the regional average, with a decline of ~4%; however, in the Clarenville-Bonavista region the number of small businesses decreased by ~25% (see Table 4.75).

Of the 504 businesses registered for the Burin Peninsula in 2017 (see Table 4.75), the majority (37.7%) offered professional, scientific and technical services (Table 4.76). Other categories included non-government services (19% of total), retail trade (16.3%), health care and social assistance (12.3%) and construction (12.1%) (Table 4.76; GNL 2018k).

### 4.7.4.2 Businesses Required

The Project will require a wide range of services to be purchased by Grieg NL and its suppliers and contractors. Grieg NL's approach to procurement will be a combination of services and supplies to be provided by companies in the Province, either directly or through partnerships and joint ventures with international companies, establishing business relationships and operations in the Province wherever possible to maximize provincial economic returns. Similar to the approach for training and education, procured supplies and services will meet and, in some cases, exceed provincial and national regulations and standards to ensure best business, environmental and labour practices.

**Table 4.76. Number of businesses on the Burin Peninsula by North American Industrial Classification System (NAICS), 2007 and 2017.**

| Industry | Province | | | Burin Peninsula | | |
|---|---|---|---|---|---|---|
| | 2007 | 2017 | % of Total (2017) | 2007 | 2017 | % of Total (2017) |
| Agriculture, Forestry, Fishing and Hunting | 561 | 408 | 2.6 | 13 | 18 | 3.6 |
| Mining and Oil and Gas Extraction | 74 | 82 | 0.5 | - | - | - |
| Utilities | 33 | 29 | 0.2 | - | - | - |
| Construction | 1,812 | 2,221 | 14.0 | 38 | 61 | 12.1 |
| Manufacturing | 529 | 398 | 2.5 | 11 | 8 | 1.6 |
| Wholesale Trade | 719 | 620 | 3.9 | 18 | 9 | 1.8 |
| Retail Trade | 2,647 | 2,449 | 15.5 | 117 | 82 | 16.3 |
| Transportation and Warehousing | 755 | 692 | 4.4 | 22 | 25 | 5 |
| Information and Cultural Industries | 142 | 157 | 1.0 | 5 | 5 | 1 |
| Finance and Insurance | 394 | 376 | 2.4 | 15 | 13 | 2.6 |
| Real Estate and Rental Leasing | 487 | 649 | 4.1 | 9 | 18 | 3.6 |
| Professional, Scientific and Technical Services | 973 | 1,182 | 7.5 | 21 | 19 | 37.7 |
| Management of Companies and Enterprises | 144 | 76 | 0.5 | - | - | - |
| Admin and Support, Waste Management, and Remediation | 553 | 533 | 3.4 | 10 | 11 | 2.2 |
| Educational Services | 156 | 153 | 1.0 | - | - | - |
| Health Care and Social Assistance | 2,244 | 1,765 | 11.2 | 127 | 62 | 12.3 |
| Arts, Entertainment and Recreation | 374 | 336 | 2.1 | 17 | 13 | 2.6 |
| Accommodation and Food Services | 1,323 | 1,298 | 8.2 | 44 | 33 | 6.5 |
| Other Services (not Public Administration) | 3,293 | 1,923 | 12.2 | 198 | 96 | 19 |
| Public Administration | 397 | 435 | 2.8 | 23 | 25 | 5 |
| Unknown | - | 33 | 0.2 | - | - | - |
| **Total** | **17,610** | **15,814** | **100.0** | **699** | **504** | **100** |

Source: (GNL 2018k).

There is some business capacity in the region to serve the Project. There are opportunities for existing public and private businesses, including hardware supplies; general freight trucking; employment placement agencies; automobile sales, parts and repair services; industrial equipment rental and leasing for construction and operation; engineering services; commercial banking; printing; media broadcast; petroleum and petroleum products; regulation, licensing and inspection; durable goods; metal work; building materials; furniture and furnishings; office supplies; surveying and mapping; seafood processing, production, preparation and packaging; accommodations and food services; wholesale and retail supplies; real estate and rentals and more (J. Bradley, Business Development Officer, Canada Business Network, pers. comm., 9 March 2018). Grieg NL has made a commitment to buy from and support as many of these local businesses as possible.

Customized suppliers and contractors will provide operating equipment and systems unique to this Project for Grieg NL's operating standards, and others that are proprietary to Grieg NL's contractors' equipment manufacturers and suppliers. Grieg NL has initiated working relationships with its core suppliers, e.g., Aqualine, AquaMaof and others tied to the schedules and plans for operation of the RAS Hatchery and sea cage sites. This will include the assembly and operation of the Aqualine Midgard Sea Cages, AquaMaof Hatchery Recirculating Aquaculture System, marine service vessels and barges, and all other related operational and maintenance equipment and systems. Grieg NL intends for procurement for these contractors to be provided on the Burin Peninsula, on-site or site-adjacent, employing local companies and businesses wherever possible. In select situations, to comply with standards and to ensure best practices, there will be procurement of materials, equipment and operating systems from out-of-Province suppliers, including original equipment manufacturers in Norway, Israel, America, mainland Canada and other jurisdictions as determined. The typical and expected range of services and supplies requiring procurement from businesses are provided in Table 4.77.

**Table 4.77. Project construction and operation service and supply requirements.**

| Construction | RAS Hatchery Operation | Sea Cage Operations |
|---|---|---|
| Earthworks | Wireless communications | Feed supplies |
| Concrete supply | Research and development | Feed handling and storage |
| Building supplies | Environmental monitoring | Service and work boats |
| Pumps | Triploid eggs | Barges |
| Tanks | Vaccination | Well boats |
| Hatchery buildings | Feed supplies | Feed boats |
| | Feed handling and storage | Food handing |
| | Fish graders | Cage systems |
| | Employee clothing | Mooring systems |
| | Employee safety supplies | Lift-up systems |
| | Sanitation services | Predator nets |
| | Water quality monitoring | Net cleaning |
| | Computer software and hardware | Employee clothing |
| | | Employee safety supplies |
| | | Sanitation services |
| | | Ensilage transfer |
| | | Fuel supply |
| | | Water quality monitoring |
| | | Employee food supply |
| | | Computer software and hardware |

Source: P. Power, Human Resources Manager, Grieg NL, pers. comm., 27 March 2018.

### 4.7.5 Employment Equity and Diversity including Under-represented Groups

Grieg NL has developed and issued a women's employment policy for the proposed aquaculture project in Placentia Bay, *Placentia Bay Atlantic Salmon Aquaculture Project Women's Employment Plan, 2016* (WEP; Grieg NL 2016b; see Appendix Y) Grieg NL is committed to diversity in its workplaces, including but not limited to the on-land hatchery and nursery, and marine farm operations. Grieg NL extends this commitment to its contractors and subcontractors, and Project tender-related documents will inform bidders of their obligation to assist with maximizing the involvement of women and reporting the results of efforts and outcomes.

Grieg NL will work with relevant groups and associations in the community to establish and maintain a positive and effective approach to employment diversification. The WEP includes measures to address employment equity and diversity in both the recruitment and retention of workers. Efforts to attract workers have already begun, with Grieg NL personnel actively engaged in school visits to introduce the aquaculture industry in person. To date, these sessions have been by young Grieg NL women already working on the Project, in the field and in research positions. Grieg NL will work with groups such as Women in Science and Engineering (WISE NL), Women in Resource Development Corporation (WRDC), MUN's Marine Institute, the Department of Advanced Education, Skills and Labour and others to ensure that training and careers in aquaculture are presented as opportunities within the Province. Any recruitment or hiring information will emphasize gender diversity, and specific efforts will be made to ensure women are well-represented in photographs or drawings of project work.

Retention of women in industries that have traditionally been male-dominated is a challenge. Grieg NL has developed a Code of Conduct and Ethics that supports women in the workplace. Grieg NL has already initiated and will continue to enforce policies and practices to address retention, including (from the WEP, page 14):

- A zero tolerance approach to gender-related harassment;
- Provision of work schedules that promote better work/life balance and career path planning, and offer the flexibility necessary to attend to family responsibilities;
- Reducing sources of unnecessary stress in the workplace, such as harassment and work-family conflict;
- An employment equity policy throughout Grieg NL operations;
- Working with contractors to ensure consistency in policy development and implementation;
- Hiring qualified women to be developed as trainers and mentors where possible; and
- Ensuring that the compensation system provides for equal pay for equal work.

There is considerable interest among Burin Peninsula residents in potential employment with the Project. A job fair in Marystown during October 2016 attracted over 1,200 people (see Appendix D). To date, Grieg NL has received 2,449 unsolicited work inquiries at their office in Marystown. A breakdown of the inquiries gives the following snapshot of interest in working with the Project:

- Of the total inquiries, 938 are female with 1,511 males expressing interest in employment;
- Interest can be classified into two categories: construction and operations;
- 407 inquiries expressed interest in all aspects of the cycle (i.e., construction and long-term operations);
    - Construction work: interest expressed by 1,170 resumes;
- The gender profile for construction interest is 1,156 male and 214 female;
    - Operational work: interest expressed by 1,686 resumes;
- The gender profile for operations is more equitable with 806 female and 880 male applicants; and
- The community breakdown indicates that out of the 2,449 applicants, 1,672 hail from the Burin Peninsula (173 are from the Placentia Bay area [Placentia, Long Harbour, Arnold's Cove, etc], 289 indicated they originally hail from the Burin Peninsula and live in other parts of the Canada and wish to return home, and 315 applications have been received from other parts of NL).

### 4.7.6 Eco-tourism Opportunities relative to Recreational Fishing and Outfitting Camps

The physical landscape of the Burin Peninsula is well suited for hiking, exploring, camping, hunting and fishing, with barrens, woods, ponds, streams and rolling hills visible from the highway. The coastal waters are accessible for boating, sailing and paddling, with inlets, coves and islands to provide shelter from high winds and seas, and to give a glimpse of past life. The waters of the Bay support whales and seals, with sightings of tuna and sharks not uncommon in recent years (C. Hepditch, Fisher, Baine Harbour, pers. comm., 20 February 2018). Eagles, otters, moose and caribou are commonly sighted on the shoreline from boats.

The high cost of insurance to be able to carry paying passengers is currently a deterrent to the development of eco-tourism in the area (L. Pomeroy, Owner/Operator, Woody Island Resort, Placentia Bay, pers. comm., 24 February 2018). At present, there is a single tour operator providing single and multi-day excursions on a commercial basis through the waters of Placentia Bay, travelling by vessel to accommodations on Woody Island, one of more than 360 islands within the Bay.

Overall, the islands are frequently visited, with individuals and families building summer homes or cabins and wharves on many of the islands, some returning to family-held land and others exploring. Visitors travel to the islands by boat, either via their own vessel or through an arrangement with someone in a

coastal community. Kayakers can arrange to be transported by fishing boat or speedboat across the open waters of the Bay to paddle and camp among the islands (D. Miller, Past President, Kayak NL, pers. comm., 25 February 2018). An estimated 400 cabins are located on the islands throughout Placentia Bay, and during the summer there are up to 200 recreational boaters on the water on a given day (NLRC 2007). Fishers in the communities nearest the proposed sea cage sites report that over the past five to ten years, there has been an increase in recreational boating in their fishing area during the summer months, with people visiting nearby islands to hike, stay at their cabins, or fish cod during the recreational fishery (K. Handrigan, Fisher, Petit Fort, pers. comm., 20 February 2018; C. Hepditch, Fisher, Baine Harbour, pers. comm., 20 February 2018).

## 4.8 Data Gaps

Existing environmental conditions have been described for the Study Area. However, there are information or data gaps for each VEC. These data gaps affect the level of confidence in the effects predictions. The key data gaps summarized below were taken into consideration when assessing effects of the Project on VECs.

### 4.8.1 Fish and Fish Habitat

There are a number of key data gaps related to fish and fish habitat in Placentia Bay. While some of these data gaps relate directly to biological components of the fish and fish habitat, others relate to water and sediment quality, both are components of fish habitat. Water temperature and dissolved oxygen data at the sea cage sites are available; however, additional water quality parameter data are either dated or lacking. Sediment quality data for Placentia Bay are also lacking, an important gap considering the unavoidable deposition of organics from the sea cages. Data related to the benthos and ichthyoplankton occurring in Placentia Bay are dated. There are limited data available on the species of wild invertebrates and fishes that are attracted to salmonid sea cage sites in Newfoundland and currently no data for Placentia Bay.

### 4.8.2 Wild Atlantic Salmon

There are a number of data gaps related to the wild Atlantic salmon stocks in Placentia Bay. Key gaps include (1) data related to the migration routes of wild salmon, both smolts and returning adults, within Placentia Bay; (2) data related to the time spent by and activities of wild salmon within Placentia Bay; and (3) data related to the degree of ecological interaction between wild salmon and escaped farmed salmon.

Somewhat related to data gaps directly associated with wild salmon, there are key gaps for the sea cage fishes as well. They include: (1) data related to the behaviour of escaped triploid female Atlantic salmon; and (2) data related to the behaviour of escaped ‘cleaner fish’ lumpfish.

Filling many of these data gaps would require the use of underwater telemetry to determine both temporal and spatial characteristics of the fish behaviour.

### 4.8.3 Sensitive Areas VEC

The primary data gaps relating to the Sensitive Areas VEC involve a lack of recent ecological information for some species within Placentia Bay.

The analysis and description of the features which led to the designation of Placentia Bay as an EBSA was completed by DFO over a decade ago (Templeman 2007), with an update describing oceanographic status and trends, ecosystem shifts, marine fauna and EBSAs within the PBGB LOMA released during 2012 (DFO 2012). An updated report will be released by DFO in the near future, with anticipated changes to the delineation and number of EBSAs within the PBGB LOMA. The updated document will presumably contain updates to the physical and biological features within the Placentia Bay extension EBSA.

Information relating to ichthyoplankton distribution within Placentia Bay is dated, with the latest directed ichthyoplankton surveys within Placentia Bay conducted during the spring and summer of 1997 and 1998. Population and/or breeding pair estimates for several seabird species within IBAs in the Study Area are similarly outdated, with some estimates dating to the late-1980s (e.g., breeding pairs of Black-legged Kittiwake at the Cape St. Mary's IBA; and Leach's Storm-petrel, and Black Guillemot at the Middle Lawn Island IBA). In addition, there are limited recent data on seal abundance and distribution in Placentia Bay. During consultations for the Project, fishers reported an increase in seal numbers in recent years (Appendix A *in* Grattan et al. 2008, Volume 3).The most recent dedicated deep-sea coral and sponge research occurred in Placentia Bay during the late-2000s, although corals and sponges are variably reported during ongoing annual DFO RV surveys in the region.

### 4.8.4 Species at Risk

In general, there is a paucity of systematically collected data on invertebrate, fish, bird and cetacean use of the marine environment of Placentia Bay. The collection of invertebrate and fish data in Placentia bay is often the result of baseline and follow-up work associated with specific proposed projects. This results in temporal and spatial patchiness on invertebrate and fish data, including those derived from the commercial fishery. Tagging data on leatherback sea turtles has been used, in part, to define proposed critical habitat for this species; however, specific information on sea turtle use of the proposed sea cage sites is lacking. There are also limited data on how cetacean and sea turtles (SAR and non-SAR) will interact with sea cages.

# 5.0 Consultations

Grieg NL met with relevant government agencies, representatives of the fishing industry, other stakeholders and interest groups as well as the general public in communities that may be affected by the Project (see Table 3.1). The purpose of these consultations was to describe the Project, identify interests, issues, and concerns, and to gather additional information relevant to the EIS. A detailed consultation report has been prepared and is provided in Appendix D. The key interests and concerns that have been identified during consultations are summarized in Table 5.1. To assist the reader, the specific section(s) in the EIS where particular issues and concerns have been addressed are listed (Table 5.1). Grieg NL will maintain an active stakeholder engagement program during planning, construction and operations, and decommissioning activities.

**Table 5.1. Summary of key issues and concerns raised during consultations for the Project.**

| **Comments and Concerns Presented to Grieg NL regarding the Placentia Bay Atlantic Salmon Aquaculture Project** | |
|---|---|
| **Issue** | **Vol. / Section in EIS** |
| **Use of Triploid Atlantic Salmon and Lumpfish Broodstock:**<br><br>• Is there an assurance that 100% of the Atlantic salmon stock will be sterile?<br>• Is there a contingency plan if the triploid Atlantic salmon prove to be unsuccessful?<br>• How will you guarantee broodstock (Atlantic salmon and lumpfish) are free of virus and infectious disease?<br>• What are the egg sampling methods and protocols used to give assurance that the triploid process is 100% effective?<br>• Will there be sampling on the mature salmon that demonstrates the triploid process was 100% successful and the mature salmon are unable to reproduce?<br>• Do triploid fish have more deformities and health issues than diploid fish? | **Vol. 1**<br><br>2.1 Overview of the Undertaking<br><br>2.4.1.1 Rationale for Proposing European-strain Sterile Triploid Atlantic Salmon<br><br>2.4.4.2 Operations and Maintenance *Cleaner Fish*<br><br>2.5.2.2 Operations and Maintenance *Fish Escapes*<br><br>**Vol. 2**<br><br>Appendix I: Stofnfiskur Certification and Verification (All-Female, Triploid)<br><br>Appendix S: Lumpfish Broodstock Collection, Domestication and Spawning Techniques Report, 2018<br><br>Appendix W: Letters of Support: (W-2), (W-3) |
| **Ice and Ice Management:**<br><br>• What is Grieg NL's mitigation plan for heavy sea ice?<br>• Why did Grieg NL state that Placentia Bay is ice-free? | **Vol. 1**<br><br>2.5.2.2 Operations and Maintenance *Ice Monitoring and Mitigation*<br><br>**Vol. 2**<br><br>Appendix T: Grieg NL Emergency Response Plan<br><br>Appendix V: Oceans Report – Metocean Conditions for the Placentia Bay Aquaculture Sites<br><br>Appendix W: Letters of Support: (W-4), (W-5) |

| Comments and Concerns Presented to Grieg NL regarding the Placentia Bay Atlantic Salmon Aquaculture Project | |
|---|---|
| **Issue** | **Vol. / Section in EIS** |
| **Control of Sea Lice:**<br><br>• Are sea lice a threat to people if they are consumed?<br>• How can Grieg NL be trusted to prevent sea lice based on previous incidents in Norway?<br>• Are the pesticides used to control sea lice harmful to humans? | **Vol. 1**<br><br>2.5.2.2 Operations and Maintenance<br>*Fish Health*<br>*(5) Sea Lice Control*<br><br>**Vol. 2**<br><br>Appendix K: Grieg NL Fish Health Management Plan |
| **Lumpfish:**<br><br>• How can we predict what will happen with lumpfish when they are already endangered in the area and what will be the ramifications of those lumpfish escaping into the ecosystem?<br>• If lumpfish are used to control sea lice, how many will be needed for this project and how long will they take to build the stock required?<br>• What is the ratio of lumpfish to salmon needed in order for the lumpfish to be effective?<br>• What happens to the lumpfish when the salmon are harvested? If they are harvested will the supplier be able to replace them in a timely manner?<br>• Since lumpfish can be opportunistic feeders, what happens if they prefer to eat the salmon feed rather than the sea lice?<br>• If lumpfish prove to be unsuccessful what is Grieg NL's contingency plan? | **Vol. 1**<br><br>2.4.4.2 Operations and Maintenance<br>*Cleaner Fish*<br><br>2.5.2.2 Operations and Maintenance<br>*Genetic Integrity and Biological Fitness of Wild Lumpfish*<br>*Fish Health*<br><br>**Vol. 2**<br><br>Appendix S: Lumpfish Broodstock Collection, Domestication and Spawning Techniques Report, 2018 |
| **Disease and Disease Management**:<br><br>• What is Grieg NL's mitigation plan for the Piscine virus (PRV) and Infectious Salmon Anemia (ISA) that is in Newfoundland, will the salmon be checked for PRV/ISA and other viruses?<br>• Which diseases will Grieg NL test for in the sea cages?<br>• When, where, how and what percentage of the stock will be tested?<br>• What type of chemicals and antibiotics will be used in the sea cages? | **Vol. 1**<br><br>2.4.4.2 Operations and Maintenance<br>*Fish Health*<br><br>2.5.2.2 Operations and Maintenance<br>*Fish Health*<br>*(7) Vaccinations*<br><br>**Vol. 2**<br><br>Appendix K: Grieg NL Fish Health Management Plan |
| **Land-Based Operations:**<br><br>• Why wouldn't Grieg NL consider a fully land-based operation?<br>• How would the combination of growing salmon up to three pounds in a land-based hatchery and then growing them to about eleven pounds in one year in Placentia Bay would be of benefit in this province? | **Vol. 1**<br><br>2.7 Alternatives |
| **Marine-Based Operations:**<br><br>• It was stated that Grieg NL is in close proximity of wild Atlantic salmon rivers in Placentia Bay. How will Grieg NL assure there will be no devastation to the salmon rivers?<br>• Grieg NL needs to assure that necessary steps are taken to prevent escapes.<br>• What is Grieg NL's mitigation plan for escaped salmon and their recapture plan?<br>• What will be the long-term effect on nursery ecology of Placentia Bay for other fish species? (e.g., capelin, cod, plaice and shellfish)<br>• Has Grieg NL reviewed the Conne River system and the reduction of salmon stock since the installation of sea cages? Also, the wild salmon smolt have to navigate around sea cages to get to open ocean.<br>• What assurances can be granted from Aqualine that the cages won't fail? | **Vol. 1**<br><br>2.5.2.2 Operations and Maintenance<br><br>**Vol. 2**<br><br>Appendix W: Letters of Support: (W-1)<br><br>**Vol. 3**<br><br>LGL 2018a<br>LGL 2018b<br>Sullivan et al. 2018 |

| Comments and Concerns Presented to Grieg NL regarding the Placentia Bay Atlantic Salmon Aquaculture Project | |
|---|---|
| **Issue** | **Vol. / Section in EIS** |
| **Predators and Sea Cages:**<br><br>• What is the plan by Grieg NL to mitigate the impact of a higher density of predators (ex: tuna and sharks) that will be attracted to sea cages?<br>• What happens when an animal gets entangled in a net?<br>• Will there be methods in place to prevent predation from birds? | **Vol. 1**<br><br>2.5.2.2 Operations and Maintenance<br>*Predator Protection and Control, Entanglement* |
| **Effects on Benthic Habitat**:<br><br>• What are the environmental ramifications of chemicals and antibiotics seeping into the natural waters? (i.e., wildlife and accumulations)<br>• What will be done about detriment accumulation under the bottom of the pens? (food waste, detriment, leftover antibiotics and chemicals)<br>• What will Grieg NL do to reduce their environmental impact?<br>• 75% of nitrogen and 77% of phosphorus from feed enters the ocean environment as waste, how will Grieg NL stop this from flowing away into the environment? | **Vol. 1**<br><br>2.5.2.2 Operations and Maintenance<br>*Effects on Marine Habitat*<br><br>**Vol. 3**<br><br>LGL 2018b |
| **Mitigation:**<br><br>• Will Grieg develop and present a mitigation plan to address regular operational failures or catastrophic failures of the project? | **Vol. 1**<br><br>2.5 Monitoring and Mitigation Measures<br><br>8.0 EPP<br><br>**Vol. 2**<br><br>Appendix J: Grieg NL Waste Management Plan<br><br>Appendix K: Grieg NL Fish Health Management Plan<br><br>Appendix M: Grieg NL Spill Management Plan<br><br>Appendix T: Grieg NL Emergency Response Plan |
| **Effects on Fishing:**<br><br>• Will the sea cage sites interfere in fishers' routes, gear and resource areas? | **Vol. 1**<br><br>2.5.2.2 Operations and Maintenance<br>*Interactions with Other Users*<br><br>**Vol. 3**<br><br>4.5.1 Fishers<br>Grattan et al. 2018 |
| **Waste:**<br><br>• What is Grieg NL's waste disposal plan? (e.g., diseased fish)<br>• Issues in Scotland regarding the amount of dead fish in sea cages from all suppliers over three years. Can Grieg NL be trusted to not ruin rivers?<br>• How will Grieg NL clean up after the project is finished?<br>• What will Grieg NL do to reduce their environmental impact? | **Vol. 1**<br><br>2.4.3.2 (RAS Hatchery) and 2.4.4.2 (Sea Farms) Operations and Maintenance<br>*Waste and Waste Management*<br><br>2.4.3.3 (RAS Hatchery) and 2.4.4.3 (Sea Farms) Decommissioning and Rehabilitation<br><br>**Vol. 2**<br><br>Appendix J: Grieg NL Waste Management Plan |

| Comments and Concerns Presented to Grieg NL regarding the Placentia Bay Atlantic Salmon Aquaculture Project | |
|---|---|
| **Issue** | **Vol. / Section in EIS** |
| | Appendix W Letters of Support: (W-6), (W-7), (W-8), (W-9) |
| **Grieg NL's Corporate Commitments**:<br><br>• How can Grieg NL assure that Newfoundland operations will be different than that of other places in the world?<br>• Is Grieg NL following the Norwegian Standard and if so is it on par with the Newfoundland standard? | **Vol. 1**<br><br>2.2.2 Project Principles<br><br>2.3.3 Norwegian Standards<br><br>**Vol. 2**<br><br>Appendix E: Grieg Seafood Sustainability Report 2017<br><br>**Vol. 3**<br><br>Sullivan et al. 2018 |
| **Indigenous Groups:**<br><br>• Will Grieg NL consult with any First Nations people on the Island during the Environmental Assessment process? | **Vol. 3**<br><br>Grattan et al. 2018<br>(4.1.1.6 *Indigenous Fisheries*) |
| **Employment and Business Opportunities**:<br><br>• What is the hiring process and will there be a local preference?<br>• How does Grieg NL plan to equalize male and female workers? | **Vol. 1**<br><br>2.6 Personnel Requirements<br><br>**Vol. 2**<br><br>Appendix Y: Women's Employment Plan |

# 6.0 Effects of the Environment on the Project

## 6.1 Wind and Waves

Wind speed and direction, and wind and wave action in the Study Area are described in Sections 4.1.2.3 and 4.2.2.3 above and Sections 2.3 and 3.2 of Appendix V, respectively. In extreme cases, wind and waves may contribute to accidental events, such as fish escapes due to damaged sea cage equipment. Such events are assessed in Section 7.7, Accidents and Malfunctions. Otherwise, high wind and wave conditions could delay the towing/mooring of sea cages and the transfer of smolt to well boats (transfers are only completed during calm conditions), may delay crew change or resupply activities, and may prevent personnel from completing routine maintenance/repair activities and in-person monitoring. In such conditions, maintenance/repair would resume when it is safe to do so, and monitoring would continue uninterrupted via the use of video cameras installed at each sea cage site, which will have 360º viewing capabilities and be submersible within the water column. Additionally, during periods of high wind and waves, fish in the sea cages could potentially be exposed to unsuitable surface conditions. Grieg NL will be using a sea cage net which extends 45 m below the water surface. This relatively deep net has sufficient volume to allow fish to swim to depths that will allow it to avoid unsuitable surface conditions and thereby decrease stress on the fish.

## 6.2 Storm and Severe Precipitation Events

Sections 4.1.2.4 and 4.2.2.5 above and Sections 2.3, 2.4, 2.7.1 and 3.2 of Appendix V describe storm conditions and patterns within the Study Area and/or Newfoundland region. Tropical storm systems are known to pass within at least 150 nm of the BMAs, generally during summer and fall, although relatively few maintain hurricane strength. Storm-related extreme outcomes, such as damaged equipment, spills and fish escapes, are assessed in Section 7.7, Accidents and Malfunctions. Effects are otherwise identical to those due to wind and waves (see above), and additionally offset by the selection of sea cage placement locations within relatively sheltered areas. As each sea cage would be moored with anchors and non-reliant on sea surface level for stability or function, severe precipitation events are not anticipated to interfere with marine Project equipment.

## 6.3 Flooding

Flood and tidal zones in Placentia Bay are summarized in Section 4.2.2.4, and tidal heights and water levels are presented in Section 3.4 of Appendix V. Within the Study Area, the communities of Rushoon and Placentia have been identified as flood risk areas. Flooding is not anticipated to occur within the proposed sea cage sites or near the RAS Hatchery and fluctuations in tide are minimal and will not affect the Project.

## 6.4 Sea Ice and Icebergs

Based on a review of Canadian Ice Service data (see Appendix V) and discussions with the Placentia MCTS (see Appendix D) and local stakeholders (Appendix W), sea ice and icebergs are not predicted to pose a threat to the sea cage sites. However, it is recognized that there is a very low probability that sea ice may occur in and near the sea cage site. Ice may occur in the Study Area during mid-February until mid-April, with the highest likelihood of ice presence during early-March (see Section 4.2.2.6 above and Section 3.3 of Appendix V). Icebergs of varying sizes are known to occur (although rarely) throughout Placentia Bay, although relatively few were recorded within the BMAs or northern portion of the Bay during 1960–2015 (see Figure 3.17 and Table 3.11 of Appendix V). Effects such as equipment damage or

fish escapes due to ice are assessed in Section 7.7, Accidents and Malfunctions. Ice incursion and/or the presence of icebergs may delay the transfer of smolt to a well boat if conditions are unfavourable for transfer hose use, and may require Project-related vessels to detour from their regular transit route. The unlikely event of extreme ice conditions may delay routine inspection and maintenance activities, or require the temporary displacement of barge vessels. As with other marine waters of Newfoundland and Labrador, Project vessels will be subject to icing from freezing precipitation and sea spray during the winter months, particularly during February (Vale 2008). Grieg NL will include ice monitoring in its operational mitigation measures and use robust sea cages intended for cold-water use (see Sullivan et al. 2018 *in* Volume 3).

## 6.5 Superchill

Fish have thermal niches with upper and lower thermal limits that are species-specific. Atlantic salmon have a lower thermal temperature limit of approximately -0.75˚C (Elliott and Elliott 2010). Although Atlantic salmon can survive temperatures below freezing, if the salmon contact ice crystals in the water mortality may occur. Superchill occurs when the water temperatures fall below freezing and ice nuclei form in the water and then develop across the epidermis of the fish (Speare 2003). This can be detrimental to the health of the fish and result in high mortalities. In Newfoundland, a superchill event resulted in farmed Atlantic salmon mortalities in 2014 (DFA 2015). Superchill can occur in Placentia Bay and affect the Project.

Grieg NL will implement measures to reduce the possibility of fish being affected by a superchill event. Temperature profiles during winter months in Placentia Bay are negatively correlated with water depth (see LGL 2018b *in* Volume 3). Salmon position themselves vertically in relation to water temperature within sea cages (Oppedal et al. 2011). Therefore, providing the fish with deep nets (i.e., 45 m below surface) will allow the fish to descend deeper into the water that is warmer than the colder surface water. Other mitigation measures which will be implemented by Grieg NL to minimize the effects of a superchill event include the cessation of feeding and other activities that require the fish to come to the surface. Additionally, water temperatures will be monitored and personnel will be trained to recognize when a superchill event may occur.

## 6.6 Climate Change

Section 2.7 of Appendix V and Section 4.1.2.4 describe climate change in the North Atlantic and eastern Canada, including an anticipated sea level rise of ~0.6 m in Placentia Bay by 2081–2100, an increase in high-latitude cyclone frequency during 1959–1997, recent increases in winter Northern Hemisphere temperatures, and ongoing updates for flood risk mapping studies in Newfoundland and Labrador using climate change projections. During years with a decrease in sea ice extent off Newfoundland and Labrador due to climate variability, fewer icebergs would likely occur near the proposed sea cage sites. Accidents and malfunctions associated with storm, ice or precipitation-related activity are assessed in Section 7.7. Other relevant effects are summarized in Sections 6.1–6.4 and Section 6.9 below.

## 6.7 Fog

Increased humidity in northern marine regions, including Placentia Bay, is positively correlated with reduced visibility due to fog, along with low cloud heights and high precipitation (see Section 4.1.2). Poor visibility can constrain vessel and personnel operations, and hinder surficial sightings of marine fauna that may become entangled with sea cage equipment. Remote underwater monitoring and maintenance activities could continue unhindered during periods of dense fog, including ROV operations

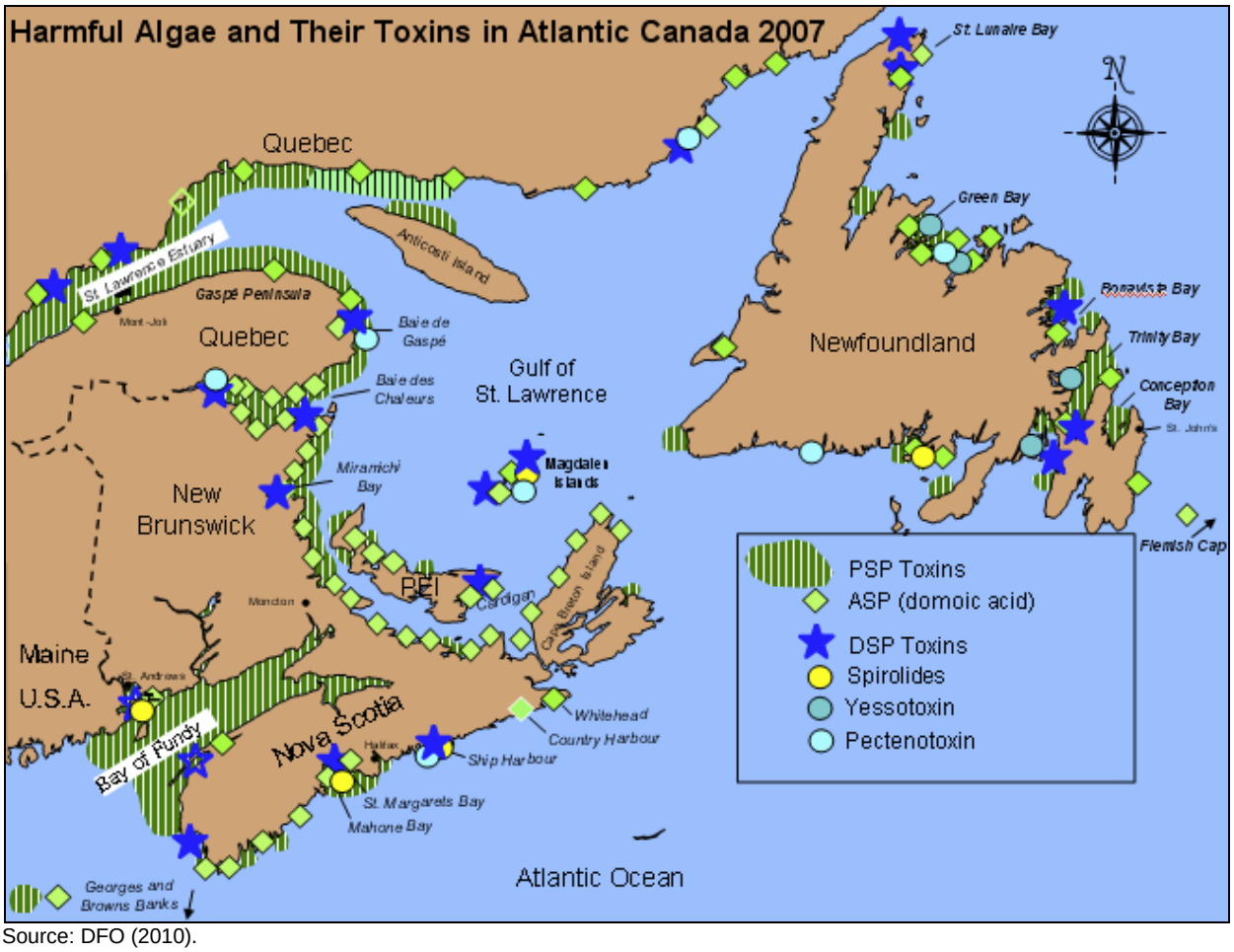
(providing sea surface conditions are within safe operating parameters), and routine monitoring using submersible video cameras mounted at each sea cage site.

## 6.8 Currents

Ocean currents within Placentia Bay are described in Section 3.1 of Appendix V, with BMA-specific summaries provided in Section 4.2.2.2. The proposed sea cage locations were selected in part due to the presence of adequate current to assist in the removal of organic deposits associated with sea cage operations, thereby minimizing depositional build-up or nutrification. Ocean currents within the BMAs are of sufficient strength to result in a positive effect on the Project, without posing undue strain on sea cages, moorings, lines, or other marine equipment.

## 6.9 Algal Blooms

Harmful algal blooms (HABs) have been increasing worldwide since the 1990s, including within Placentia Bay (Bates 1997, and Bates and Forbes 2009 *in* DFO 2010c). Algal blooms can occur wherever suitable environmental conditions occur, and are often associated with nutrient enrichment in inshore areas (DFO 2010c). Ballast water is a major vector of HABs (Hallegraff and Bolch 1991, and Humphrey 2008 *in* DFO 2010c), and climate change is expected to further increase HAB frequency (McGillicuddy et al. 2003 *in* DFO 2010c). Placentia Bay's relatively high ship traffic density may increase its susceptibility to HABs, particularly within the northern and northeastern portions of the Bay (Figure 6.1) (DFO 2010c). Of note, Project vessels will not be discharging ballast water in or near the sea cage sites. Algal blooms within the Placentia Bay area are of short duration, although cysts of some algal species can remain dormant indefinitely in sediments, and resuspension of such sediments into the photic zone can result in bloom reoccurrence (DFO 2010c). The toxins associated with HABs can accumulate in fish and shellfish, with paralytic shellfish poisoning (PSP) among the most toxic, whereby small quantities of PSP are capable of causing rapid paralysis and death for various marine fauna (DFO 2010c). An accumulation of HABs within local food webs can result in the mortality of marine organisms of all trophic levels (Sindermann 2003, and Agriculture and Consumer Affairs 2004 *in* DFO 2010c). However, reports of farmed finfish mortalities associated with PSP toxin-producing dinoflagellates are comparatively infrequent. For example, Cembella et al. (2002) report two cases of salmon mortality associated with algal blooms: one in Denmark in 1984 and one in Nova Scotia in 2000. Water quality monitoring will enable Grieg NL personnel to detect algal bloom events at the sea cage sites. This water quality monitoring combined with monitoring the DFO Shellfish Sanitation Closures website will give indications of potential HABs.




Source: DFO (2010).

**Figure 6.1. Risk areas of harmful algal bloom events in eastern Atlantic Canada, 2007 (based on Historical Monitoring Records).**

## 6.10 Assessment of Effects of the Environment on the Project

With mitigation measures and monitoring in place, residual effects of the environment on the Project, excluding extreme scenarios which are assessed in Section 7.7, Accidents and Malfunctions, are predicted to be *not significant*.

# 7.0 Effects of the Project on the Environment

An analysis of the predicted environmental effects of the Project on the VECs is provided. Residual effects have been assessed relative to a Project phase (Construction, Operations and Maintenance, and Decommissioning and Rehabilitation) and a specific Project activity. This section also presents the cumulative effects analysis and assesses potential effects of the accident and malfunction scenarios defined in Section 2.8. Where possible, predicted future conditions of the environment have been considered in the assessment—however, this is more applicable to effects of the environment on the Project (see Section 6.0) and the socio-economic effects assessment.

Key mitigation measures for each VEC and Project activity interaction are summarized where appropriate in the subsections below. Detailed mitigation measures are presented in Section 2.5 and a summary table is presented later in Section 8.1.

The terrestrial components of the Project include the RAS Hatchery, which is located in the Marystown Marine Industrial Park. No roads will be constructed to access sea cage sites. Air emissions during the construction, operation, and decommissioning of the RAS Hatchery are negligible. As described in Sections 2.4.2.1 and 2.4.3.1, site clearing for the RAS Hatchery was completed on behalf of Grieg NL during late summer and fall 2016 and grubbing of the site was undertaken during summer 2017. Appropriate mitigation measures were in place for managing erosion and sedimentation and for site clearance for breeding birds (see Section 2.5.1.1). Existing conditions at the RAS Hatchery site are not considered suitable habitat for terrestrial fauna given that vegetation has been cleared. Interactions between Project activities during Construction, Operations and Maintenance, and Decommissioning and terrestrial wildlife are not expected. However, it is possible that some terrestrial fauna, namely birds, may occur there periodically. Species at risk (birds) that may occur at the RAS Hatchery site are listed in Section 4.2.5. The assessment considers the potential effects of accidents and malfunctions at the RAS Hatchery on land birds considered at risk. Planned project activities at the RAS Hatchery site are not considered further.

## 7.1 Fish and Fish Habitat VEC

The potential interactions between planned activities associated with the sea farm component of the Project and the Fish and Fish Habitat (FFH) VEC were examined and the interactions determined most likely to occur are presented in Table 7.1. Only identified interactions are carried forward to the assessment criteria table (Table 7.2) and the significance table (Table 7.3).

The Project activities associated with its sea farm component that will interact with the FFH VEC include:

- *Sea cage installation* during ‘construction’
- *Feeding of the farmed salmon* during ‘operations and maintenance’
- *Presence of farmed salmon* during ‘operations and maintenance’
- *Deposition or organic material from the sea cages* during ‘operations and maintenance’
- *Maintenance of farmed salmon health* during ‘operations and maintenance’
    - *Use of cleaner fish* (lumpfish)
    - *Farmed salmon mortalities*
    - *Use of therapeutants*
    - *Use of antibiotics*
- *Maintenance of sea cages* during ‘operations and maintenance’

    - *Cleaning of the net*
- *Sea cage sites* during 'operations and maintenance'
    - *Presence of sea cages*
    - *Lights on sea cages*
- *Use of vessels* during 'operations and maintenance'
    - *Lights on vessels*
- *Production of waste materials* during 'operations and maintenance'
- *Sea cage system removal* during 'decommissioning and rehabilitation'

Each of these interactions is discussed and assessed in the following subsections.

**Table 7.1. Potential interactions of planned sea farm Project activities and the Fish and Fish Habitat VEC.**

| Valued Environmental Component: Fish and Fish Habitat | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project Activities** | **Non-Biological** | **Biological** | | | | | |
| | **Water and Sediment** | **Plankton** | **Benthos** | **Eggs & Larvae** | **Juveniles[a]** | **Pelagic Fish** | **Ground-fish** |
| **CONSTRUCTION** | | | | | | | |
| **Towing Sea Cages** | | | | | | | |
| **Sea Cage System Installation** | x | | x | | | | x |
| **Vessel Traffic** | | | | | | | |
| **OPERATIONS & MAINTENANCE** | | | | | | | |
| **Transfer Fish to Sea** | | | | | | | |
| **Feeding Fish** | x | | x | | x | x | x |
| **Presence of Farmed Salmon** | | | | | | x | |
| **Deposition from Sea Cages** | x | | x | | x | | x |
| **Fish Health Maintenance** | | | | | | | |
| Use of Cleaner Fish | x | | x | | x | x | x |
| Fish Mortalities | x | | x | | x | x | x |
| Thermolicer[b] | | | | | | | |
| Therapeutants[b] | x | x | x | x | x | x | x |
| Antibiotics[c] | x | x | x | x | x | x | x |
| **Sea Cage Maintenance** | | | | | | | |
| Net Cleaning | x | | x | | x | x | x |
| Net Repair | | | | | | | |
| **Sea Cage Sites** | | | | | | | |
| Presence | | | | | | x | |
| Lights | | x | | x | x | x | |
| **Use of Vessels[d]** | | | | | | | |
| Presence | | | | | | | |
| Lights | | x | | x | x | x | |
| Noise | | | | | | | |
| Atmospheric Emissions | | | | | | | |
| **Transfer Fish from Sea** | | | | | | | |
| **Production of Wastes** | x | x | x | x | x | x | x |
| **DECOMMISSIONING & REHABILITATION** | | | | | | | |
| **Towing Sea Cages** | | | | | | | |
| **Sea Cage System Removal** | x | | x | | | | x |
| **Vessel Traffic** | | | | | | | |

[a] Juveniles are young fish that are no longer planktonic and are often closely associated with the sea bottom.
[b] The use of the Thermolicer and therapeutants are adaptive mitigation measures for sea lice and will only be used as a last resort based on guidance from private and provincial veterinarians.
[c] Antibiotics will only be used as a last resort and will be based on guidance from private and provincial veterinarians.
[d] All Project vessels including those associated with personnel transfer and resupply.

**Table 7.2. Assessment of effects of planned sea farm Project activities on the Fish and Fish Habitat VEC.**

| Valued Environmental Component: Fish and Fish Habitat | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Project Activity** | **Potential Positive (P) or Negative (N) Environmental Effect** | **Key Mitigation Measures(s)** | **Evaluation Criteria for Assessing Environmental Effects** | | | | | |
| | | | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| **CONSTRUCTION** | | | | | | | | |
| **Sea Cage System Installation** | Mooring anchors will cover portions of the seabed (N) | • Minimize the number and footprint of mooring anchors | 0 | 1 | 6 | 5 | R | 2 |
| **OPERATIONS & MAINTENANCE** | | | | | | | | |
| **Feeding Fish** | Introduction of extra organic material into the marine environment (N) | • Feeding stops at ~80% fish satiation;<br>• Suitable siting of sea cages;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling;<br>• Fallowing of sea cage sites | 1 | 1 | 5 | 3 | R | 2 |
| **Presence of Farmed Salmon** | Transfer of disease/parasites to wild fishes (N);<br><br>Attraction of wild fishes to the sea cages (N); | • Vaccination of fish in the sea cages;<br>• Ongoing monitoring of health of fish in the sea cages;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices;<br>• Fish Health Management Plan;<br>• Predator Control Plan;<br>• Reinforced netting at bottom of sea cages; and<br>• Monitoring of farmed salmon behavior with underwater cameras | 1 | 1 | 6 | 3 | R | 2 |
| **Deposition from Sea Cages** | Accumulation of organic material on the seabed below and in the vicinity of the sea cages (N) | • Minimization of feed component through cessation of feeding at ~80% fish satiation;<br>• Siting of sea cages in locations with sufficient water currents to disperse organic material (i.e., feed, fish feces, biofoulants) falling from the sea cages;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling; and<br>• Fallowing of sea cage sites at the end of each production cycle for 16-19 months<br>• Daily removal of fish mortalities from the sea cages | 1 | 1 | 6 | 3 | R | 2 |
| **Fish Health Maintenance** | | | | | | | | |
| Use of Cleaner Fish | Additional fish feces being deposited to the seabed (N);<br><br>Additional vectors for diseases and parasites (N) | • Siting of sea cages in locations with sufficient water currents to disperse organic material (i.e., feed, fish feces, biofoulants) falling from the sea cages;<br>• Fallowing of sea cage sites at the end of each production cycle for 16-19 months;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling;<br>• Monitoring fish for presence of disease and/or parasites; | 1 | 1 | 6 | 3 | R | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | • Vaccination of lumpfish and no reuse of lumpfish;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices; and<br>• Fish Health Management Plan. | | | | | | |
| Fish Mortalities | Attraction of wild fish to the sea cages, including potential predators (N) | • Video monitoring of sea cages for mortalities;<br>• Daily removal of fish mortalities from sea cage using Mortex system; and<br>• Removal of any visibly moribund fish at surface; | 1 | 1 | 6 | 3 | R | 2 |
| Therapeutants[a] | Availability to wild invertebrates and fishes (N) | • Advice of the provincial veterinarian regarding necessity of use and dosage if required;<br>• Use of low water-soluble therapeutant so that any excess remains in the sediment; and<br>• Monitoring of feed consumption by salmon and subsequent cessation of feed provision at ~80% satiation. | 1 | 1 | 1 | 1-2 | R | 2 |
| Antibiotics[b] | Availability to wild invertebrates and fishes (N) | • Advice of the provincial veterinarian regarding necessity of use and dosage if required;<br>• Use of low water-soluble therapeutant so that any excess remains in the sediment; and<br>• Monitoring of feed consumption by salmon and subsequent cessation of feed provision at ~80% satiation. | 1 | 1 | 1 | 1-2 | R | 2 |
| **Sea Cage Maintenance** | | | | | | | | |
| Net Cleaning | Deposition of extra organic material to the seabed (N) | • Siting of sea cages in locations with sufficient water currents to disperse biofoulants falling from the sea cages;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling; and<br>• Fallowing of sea cage sites at the end of each production cycle for 16-19 months. | 0-1 | 1 | 3 | 3 | R | 2 |
| **Sea Cage Sites** | | | | | | | | |
| Presence | Accumulation of biofoulants on sea cage system components (i.e., artificial reef effect) (N) | • Siting of sea cages in locations with sufficient water currents to disperse biofoulants falling from the sea cages;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling; and<br>• Fallowing of sea cage sites at the end of each production cycle for 16-19 months. | 1 | 1-2 | 6 | 3 | R | 2 |
| Lights | Attraction of wild invertebrates and fishes to the sea cages (Neutral) | • Minimize the amount of lighting on sea cages | 0-1 | 1 | 5 | 3 | R | 2 |
| **Use of Vessels**[c] | | | | | | | | |
| Lights | Attraction of wild invertebrates and fishes to the sea cages (Neutral) | • Minimize the amount of lighting on vessels | 0-1 | 1 | 5 | 3 | R | 2 |
| **Production of Waste** | Accumulation of organic material on the seabed below and in the vicinity of the sea cages;(N);<br><br>Contamination of wild invertebrates and fishes (N) | • Siting of sea cages in locations with sufficient water currents to disperse organic material (i.e., feed, fish feces, biofoulants) falling from the sea cages;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling; and<br>• Fallowing of sea cage sites at the end of each production cycle for 16-19 months;<br>• Vessels will have internal tanks for freshwater, grey water, and | 1 | 1 | 6 | 3 | R | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | sewer/waste waters;<br>• Vessels will carry portable waste tanks interchangeable with the barge systems;<br>• Management practices in place to reduce the amount, frequency and risk associated with the use of petroleum products;<br>• Reuse of petroleum products when possible (e.g. waste oil can be collected and burned);<br>• Choice of environmentally friendly petroleum products when possible (e.g. food grade grease/oil);<br>• Minimization of use paint products by ensuring that most painting is done either prior to deployment or during the time of site fallowing;<br>• Reduction of the amount of operational debris waste generated (e.g., buy feed and products in bulk, buy products with less packaging, etc.);<br>• Recycling when possible (e.g. cardboard, feed bags, aluminum cans, plastic bottles, e-waste, etc. and bring to shore on service vessel);<br>• Transference of on site waste to land for disposal in accordance with BPWMC;<br>• Implementation of management practices to reduce the amount and frequency of cleaning products; and<br>• Use of cleaning products that can enter the vessels' grey water tanks and are easily broken down. | | | | | | |
| **DECOMMISSIONING & REHABILITATION** | | | | | | | | |
| **Sea Cage System Removal** | Removal of mooring anchors will disturb portions of the seabed (N) | • Minimize dragging of mooring anchors along seabed during removal | 0-1 | 1 | 1 | 1-2 | R | 2 |

Key:

Magnitude:
0 = Negligible
1 = Minor
2 = Moderate
3 = Major

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = Continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1-km$^2$
2 = 1-10-km$^2$
3 = 11-100-km$^2$
4 = 101-1,000-km$^2$
5 = 1,001-10,000-km$^2$
6 = > 10,000-km$^2$

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not affected by human activity
2 = Evidence of existing effects

[a] The use of the Thermolicer and therapeutants are adaptive mitigation measures for sea lice and will only be used as a last resort based on guidance from private and provincial veterinarians.
[b] Antibiotics will only be used as a last resort and will be based on guidance from private and provincial veterinarians.
[c] All Project vessels including those associated with personnel transfer and resupply.

**Table 7.3. Significance of potential residual environmental effects of planned sea farm Project activities on the Fish and Fish Habitat VEC.**

| Valued Environmental Component: Fish and Fish Habitat | | | | |
|---|---|---|---|---|
| **Project Activity** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[a]** | |
| | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **CONSTRUCTION** | | | | |
| **Sea Cage System Installation** | NS | 3 | | |
| **OPERATIONS & MAINTENANCE** | | | | |
| **Feeding Fish** | NS | 2-3 | | |
| **Presence of Farmed Salmon** | NS | 2 | | |
| **Deposition from Sea Cages** | NS | 2 | | |
| **Sea Cage Maintenance** | | | | |
| Use of Cleaner Fish | NS | 2-3 | | |
| Fish Mortalities | NS | 2-3 | | |
| Therapeutants[b] | NS | 2 | | |
| Antibiotics[c] | NS | 2 | | |
| **Sea Cage Maintenance** | | | | |
| Net Cleaning | NS | 2-3 | | |
| **Sea Cage Sites** | | | | |
| Presence | NS | 2-3 | | |
| Lights | NS | 3 | | |
| **Use of Vessels[d]** | | | | |
| Lights | NS | 3 | | |
| **Production of Waste** | NS | 2-3 | | |
| **DECOMMISSIONING & REHABILITATION** | | | | |
| **Sea Cage System Removal** | NS | 3 | | |

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 $km^2$.

Residual environmental Effect Rating:
S = Significant Negative Environmental Effect
NS = Not-significant Negative Environmental Effect
P = Positive Environmental Effect

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Level of Confidence: based on professional judgment:
1 = Low
2 = Medium
3 = High

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low
2 = Medium
3 = High

[a] Considered only in the case where 'significant negative effect' is predicted.
[b] The use of the Thermolicer and therapeutants are adaptive mitigation measures for sea lice and will only be used as a last resort based on guidance from private and provincial veterinarians.
[c] Antibiotics will only be used as a last resort and will be based on guidance from private and provincial veterinarians.
[d] All Project vessels including those associated with personnel transfer and resupply.

## 7.1.1 Construction

### 7.1.1.1 Sea Cage Installation

The only notable effect of sea cage installation during construction on the FFH VEC relates to the direct contact that mooring anchors will make with the benthic substrate. The anchors will cause effects on the benthic substrate and the biota living within and on it by covering the seabed. Infauna (invertebrates that live in the surficial sediment) and epibiota (flora, benthic invertebrates and fishes that live on the seabed)

will not be able to use those areas of the seabed within the anchor footprints. The total number of anchors that will be deployed at each of the nine semi-annual sea cage sites and two seasonal sea cage sites are 44 and 28, respectively. Since the footprint of each of the anchors is ~1 $m^2$, the maximum areas of seabed that will be impacted by the mooring anchors at the semi-annual sites and the seasonal sites are 44 $m^2$ and 28 $m^2$, respectively.

The areas of the nine semi-annual sea cage sites range from 1.19–3.16 $km^2$, and the areas of the two seasonal sea cage sites range from 0.78–1.17 $km^2$. Based on these sea cage site areas and anchor footprint size, the percentage of the seabed at the sea cage sites that will be covered by the anchors ranges from 0.001 % to 0.004 %.

The key mitigation measure for this very limited effect is to use the lowest number of suitable small-footprint anchors possible that will still meet mooring requirements for the sea cages.

The anchors deployed during sea cage site construction are predicted to have residual *negative* effects on the FFH VEC that are *negligible* in magnitude over a geographic extent of *<1 km²* for a duration of *>72 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of sea cage mooring anchor placement on the seabed on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *high*.

### 7.1.2 Operations and Maintenance

#### 7.1.2.1 Feeding of Farmed Salmon

The effect of daily feeding of farmed salmon on the FFH VEC relates to the deposition of unconsumed feed from the sea cages to the seabed below and in the vicinity of the sea cages. Accumulation of unconsumed feed in the marine system can negatively affect the ecosystem by contributing to the organic enrichment of the benthic systems (i.e., biochemical oxygen demand [BOD] matter) (Strain and Hargrave 2005 *in* Taranger et al. 2015). Excessive loading of organics to sediments may lead to dramatic changes in biogeochemical processes leading to grossly anoxic conditions (Valdemarsen et al. 2012 *in* Taranger et al. 2015). See Section 4.4 *in* LGL (2018b *in* Volume 3) for more information regarding benthic deposition.

The key mitigation measures for the effect of feeding of farmed salmon on the FFH include:

- Cessation of feeding once the farmed fish have reached ~80% satiation, based on video monitoring of fish behaviour;
- Siting of sea cages in locations with appropriate ambient environmental conditions (e.g., sufficient current velocity and direction, sufficient water depth, and >50% hard substrate), as per the requirements of the AAR and DFLR's Aquaculture Licence Application process;
- Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling; and
- Fallowing of sea cage sites at the end of each production cycle.

Fallowing of sea cage sites (leaving sites without fish after a production cycle) is designed to minimize the effects of aquaculture on marine habitat. Atlantic salmon aquaculture sites in Newfoundland and Labrador are located predominantly over hard bottom substrates where it is difficult to consistently obtain sediment samples. The primary mitigation measure to manage potential effects from uneaten feed and

feces is to fallow at the end of each production cycle. Feeding of farmed salmon will continue for up to 18 months at each sea cage site during a single production cycle. In Newfoundland and Labrador, the mandatory fallowing time after harvesting is seven months for a sea cage site and four months for a BMA. Grieg NL will increase the fallowing time for a sea cage site to a minimum of 16 months and a maximum of 19 months after harvesting, increasing the time for the benthic community to recover.

Feeding of farmed salmon will continue for up to 18 months at each sea cage site during a single production cycle.

Grieg NL's Waste Management Plan (Appendix J) and Section 2.5.2.2 of the EIS provide more details regarding these mitigation measures.

After implementation of the mitigation measures, feeding of farmed fish is predicted to have residual *negative* effects on the FFH VEC at each sea cage site that are *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *13–36 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of feeding of farmed fish on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *medium* to *high*.

### 7.1.2.2 Presence of Farmed Salmon

The main potential effect of the presence of farmed salmon in the sea cages is the potential for disease/parasite transfer to wild fish. Secondary potential effects of farmed fish presence include the attraction of wild fishes to the sea cage sites, and the deposition of fish feces to the seabed.

Two of the most common sea louse species that infect farmed and wild Atlantic salmon in Atlantic Canada are the parasitic copepods *Lepeophtheirus salmonis* and *Caligus elongatus*. Sea lice are problematic for fish farmers so controlling them is a high priority area of aquaculture research (Rittenhouse et al. 2016). In addition to the external damage that they cause to salmon, they are capable of facilitating the transfer of pathogens which can lead to disease and increased mortality in both farmed and wild salmon (Jensen et al. 2010; DFO 2014a; Verspoor et al. 2015). If not controlled, particularly during infestations, sea lice on farmed salmon can increase the abundance of sea lice in the vicinity of sea cages and the probability of sea lice infesting migrating wild salmon passing through the area (Jensen et al. 2010; DFO 2014a; Saksida et al. 2015). It is not necessary that farmed fish escape cages to spread sea lice and/or pathogens and disease to wild salmon (Verspoor et al. 2015). Based on current science information, the free-living stages of sea lice can disperse distances of tens of kilometres (DFO 2014a).

Although there is a paucity of information in the primary literature regarding the resistance of triploid Atlantic salmon to pathogens, anecdotal evidence from fish farmers indicates that triploid fish may be less resistant to pathogens and parasites, potentially resulting in increased disease transmission to wild salmon (DFO 2013; Benfey 2015). Cases of ISA were reported in Atlantic salmon in Newfoundland during 2012 to 2017, the most recent case occurring in October and November of 2017 (CFIA 2017). ISA is a serious disease for salmon and is required to be reported to the CFIA immediately upon discovery.

While parasite and disease transfer between farmed salmon and wild salmon has been identified as an issue with aquaculture, less is known about parasite/disease transmission between farmed salmon and wild non-salmonid fishes (Uglem et al. 2014). Transmission of parasites and pathogens between farmed salmon and wild fishes is likely density-dependent. Generally, the higher the host fish densities, the greater the potential for the spread and persistence of parasites and pathogens to host fishes (Krkošek 2017).

Lumpfish and Atlantic salmon are susceptible to some of the same diseases (e.g., vibriosis, pseudomoniasis). Close mixing of lumpfish with salmon creates favourable conditions for the emergence and transfer of diseases in both lumpfish and salmon so consideration must be given to general processes by which disease emerges in aquaculture (Murray 2016 *in* Powell et al. 2017). The development of selected lumpfish lines that show increased disease resistance is therefore a strategy that would benefit salmon aquaculture.

The key mitigation measures for the potential disease/parasite transfer effect on the FFH include:

- Vaccination of fish in the sea cages;
- Ongoing monitoring of health of fish in the sea cages;
- Implementation of biosecurity measures;
- Routine husbandry practices;
- Implementation of Fish Health Management Plan (Appendix K).

Grieg NL's Fish Health Management Plan (Appendix K) and Section 2.5.2.2 of the EIS provide more details regarding the mitigation measures.

Another potential effect of presence of farmed salmon on the FFH VEC is attraction of wild biota like sharks and tunas which could result in breaches of sea cage nets. Small numbers of escapes from sea cages on the south coast of Newfoundland were reported in 2012 as a result of damage to the netting caused by sharks and tuna. In August 2015, an unknown number of salmon escaped sea cages in southern Newfoundland that had holes in the netting due to damage caused by predator strikes (DFO 2017a). During consultations for the Grieg NL EIS, fishers indicated that they have seen a marked increase in the number of sharks and tuna in Placentia Bay during the past four to five years (Grattan et al. 2018 *in* Volume 3). A Predator Control Plan, required as part of Grieg NL's aquaculture license application, will include methods to monitor, deter and exclude marine predators from the sea cages sites.

The last effect of the presence of farmed salmon in the sea cages on the FFH VEC relates to the deposition of fish feces from the sea cages. The fish feces are a component of the organic material that will be deposited to the seabed. Details regarding the potential effects of this deposition are provided below in Section 7.1.2.3. The key mitigation measures for this aspect of presence of farmed salmon include:

- Suitable siting of the sea cage sites in areas of good water exchange;
- Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling; and
- Fallowing of the sea cage sites after each production cycle.

Section 2.5.2.2 of the EIS provides more details regarding the mitigation measures.

Fish will be present in sea cages for up to 18 months during a single production cycle.

After implementation of mitigation measures, presence of farmed salmon is predicted to have residual *negative* effects on the FFH VEC at each sea cage site that are *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *13–36 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of presence of farmed salmon on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *medium*.

### 7.1.2.3 Deposition from the Sea Cages

The interaction between deposition from the sea cages and the FFH VEC relates primarily to the effects of the release of organic and inorganic matter (e.g., carbon, nitrogen and phosphorus) to the surrounding marine environment in the form of excess feed and fish feces. Accumulation of these elements in the marine system can negatively impact the ecosystem by contributing to eutrophication of pelagic systems, fertilization of benthic macrophytes in the euphotic zone, and organic enrichment of the benthic systems (i.e., BOD matter) (Strain and Hargrave 2005 *in* Taranger et al. 2015; Hamoutene et al. 2015a; Verhoeven et al. 2016; Salvo et al. 2017). The area of influence and degree of enrichment of the environment depends on a number of factors including the biomass of fish in the sea cages, the ambient environmental conditions (e.g., hydrodynamics, water depth, wave exposure, topography and substrate type) and the husbandry practices at the sea farm (Holmer et al. 2005 *in* Taranger et al. 2015). At deep aquaculture sites, fish farming "effluents" can be traced into the wider environment and in benthic food webs up to 1 km from the sea cages (Olsen et al. 2012 *in* Taranger et al. 2015). At low deposition levels, organic enrichment of benthic sediments stimulates secondary production in soft bottom communities, resulting in shifts in benthic faunal community structure (Bannister et al. 2014 *in* Taranger et al. 2015). Excessive loading of organic effluents to sediments may lead to dramatic changes in biogeochemical processes leading to grossly anoxic conditions (Valdemarsen et al. 2012 *in* Taranger et al. 2015). The emissions of dissolved nutrients from salmon farms are typically quickly diluted in the water column at dynamic sites and elevated nutrient levels are hardly detected at distances beyond 200 m from the sea cages (Sanderson et al. 2008 *in* Taranger et al. 2015).

Video surveys are routinely conducted to assess effects on the benthic habitat at salmon farms (Hamoutene et al. 2013, 2014). These types of surveys are cost-effective, relatively easy to conduct, and result in the generation of permanent records of environmental conditions at the time of the survey (DFO 2014b). Visual indicators of organic enrichment (IOE) of benthic communities include the presence and offgassing of flocculent matter (dark layer of decomposing fish feces and pellets which covers the seabed), the formation of white *Beggiatoa* (bacterium) mats that indicate hypoxic/anoxic conditions and the production of sulphur, the occurrence of opportunistic polychaete complexes (OPC), and/or the occurrence of barren sites (i.e., no presence of organisms) (Hamoutene et al. 2016; Salvo et al. 2017). The presence of these indicators, in particular the *Beggiatoa* mats and OPC, typically decreases with distance from sea cages. They do not occur at reference sites without impact from aquaculture organic inputs, thereby making them ideal indicators for assessing effects (DFO 2014b; Hamoutene et al. 2014, 2016). It is important to consider all of these visual indicators when assessing for impacts of aquaculture since *Beggiatoa* mats and OPC may be absent from sites due to water depth or seasonal hypoxic conditions (Hamoutene et al. 2014, 2016). Furthermore, it is important to select sea cage sites where water masses are well oxygenated in order to minimize effects of deposition from the sea cages on the surrounding environment and to facilitate recovery of the benthic habitat after production in the sea cages has ended. Hamoutene et al. (2016) found that the presence of visual indicators near fish farms were influenced primarily by distance from the sea cage, and secondarily by substrate type, median current velocity, biomass of farmed fish, and water depth.

While *Beggiatoa* and OPC are commonly used as indicators of environmental impact in regulatory assessment (Hamoutene et al. 2014), there are also other bacteria that are present in flocculent matter and bacterial mats located on deep water bedrock farm sites. For example, Verhoeven et al. (2016) assessed bacterial communities from flocculent matter and bacterial mats obtained beneath salmon farms in southern Newfoundland that had been fallowed for three months. Flocculent matter samples had significantly higher average bacterial diversity than bacterial mats. The flocculent matter was mainly comprised of the four bacterial taxa groups *Bacteroidia, Spirochaetes, Clostridia,* and *Cytophagia,* whereas bacterial mats were mainly comprised of *Odoribacter, Spirochaeta, Prevotella,* and *Meniscus*.

The low oxygen availability in areas impacted by organic inputs from sea cages alters the native infaunal and epifaunal communities beneath and adjacent to sea cages. For example, in July - August 2010, Hamoutene et al. (2015a) used video monitoring to assess the impact of salmon farms on epibenthic communities on the south coast of Newfoundland (Fortune Bay, Bay D'Espoir, and Connaigre Bay). They recorded abundance and taxa richness for three production sites, one fallowed site, and one control site, and related this information to water depth, substrate type, distance to cage, and aquaculture production state (i.e., production, fallow, or control). They found that all sites had comparable depth profiles, benthic compositions, substrate types, and low velocity currents (median current speeds of 2–5 cm/s). Hamoutene et al. (2015a) determined that the total abundance of individuals and taxa richness increased with depth, and that total abundances and taxa richness differed significantly between substrate types. Bedrock tended to be characterized by greater abundances and taxa richness than flocculent matter substrates. Depth and substrate type were found to be two of the most influential factors on epibenthic communities. Total abundances and taxa richness also differed significantly by distance to sea cages. Occurrence of *Beggiatoa* sp. mats decreased with increasing distance from sea cages, although some were observed as far as 145 m from cages. In terms of production state, total abundances were found to be significantly lower at the fallow site compared with the control site and production sites, and taxa richness was highest at the control site, followed by the production sites and the fallow site. Overall, Hamoutene et al. (2015a) observed low diversity of taxa richness and low total abundances of benthic individuals at all sites on the south coast of Newfoundland. Tube worms, soft corals, sponges, anemones, sea stars, urchins, coralline algae, *Beggiatoa* sp., and OPC were observed throughout the sampled areas, including the control site. Seven different assemblages that included some of the species mentioned above were noted at the different sites.

In a similar study, Salvo et al. (2017) monitored epibenthic communities located at salmon farms in Fortune Bay and Hermitage Bay on the south coast of Newfoundland. They conducted drop camera surveys to characterize epibenthic communities at production sites, fallowed sites and control sites (i.e., sites without a history of aquaculture production). They found that while flocculent matter was exclusive to both production and fallowed sites, no megafauna was observed in these areas. The authors noted changes to benthic community assemblages at aquaculture production sites less than a month after sea cages were stocked with salmon. Indicators of organic enrichment were found as far as 160 m from sea cages at production and fallowed sites, although most were observed within 100 m of the sea cages. Analyses concluded that the primary factors affecting epibenthic community assemblages and taxa richness were distance from sea cages, production state (active production, fallow, control), and cage location. Other factors that appeared to affect the benthos included substrate type and water depth. Organisms including coralline algae, crinoids, serpulids, and sponges were observed more often at areas farther from the sea cage sites. Salvo et al. (2017) found that after sites had been fallow for 15 months, the benthic communities at these sites had not returned to a state resembling that of control sites, suggesting slow recovery of benthic communities after production cycles. Time for recovery will depend on a number of factors (e.g., currents at the sea cages, total amount of deposition).

Brager et al. (2016) examined levels of suspended particulate matter from fish waste (feces and feed pellets) at Atlantic salmon fish farms in Canada (Nova Scotia) and Norway. They found that fish farming operations had an insignificant effect on suspended particulate waste matter in the water column near the sea cages.

In 2016, Grieg NL contracted a modelling exercise to determine depositional contours of carbon at each of the sea cage sites based on known information regarding bathymetry and currents at each site, as well as anticipated feeding rates of farmed salmon. Overall, the majority of the depositional contours predicted by the modelling did not exceed 1 g $C/m^2$/day with minimal exceptions at the shallower sea cage sites (Amec 2016). As per DFO AAR permitting requirements, the modelling predicted the contours

of the depositional footprints for 1, 5 and 10 grams of carbon per square metre per day. The modelling indicated that the areal extents of the deposition footprints at the sea cage sites ranged from 0.09–0.32 $km^2$. In terms of percentages of the areal extents of the sea cage sites, this represents a range of 6.1% (Gallows Harbour) to 19.3% (Red Island).

Section 4.1.2 *in* LGL (2018b) provides more details regarding the benthic habitat associated with the proposed Grieg NL sea cage sites. Predominant fauna observed during the drop camera surveys included various echinoderms (e.g., sea stars, brittle stars,), sea anemones, crabs, and unidentified small fish. These animals are typical of hard bottom substrates in Placentia Bay.

The principal mitigation measures for the effect of deposition from the sea cages on the FFH include:

- Cessation of feeding once the farmed fish have reached ~80% satiation, based on video monitoring of fish behaviour;
- Siting of sea cages in locations with appropriate ambient environmental conditions (e.g., sufficient current velocity and direction, sufficient water depth, and >50% hard substrate), as per the requirements of the AAR and DFLR's Aquaculture Licence Application process;
- Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling;
- Fallowing of sea cage sites at the end of each production cycle for 16–19 months; and
- Daily removal of fish mortalities from the sea cages.

Grieg NL's Waste Management Plan (Appendix J) and Section 2.5.2.2 of the EIS provide more details regarding the mitigation measures.

After implementation of the mitigation measures, deposition from the sea cages is predicted to have residual *negative* effects on the FFH VEC at each sea cage site that are *minor* in magnitude over a geographic area of *<1 $km^2$* for a duration of *13–36 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of deposition from the sea cages on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *medium*.

### 7.1.2.4 Maintenance of Farmed Salmon Health

There are three aspects to maintenance of farmed salmon health that are relevant to its interaction with the FFH VEC: (1) use of cleaner fish; (2) use of therapeutants; and (3) use of antibiotics. All of these aspects have potential to affect the FFH VEC.

***Cleaner Fish***

The primary method of controlling sea lice in the sea cages will be the use of cleaner fish, specifically lumpfish. The use of lumpfish will produce additional organic matter (i.e., fish feces) in the sea cages. Potential effects include the deposition of additional organic matter on the benthic substrate (i.e., fish feces), and transfer of disease and parasites to wild lumpfish. See Section 7.1.2.3, Deposition from the Sea Cages, for more details regarding the deposition of organic material and its potential effects on the FFH.

The key mitigation measures for the effect of the addition of lumpfish feces to the depositional material falling from the sea cages include:

- Siting of sea cages in locations with appropriate ambient environmental conditions (e.g., sufficient current velocity and direction, sufficient water depth, and >50% hard substrate), as per the requirements of the AAR and DFLR's Aquaculture Licence Application process; and
- Fallowing of the sea cage sites after each production cycle.

With respect to lumpfish potentially being disease and parasite vectors, the key mitigation measures for the effect of disease and parasite transfer to wild fish include:

- Vaccination of lumpfish;
- Ongoing monitoring of health of lumpfish in the sea cages;
- Implementation of biosecurity measures;
- No reuse of lumpfish between sea cages (i.e., lumpfish will be harvested at the same time as salmon);
- Routine husbandry practices;
- Implementation of Fish Health Management Plan (Appendix K).

Grieg NL's Fish Health Management Plan (Appendix J) and Section 2.5.2.2 of the EIS provide more details regarding the mitigation measures.

After implementation of mitigation measures, the presence of cleaner fish (i.e., lumpfish) in the sea cages is predicted to have residual *negative* effects on the FFH VEC that are *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *13–36 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of presence of cleaner fish in the sea cages on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *medium* to *high*.

***Fish Mortalities***

Dead fish, including farmed salmon and cleaner fish, typically accumulate at the bottom of the sea cages. Moribund fish can occur at the water's surface. Fish mortalities could potentially attract wild biota (DFO 2017a). If sharks or tunas are attracted to the sea cages, these species could cause net damage potentially resulting in escapes of farmed salmon and lumpfish. As such, effects on the FFH VEC could include increased ecological competition with wild fishes, and perhaps transmission of diseases and parasites to wild fishes. Fish in the sea cages will be monitored with video cameras. Grieg NL is planning to use a centralized system for removing fish mortalities called Mortex which will remove dead fish from the sea cages daily. Dead fish will be pumped from the bottom of the sea cages through a pipe system to an ensilage tank on the feed barge.

The key mitigation measures for the effect of fish mortality in the sea cages on the FFH VEC include:

- Use of a centralized system called Mortex to remove dead fish on a daily basis from the sea cages to an ensilage tank on a feed barge;
- Removal of any visible moribund fish at surface by Grieg NL personnel and transfer to an ensilage tank on a feed barge; and
- Video monitoring of sea cages, both at surface and under water, to detect fish mortalities and ensure dead fish are removed promptly.

Section 2.5.2.2 of the EIS provides more details regarding the mitigation measures.

Fish mortalities will occur in the sea cages during the entire production cycle which can last as long as 18 months.

After implementation of mitigation measures, fish mortalities in the sea cages is predicted to have residual *negative* effects on the FFH VEC that are *minor* in magnitude over a geographic area of *<1 km²* for a duration of *13–36 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of fish mortalities in the sea cages on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *medium* to *high*.

***Use of Therapeutants***

The use of therapeutants to control sea lice would be the last option if all other approaches (i.e., cleaner fish, subsea feeding, sea lice skirts, and Thermolicer) fail (see Section 2.5.2.2). Grieg NL will also consider harvesting the fish before using therapeutants. If necessary, based on advice from the provincial veterinarian (and Grieg NL's private veterinarian), the therapeutant SLICE would be administered in the feed. The active ingredient in SLICE is avermectin emamectin benzoate (EMB) (Burridge et al. 2010). The potential impact of using SLICE relates to excess SLICE not consumed by the target fish and how it might affect wild invertebrates and fishes. Emamectin benzoate has very low solubility in water so excess SLICE will most likely remain bound to the feed and be deposited to the seabed. Therefore excess SLICE would be most available to benthic organisms, including crustaceans.

Waddy et al. (2002) reported that ingestion of SLICE may have induced premature molting of American lobsters. They also indicated that other factors such as water temperature, molt status and reproductive status likely contributed to the premature molting. Waddy et al. (2007) concluded that the premature molting response may be limited to a small number of individuals and that widespread population effects are unlikely.

Black et al. (2005) reported that a five-year study found no far-field effects of a range of sea lice treatments in Scottish lochs on zooplankton, phytoplankton, sub-littoral settlement, intertidal communities or sediment macro- or meiofauna. Although they acknowledged that there could be some near-field effects, they were unable to separate them from the effect of organic enrichment.

Tett et al. (2018) completed a review of the environmental impacts of salmon farming in Scotland which included an examination of the literature related to the effects of discharge of medicines and chemicals used in salmon farming. They indicated that studies on the longer-term impacts of anti-lice compounds such as SLICE on fish and fish habitat are limited. Samuelsen et al. (2015 *in* Tett et al. 2018) reported a half-life of 170 days for EMB in sediments. They also indicated that EMB residues in biota (i.e., range of invertebrates and fishes) were undetectable after eight months, exceptions being some polychaetes and crustaceans which still had minimal detectable levels.

The principal mitigation measures for the effects of the use of therapeutants on the FFH VEC include:

- Reliance on the advice of the provincial veterinarian in relation to whether or not therapeutant use is necessary, and if so, what minimum dose is required; and
- Use of therapeutants with low water solubility (i.e. SLICE).; and
- Monitoring feed consumption by salmon and subsequent cessation of feeding at ~80% satiation.

Grieg NL's Fish Health Management Plan (Appendix K) provides information on procedures to maintain healthy fish in the sea cages. More details regarding the mitigation measures, including a description of Grieg NL's approach for treating sea lice, are provided in Section 2.5.2.2 of the EIS.

Given the predicted small footprint of deposited organics from the sea cages, including feed with SLICE, and after implementation of mitigation measures, the use of therapeutants is predicted to have residual *negative* effects on the FFH VEC that are *minor* in magnitude over a geographic area of *<1 km²* for a duration of *<1 month* to *1–12 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of the use of therapeutants on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *medium.*

***Use of Antibiotics***

Grieg NL will aim to avoid the use of antibiotics. There are some potential pathogens that may require treatment and each case will be assessed in consultation with Grieg NL's private veterinarian and the provincial veterinarian. Any antibiotic use will be with approved products, judicious use and under prescription. An example would be ERM disease that is caused by a bacterium that has a wide host range and a broad geographical distribution but can be treated before it becomes a chronic issue. Grieg NL will only utilize antibiotics as a last resort based on recommendations of health authorities such as the private and provincial veterinarians in consideration of the health and welfare of the fish.

All antibiotics would be administered in the feed so any unconsumed feed with it would be deposited to the seabed. The potential impact of using antibiotics relates to the consumption of it (via consumption of feed) by wild invertebrates and fishes that opportunistically feed in the organics depositional field below and in the vicinity of the sea cages. The three antibiotics that would most likely be used include Oxytetracycline, Florfenicol and Trimethoprim Sulfa. All three have very low water solubility so would stay bound to any excess feed that deposits to the sea bed.

The key mitigation measures for the effect of the use of antibiotics on the FFH VEC include:

- Reliance on the advice of the provincial veterinarian in relation to whether or not antibiotic use is necessary, and if needed, what minimum dose is required;
- Use of antibiotics with low water solubility; and
- Monitoring of fish feeding behaviour via underwater video camera(s) to minimize excess feed deposition to the seabed.

Grieg NL's Health Management Plan (Appendix K) provides information on procedures to maintain healthy fish in the sea cages. Additional details regarding mitigation measures are provided in Section 2.5.2.2 of the EIS.

After implementation of mitigation measures, the use of antibiotics is predicted to have residual *negative* effects on the FFH VEC that are *minor* in magnitude over a geographic area of *<1 km²* for a duration of *<1 month* to *1–12 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of the use of antibiotics on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *medium.*

### 7.1.2.5 Maintenance of Sea Cages

***Cleaning of the Net***

Biofouling of sea cages and fish farm equipment can lead to reduced water exchange in sea cages, increased risk of disease to farmed and wild fishes, and the deformation and damaging of sea cage nets and equipment (Fitridge et al. 2012). Biofouling is the result of the spores and propagules of marine algae and larvae of marine invertebrates (e.g., barnacles, bivalves, polychaetes, sponges, hydroids, bryozoans, and ascidians) attaching to and colonizing nets and equipment (Fitridge et al. 2012). Biofouling of sea cages and equipment can be mitigated by routine changing/cleaning of sea cages and equipment. This can be conducted *in situ* using either ROVs modified to clean nets or SCUBA divers that clean the netting manually. Sea cage collars and other equipment can be cleaned with high pressure water. Chemical antifoulants, such as copper, are toxic to many marine invertebrates and fish (Fitridge et al. 2012). The use of herbivorous fish to clean cages is another option but this method has not been successfully implemented in large scale commercial fish farming operations (Fitridge et al. 2012).

Marine fouling of sea cages will vary depending on a number of factors including season, water temperature and biotic processes such as shellfish settling. Grieg NL does not intend to use nets coated in anti-fouling material which can leach toxins into the environment. Grieg NL maintains that daily sea cage inspections and a systematic cleaning routine with specialized equipment can control biofouling. The cleaning schedule for cages and nets will be developed based on environmental conditions in Placentia Bay as well as routine monitoring. Nets will typically be cleaned weekly and cages will be cleaned once or twice during heavy fouling periods. Cages and nets will also be cleaned after harvesting is completed and prior to cages being transferred to other BMAs. Routine checks of equipment utilizing underwater cameras, ROVs, and inspections by divers (as needed) will be used to confirm the cleaning schedule of the sea cages. Grieg NL will ensure equipment has minimal fouling.

The primary effect of net cleaning will be the additional deposition of organic material from the sea cages to the water column and the sea bed below and in the vicinity of the cages. See Section 7.1.2.3, Deposition from the Sea Cages, for more details regarding the deposition of organic material.

The key mitigation measures that will minimize the effect of further accumulation of organic material on the seabed include:

- Siting of sea cages in locations with appropriate ambient environmental conditions (e.g., sufficient current velocity and direction, sufficient water depth, and >50% hard substrate), as per the requirements of the AAR and DFLR's Aquaculture Licence Application process;
- Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling; and
- Fallowing of sea cage sites at the end of each production cycle for 16–19 months.

Additional details regarding mitigation measures are provided in Section 2.5.2.2 of the EIS.

After implementation of mitigation measures, the cleaning of sea cage nets is predicted to have residual *negative* effects on the FFH VEC that are *negligible* to *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *13–36 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of the cleaning of sea cage nets on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *medium* to *high*.

### 7.1.2.6 Sea Cage Sites

***Presence of Sea Cages***

As indicated above, biofoulants will settle and accumulate on the infrastructure of the sea cages. Cleaning of the sea cages will result in the impact of deposition of organic material to the seabed below and in the vicinity of the sea cages, thus affecting that component of the FFH VEC. This deposition of biofoulants to the seabed could be considered loss of habitat for wild fishes and invertebrates, especially when considered in combination with other sources of organic deposition. See Section 7.1.2.3, Deposition from the Sea Cages, for more details regarding the deposition of organic material.

The principal mitigations that will minimize the effect of further accumulation of organic material on the seabed include:

- Siting of sea cages in locations with appropriate ambient environmental conditions (e.g., sufficient current velocity and direction, sufficient water depth, and >50% hard substrate), as per the requirements of the AAR and DFLR's Aquaculture Licence Application process;
- Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling; and
- Fallowing of sea cage sites at the end of each production cycle for 16–19 months.

More details regarding the mitigations are provided in Section 2.5 of the EIS.

After implementation of mitigation measures, the presence of the sea cages at each sea cage site is predicted to have residual *negative* effects on the FFH VEC that are *minor* in magnitude over a geographic area of *<1 km$^2$* to *1–12 km$^2$* for a duration of *13–36 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of the presence of sea cages on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *medium* to *high*.

***Lights on Sea Cages***

The primary impact of lights on the sea cages will be the attraction of plankton, pelagic invertebrates and pelagic fishes to the upper water column during nighttime periods (Becker et al. 2013). The effects of light attraction on the FFH VEC are considered neutral. Plankton and pelagic invertebrates typically ascend to the upper water column during the night regardless of the presence of light. Pelagic fishes attracted by the lights will likely have a more concentrated food source in the upper water column as a result of the movement of plankton and pelagic invertebrates towards the surface.

The key mitigation measure that will minimize the attraction to sea cage lighting is to limit the amount of lighting on the sea cages and mooring system to the extent that is safe to do so.

The lighting on the sea cage systems is predicted to have residual *neutral* effects on the FFH VEC that are *negligible* to *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *13–36 months* (see Table 7.2). Based on these criteria ratings, the *reversible* and *neutral* residual effects of the presence of lighting on the sea cage systems on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *high*.

### 7.1.2.7 Use of Vessels

***Lights on Vessels***

The primary effect of lights on Project vessels will be the attraction of plankton, pelagic invertebrates and pelagic fishes to the upper water column during nighttime periods. The effects on the FFH VEC can be considered neutral. Many plankton and pelagic invertebrates typically ascend to the upper water column during the night in the absence of artificial light. Pelagic fishes attracted by the lights will likely have a more concentrated food source in the upper water column as a result of the movement of plankton and pelagic invertebrates towards the surface.

The key mitigation measure that will minimize the attraction to vessel lighting is to limit the amount of lighting on the vessels to the extent that is safe to do so.

The lighting on the vessels is predicted to have residual *neutral* effects on the FFH VEC that are *negligible* to *minor* in magnitude over a geographic area of *<1 km*$^2$ for a duration of *13–36 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *neutral* effects of the presence of lighting on project vessels on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *high*.

### 7.1.2.8 Production of Waste Materials

As indicated in Table 2.19, wastes that will be generated at the sea cage sites include:

- Sanitary waste and wastewater;
- Fish waste;
- Fish mortalities;
- Uneaten fish feed;
- Petroleum products;
- Paints;
- Operational debris; and
- Cleaning products.

The deposition of organic material (i.e., fish feed, fish feces, rotting mortalities) have already been discussed above (see Section 7.1.2.3) in terms of potential effects and mitigation measures to minimize their effects.

Release of the other wastes types listed above to the marine environment could potentially have negative effects on the FFH VEC; however, these releases would be accidental. The principal mitigation measures for the potential effects of these wastes on the FFH include:

- Vessels will have internal tanks for freshwater, grey water, and sewer/waste waters;
- Vessels will carry portable waste tanks interchangeable with the barge systems;
- Management practices in place to reduce the amount, frequency and risk associated with the use of petroleum products;
- Reuse of petroleum products when possible (e.g., waste oil can be collected and burned);
- Choice of environmentally friendly petroleum products when possible (e.g., food grade grease/oil);

- Minimization of use paint products by ensuring that most painting is done either prior to deployment or during the time of site fallowing;
- Reduction of the amount of operational debris waste generated (e.g., buy feed and products in bulk, buy products with less packaging, etc.);
- Recycling when possible (e.g. cardboard, feed bags, aluminum cans, plastic bottles, e-waste, etc. and bring to shore on service vessel);
- Transference of on site waste to land for disposal in accordance with BPWMC;
- Implementation of management practices to reduce the amount and frequency of cleaning products; and
- Use of cleaning products that can enter the vessels' grey water tanks and are easily broken down.

Grieg NL's Waste Management Plan (Appendix J) and Section 2.5.2.2 of the EIS provide additional details regarding the mitigation measures.

After implementation of mitigations measures, the production of waste materials is predicted to have residual *negative* effects on the FFH VEC that are *minor* in magnitude over a geographic area of *<1 km²* for a duration of *13–36 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of the production of waste materials on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *medium* to *high*.

### 7.1.3 Decommissioning and Rehabilitation

The primary impact of sea cage system removal during decommissioning will be disturbance to the seabed when the anchors are retrieved. There will be temporary seabed disturbance but the removal of the anchors will essentially allow rehabilitation of the seabed areas covered by the anchors.

The sea cage system removal, specifically anchor removal, is predicted to have residual *negative* effects on the FFH VEC that are *negligible* to *minor* in magnitude over a geographic area of *<1 km²* for a duration of *<1 month* to *1–12 months* (see Table 7.2). Based on these criteria ratings, the *reversible* residual *negative* effects of sea cage system removal on the FFH VEC are predicted to be *not significant* (see Table 7.3). The level of confidence associated with this prediction is *high*.

## 7.2 Wild Salmon VEC

The potential interactions between planned activities associated with the sea farm component of the Project and the Wild Salmon (WS) VEC were examined and the interactions determined most likely to occur are presented in Table 7.4. Only identified interactions are carried forward to the assessment criteria table (Table 7.5) and the significance table (Table 7.6).

The Project activities associated with its sea farm component that will interact with the WS VEC include:

- *Feeding of the farmed salmon* during 'operations and maintenance'
- *Presence of farmed salmon* during 'operations and maintenance'
- *Maintenance of farmed salmon health* during 'operations and maintenance'
    - *Use of cleaner fish* (lumpfish)
    - *Fish mortalities*
    - *Use of therapeutants*
    - *Use of antibiotics*

- *Sea cage sites* during 'operations and maintenance'
  - *Lights on sea cages*
- *Use of vessels* during 'operations and maintenance'
  - *Lights on vessels*
- *Production of waste materials* during 'operations and maintenance'

Each of these interactions is discussed and assessed in the following subsections.

**Table 7.4. Potential interactions of planned sea farm Project activities and the Wild Salmon VEC.**

| Project Activity | Valued Environmental Component: Wild Salmon | |
|---|---|---|
| | Immature (i.e., smolt) | Mature |
| **CONSTRUCTION** | | |
| **Towing Sea Cages** | | |
| **Sea Cage System Installation** | | |
| **Vessel Traffic** | | |
| **OPERATIONS & MAINTENANCE** | | |
| **Transfer Fish to Sea** | | |
| **Feeding Fish** | x | x |
| **Presence of Farmed Salmon** | x | x |
| **Deposition from Sea Cages** | | |
| **Fish Health Maintenance** | | |
| Use of Cleaner Fish | x | x |
| Fish Mortalities | x | x |
| Thermolicer[a] | | |
| Therapeutants[a] | x | x |
| Antibiotics[b] | x | x |
| **Sea Cage Maintenance** | | |
| Net Cleaning | | |
| Net Repair | | |
| **Sea Cage Sites** | | |
| Presence | | |
| Lights | x | x |
| **Use of Vessels**[c] | | |
| Presence | | |
| Lights | x | x |
| Noise | | |
| Atmospheric Emissions | | |
| **Transfer Fish from Sea** | | |
| **Production of Waste** | x | x |
| **DECOMMISSIONING & REHABILITATION** | | |
| **Towing Sea Cages** | | |
| **Sea Cage System Removal** | | |
| **Vessel Traffic** | | |

[a] The use of the Thermolicer and therapeutants are adaptive mitigation measures for sea lice and will only be used as a last resort based on guidance from private and provincial veterinarians.
[b] Antibiotics will only be used as a last resort and will be based on guidance from private and provincial veterinarians.
[c] All Project vessels including those associated with personnel transfer and resupply.

**Table 7.5. Assessment of effects of planned sea farm Project activities on the Wild Salmon VEC.**

| Valued Environmental Component: Wild Salmon | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Project Activity** | **Potential Positive (P) or Negative (N) Environmental Effect** | **Key Mitigation Measure(s)** | **Evaluation Criteria for Assessing Environmental Effects** | | | | | |
| | | | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| **OPERATIONS & MAINTENANCE** | | | | | | | | |
| **Feeding of Farmed Salmon** | Attraction of wild salmon to excess feed on the seabed, thereby making them more vulnerable to disease and/or parasite transfer from sea cage fish (N) | • Cessation of feeding at ~80% fish satiation;<br>• Suitable siting of sea cages;<br>• Vaccination of farmed salmon;<br>• Ongoing monitoring of health of fish in the sea cages;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices; and<br>• Fish Health Management Plan | 1 | 1 | 5 | 3 | R | 2 |
| **Presence of Farmed Salmon** | Attraction of wild salmon to the sea cages, thereby making them more vulnerable to disease and/or parasite transfer from sea cage fish (N) | • Vaccination of farmed salmon;<br>• Ongoing monitoring of health of fish in the sea cages;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices; and<br>• Fish Health Management Plan | 1 | 1 | 6 | 3 | R | 2 |
| **Fish Health Maintenance** | | | | | | | | |
| Use of Cleaner Fish | Control of sea lice that could negatively impact wild salmon (P) | | 2-3 | 1 | 6 | 3 | R | 2 |
| Fish Mortalities | Attraction of wild fishes to the sea cages, possibly including sharks and tunas which could potentially cause breaches in a sea cage net, leading to fish escapes (N) | • Video monitoring of sea cages for mortalities;<br>• Daily removal of fish mortalities from sea cage using Mortex system; and<br>• Removal of any visibly moribund fish at surface; | 1 | 1 | 5 | 3 | R | 2 |
| Therapeutants[a] | Availability to wild salmon (N) | • Advice of the provincial veterinarian regarding necessity of use and dosage if required;<br>• Use of low water-soluble therapeutant so that any excess remains in the sediment; and<br>• Monitoring of feed consumption by salmon and subsequent cessation of feed provision at ~80% satiation. | 1 | 1 | 1 | 1-2 | R | 2 |
| Antibiotics[b] | Availability to wild salmon (N) | • Advice of the provincial veterinarian regarding necessity of use and dosage if required;<br>• Use of low water-soluble therapeutant so that any | 1 | 1 | 1 | 1-2 | R | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | excess remains in the sediment; and<br>• Monitoring of feed consumption by salmon and subsequent cessation of feed provision at ~80% satiation. | | | | | | |
| **Sea Cage Sites** | | | | | | | | |
| Lights | Attraction of wild salmon to the sea cages, thereby making them more vulnerable to disease and/or parasite transfer from sea cage fish (N) | • Minimize the amount of lighting on sea cages;<br>• Ongoing monitoring of health of fish in the sea cages;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices; and<br>• Fish Health Management Plan | 0-1 | 1 | 5 | 3 | R | 2 |
| **Use of Vessels**[c] | | | | | | | | |
| Lights | Attraction of wild salmon to the sea cages, thereby making them more vulnerable to disease and/or parasite transfer from sea cage fish (N) | • Minimize the amount of lighting on vessels;<br>• Ongoing monitoring of health of lumpfish in the sea cages;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices; and<br>• Fish Health Management Plan. | 0-1 | 1 | 5 | 3 | R | 2 |
| **Production of Waste** | Accumulation of organic material on the seabed below and in the vicinity of the sea cages;(N);<br><br>Contamination of wild salmon (N) | • Siting of sea cages in locations with sufficient water currents to disperse organic material (i.e., feed, fish feces, biofoulants) falling from the sea cages;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling; and<br>• Fallowing of sea cage sites at the end of each production cycle for 16-19 months:<br>• Vessels will have internal tanks for freshwater, grey water, and sewer/waste waters;<br>• Vessels will carry portable waste tanks interchangeable with the barge systems;<br>• Management practices in place to reduce the amount, frequency and risk associated with the use of petroleum products;<br>• Reuse of petroleum products when possible (e.g. waste oil can be collected and burned);<br>• Choice of environmentally friendly petroleum products when possible (e.g. food grade grease/oil);<br>• Transference of on site waste to land for disposal in accordance with BPWMC;<br>• Implementation of management practices to reduce the amount and frequency of cleaning products; and<br>• Use of cleaning products that can enter the vessels' grey water tanks and are easily broken down. | 1 | 1 | 6 | 3 | R | 2 |

Key:

| Magnitude: | Frequency: | Reversibility: | Duration: |
|---|---|---|---|
| 0 = Negligible | 1 = < 11 events/yr | R = Reversible | 1 = < 1 month |
| 1 = Minor | 2 = 11-50 events/yr | I = Irreversible | 2 = 1-12 months |
| 2 = Moderate | 3 = 51-100 events/yr | (refers to population) | 3 = 13-36 months |
| 3 = Major | 4 = 101-200 events/yr | | 4 = 37-72 months |
| | 5 = > 200 events/yr | | 5 = > 72 months |
| | 6 = Continuous | | |

| Geographic Extent: | Ecological/Socio-cultural and Economic Context: |
|---|---|
| 1 = < 1-$km^2$ | 1 = Relatively pristine area or area not affected by human activity |
| 2 = 1-10-$km^2$ | 2 = Evidence of existing effects |
| 3 = 11-100-$km^2$ | |
| 4 = 101-1,000-$km^2$ | |
| 5 = 1,001-10,000-$km^2$ | |
| 6 = > 10,000-$km^2$ | |

[a] The use of the Thermolicer and therapeutants are adaptive mitigation measures for sea lice and will only be used as a last resort based on guidance from private and provincial veterinarians.
[b] Antibiotics will only be used as a last resort and will be based on guidance from private and provincial veterinarians.
[c] All Project vessels including those associated with personnel transfer and resupply.

**Table 7.6. Significance of potential residual environmental effects of planned sea farm Project activities on the Wild Salmon VEC.**

| Valued Environmental Component: Wild Salmon | | | | |
|---|---|---|---|---|
| **Project Activity** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[a]** | |
| | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **OPERATIONS & MAINTENANCE** | | | | |
| **Feeding Fish** | NS | 2 | | |
| **Presence of Farmed Salmon** | NS | 2 | | |
| **Fish Health Maintenance** | | | | |
| Use of Cleaner Fish | P | 3 | | |
| Fish Mortalities | NS | 2-3 | | |
| Therapeutants[b] | NS | 2 | | |
| Antibiotics[c] | NS | 2 | | |
| **Sea Cage Sites** | | | | |
| Lights | NS | 2 | | |
| **Use of Vessels[d]** | | | | |
| Lights | NS | 2 | | |
| **Production of Waste** | NS | 2-3 | | |

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 $km^2$.

Residual environmental Effect Rating:
S = Significant Negative Environmental Effect
NS = Not-significant Negative Environmental Effect
P = Positive Environmental Effect

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Level of Confidence: based on professional judgment:
1 = Low
2 = Medium
3 = High

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low
2 = Medium
3 = High

[a] Considered only in the case where 'significant negative effect' is predicted.
[b] The use of therapeutants are adaptive mitigation measures for sea lice and will only be used as a last resort based on guidance from private and provincial veterinarians.
[c] The use of antibiotics are adaptive mitigation measures for disease and will only be used as a last resort based on guidance from private and provincial veterinarians.
[d] All Project vessels including those associated with personnel transfer and resupply.

While little is known regarding the locations of the migration corridors of immature smolt and mature adult salmon in Newfoundland nearshore waters (including Placentia Bay), the mouths of the majority of the scheduled and non-scheduled salmon rivers in Placentia Bay are more than 20 km from any of the proposed sea cage sites (Section 4.4 *in* LGL 2018a). This spatial separation between river mouths and sea cage sites could lower the probability of wild salmon migrating close to the sea cages. During migrations between the rivers and the ocean, salmon typically swim in the upper 10 m of the water column, sometimes as close as 2–3 m from the surface (Renkawitz et al. 2012; Thorstad et al. 2012; Godfrey et al. 2015). Specific Atlantic salmon migratory corridors in Placentia Bay have not yet been identified, however, a study is by DFO is planned for Placentia Bay this year to investigate the corridors (B. Dempson, DFO Research Scientist, pers. comm., 12 April 2018).

## 7.2.1 Operations and Maintenance

### 7.2.1.1 Feeding of Farmed Salmon

The potential impact of daily feeding of farmed salmon on the WS VEC relates to the deposition of unconsumed feed from the sea cages to the seabed in the vicinity of the sea cages. The presence of salmon feed on the seabed could potentially attract wild salmon to the area. If wild salmon do tend to use the upper 10 m of the water column during movements in the marine environment, they could potentially be more prone to the transfer of disease and/or parasites from any infected fish in the sea cages, particularly sea lice that occur in the upper water column.

Two of the most common sea louse species that infect farmed and wild Atlantic salmon in Atlantic Canada are the parasitic copepods *Lepeophtheirus salmonis* and *Caligus elongatus*. Sea lice are problematic for fish farmers so controlling them is a high priority area of aquaculture research (Rittenhouse et al. 2016). In addition to the external damage that they cause to salmon, they are capable of facilitating the transfer of pathogens which can lead to disease and increased mortality in both farmed and wild salmon (Jensen et al. 2010; DFO 2014a; Verspoor et al. 2015). If not controlled, particularly during infestations, sea lice on farmed salmon can increase the abundance of sea lice in the vicinity of sea cages and the probability of sea lice infesting migrating wild salmon passing through the area (Jensen et al. 2010; DFO 2014a; Saksida et al. 2015). It is not necessary that farmed fish escape cages to spread sea lice and/or pathogens and disease to wild salmon (Verspoor et al. 2015). Based on current science information, the free-living stages of sea lice can disperse distances of tens of kilometres (DFO 2014a).

Although there is little information in the primary literature regarding the resistance of triploid Atlantic salmon to pathogens, anecdotal evidence from fish farmers indicates that triploid fish may be less resistant to pathogens and parasites, potentially resulting in increased disease transmission to wild salmon (DFO 2013; Benfey 2015). Cases of ISA were reported in Atlantic salmon in Newfoundland during 2012–2018, the most recent case occurring in February 2018 (CFIA 2017). ISA is a serious disease for salmon and is required to be reported to the CFIA immediately upon discovery.

Transmission of parasites and pathogens between farmed salmon and wild salmon is likely density-dependent. Generally, the higher the host fish densities, the greater the potential for the spread and persistence of parasites and pathogens to host fishes (Krkošek 2017).

The principal mitigations for the potential of attraction of wild salmon to sea cages due to the deposition of extra feed include:

- Cessation of feeding once the farmed fish have reached ~80% satiation, based on video monitoring of fish behavior; and
- Siting of sea cages in locations with appropriate ambient environmental conditions (e.g., sufficient current velocity and direction, sufficient water depth, and >50% hard substrate), as per the requirements of the AAR and DFLR's Aquaculture Licence Application process.

The principal mitigations for the potential of disease and/or parasite transfer to wild salmon attracted to the sea cages include:

- Vaccinations;
- Ongoing monitoring of health of fish in the sea cages;

- Implementation of biosecurity measures; and
- Routine husbandry practices.

Grieg NL's Fish Health Management Plan (Appendix K) and Section 2.5.2.2 of the EIS provide more details regarding mitigation measures associated with the health of fish in the sea cages.

Feeding of farmed salmon will continue for the duration of a production cycle which could be as long as 18 months.

After implementation of the mitigation measures, feeding of farmed salmon is predicted to have residual *negative* effects on the WS VEC at each sea cage site that are *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *13–36 months* (see Table 7.5). Based on these criteria ratings, the *reversible* residual *negative* effects of feeding of farmed salmon on the WS VEC are predicted to be *not significant* (see Table 7.6). The level of confidence associated with this prediction is *medium*

### 7.2.1.2 Presence of Farmed Salmon

The main potential effect of the presence of farmed salmon in the sea cages is the potential for disease/parasite transfer to wild salmon. A secondary potential effect of farmed salmon presence is the attraction of predators to the sea cage sites. A discussion related to the potential transfer of diseases and/or parasites to wild salmon is provided in Section 7.2.1.1.

The key mitigation measures for the potential of disease and/or parasite transfer to wild salmon include:

- Vaccination of farmed fish;
- Ongoing monitoring of health of fish in the sea cages;
- Implementation of biosecurity measures; and
- Routine husbandry practices.

Grieg NL's Fish Health Management Plan (Appendix K) and Section 2.5.2.2 of the EIS provide more details regarding mitigation measures associated with the health of fish in the sea cages.

The presence of farmed salmon could also attract predators (e.g., sharks, tuna, seals) which could result in breaches of sea cage nets. Small numbers of escapes from sea cages on the south coast of Newfoundland were reported in 2012 as a result of damage to the netting caused by sharks and tuna. In August 2015, an unknown number of salmon escaped sea cages in southern Newfoundland that had holes in the netting due to damage caused by predator strikes (DFO 2017a). During consultations for the Grieg NL EIS, fishers indicated that they have seen a marked increase in the number of sharks and tuna in Placentia Bay during the past four to five years (Grattan et al. 2018 *in* Volume 3). A Predator Control Plan, required as part of Grieg NL's aquaculture license application, will include methods to monitor, deter and exclude marine predators from the sea cages sites. The assessments of two accidental fish escape scenarios are provided in Section 7.7.1.

Farmed salmon will be present in the sea cages for the duration of a production cycle which could be as long as 18 months.

After implementation of the appropriate mitigations, presence of farmed salmon is predicted to have residual *negative* effects on the WS VEC that are *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *13–36 months* (see Table 7.5). Based on these criteria ratings, the *reversible* residual

*negative* effects of presence of farmed salmon on the WS VEC are predicted to be *not significant* (see Table 7.6). The level of confidence associated with this prediction is *medium*.

### 7.2.1.3 Maintenance of Farmed Salmon Health

There are four aspects to maintenance of farmed salmon health that are relevant to its interaction with the WS VEC: (1) use of cleaner fish; (2) fish mortalities in the sea cages (3) use of therapeutants; and (4) use of antibiotics. All of these aspects of fish maintenance have potential to affect the WS VEC.

***Cleaner Fish***

The primary method of controlling sea lice (*L. salmonis)* will be through the use of cleaner fish, more specifically North Atlantic lumpfish (*C. lumpus)*. Therefore, the use of cleaner fish results in a *positive* effect on the WS VEC.

Lumpfish naturally exhibit a "scan-and-pick" feeding behaviour and have been successfully used as cleaner fish in cold-water aquaculture projects. The use of cleaner fish in the salmon aquaculture industry, particularly in Norway, has seen a large increase since 2008 with almost 26 million cleaner fish used in 2015 in Norway alone and projections of up to 50 million required by 2020 (Powell et al. 2017).

Cleaner fish will be present in the sea cages for the duration of a production cycle which could be as long as 18 months.

The use of cleaner fish at a sea cage site is predicted to have *positive* effects on the WS VEC that are *moderate* to *major* in magnitude over a geographic area of *<1 km*$^2$ for a duration of *13–36 months* (see Table 7.4). The level of confidence associated with this prediction is *high* (see Table 7.5).

***Fish Mortalities***

Dead fish, including farmed salmon and cleaner fish, typically accumulate at the bottom of the sea cages. Moribund fish can occur at the water's surface. Fish mortalities could potentially attract wild biota (DFO 2017a). If sharks or tunas are attracted to the sea cages, these species could cause net damage potentially resulting in escapes of farmed salmon and lumpfish. The assessments of two fish escape scenarios and two mass mortality scenarios in Section 7.7.1 includes examination of the potential effects of accidents and malfunctions on the WS VEC.

The key mitigation measures for the effect of fish mortalities in the sea cages on the WS VEC include:

- Use of a centralized system called Mortex to remove dead fish on a daily basis from the sea cages to an ensilage tank on a feed barge;
- Removal of any visible moribund fish at surface by Grieg NL personnel and transfer to an ensilage tank on a feed barge;
- Video monitoring of sea cages, both at surface and under water, to detect fish mortalities and ensure dead fish are removed promptly.

Section 2.5.2.2 of the EIS provides more details regarding the mitigation measures.

Fish mortalities will occur in the sea cages during the entire production cycle which can last as long as 18 months.

After implementation of mitigation measures, expected levels of fish mortality in the sea cages are predicted to have residual *negative* effects on the WS VEC that are *minor* in magnitude over a geographic area of *<1 km²* for a duration of *13–36 months* (see Table 7.5). Based on these criteria ratings, the *reversible* residual *negative* effects of fish mortalities in the sea cages on the WS VEC are predicted to be *not significant* (see Table 7.6). The level of confidence associated with this prediction is *medium* to *high*.

***Use of Therapeutants***

The use of therapeutants to control sea lice would be the last option if all other approaches (i.e., cleaner fish, subsea feeding, sea lice skirts, and Thermolicer) fail (see Section 2.5.2.2). Grieg NL will also consider harvesting the fish before using therapeutants. If necessary, based on advice from the provincial veterinarian (and Grieg NL's private veterinarian), the therapeutant SLICE would be administered in the feed. The active ingredient in SLICE is avermectin emamectin benzoate (EMB) (Burridge et al. 2010). The potential impact of using SLICE relates to excess SLICE not consumed by the target fish and how it might affect wild salmon. Emamectin benzoate has very low solubility in water so excess SLICE will most likely remain bound to the feed and be deposited to the seabed. Therefore, excess SLICE would be most available to animals that feed on prey and food matter on the seabed. Tett et al. (2018) completed a review of the environmental impacts of salmon farming in Scotland which included an examination of the literature related to the effects of discharge of medicines and chemicals used in salmon farming. They indicated that studies on the longer-term impacts of anti-lice compounds such as SLICE on fish and fish habitat are limited. Samuelsen et al. (2015 *in* Tett et al. 2018) reported a half-life of 170 days for EMB in sediments. They also indicated that EMB residues in biota (i.e., range of invertebrates and fishes) were undetectable after eight months, exceptions being some polychaetes and crustaceans which still had minimal detectable levels.

While wild salmon could be attracted to the excess feed with SLICE, their suggested use of the upper 10 m of the water column during migration in the marine environment could decrease that possibility.

The principal mitigation measures for the effects of the use of therapeutants on the FFH VEC include:

- Reliance on the advice of the provincial veterinarian in relation to whether or not therapeutant use is necessary, and if so, what minimum dose is required; and
- Use of therapeutants with low water solubility (i.e. SLICE).; and
- Monitoring feed consumption by salmon and subsequent cessation of feeding at ~80% satiation.

Grieg NL's Fish Health Management Plan (Appendix K) provides information on procedures to maintain healthy fish in the sea cages. More details regarding the mitigation measures, including a description of Grieg NL's approach for treating sea lice, are provided in Section 2.5.2.2 of the EIS.

This assessment assumes that the therapeutants in the excess feed on the seabed remain available to wild salmon for a number of months.

After implementation of mitigation measures, the use of therapeutants is predicted to have residual *negative* effects on the WS VEC that are *minor* in magnitude over a geographic area of *<1 km²* for a duration of *<1 month* to *1–12 months* (see Table 7.5). Based on these criteria ratings, the *reversible* residual *negative* effects of the use of therapeutants on the WS VEC are predicted to be *not significant* (see Table 7.6). The level of confidence associated with this prediction is *medium.*

***Use of Antibiotics***

Grieg NL intends to avoid the use of antibiotics. There are some potential pathogens that may require treatment and each case will be assessed in consultation with Grieg NL's private veterinarian and the provincial veterinarian. Any antibiotic use will be with approved products, judicious use and under prescription. An example would be ERM disease that is caused by a bacterium that has a wide host range and a broad geographical distribution but can be treated before it becomes a chronic issue. Grieg NL will only utilize antibiotics as a last resort based on recommendations of health authorities such as the private and provincial veterinarians in consideration of the health and welfare of the fish.

All antibiotics would be administered in the feed so any unconsumed feed with it would be deposited to the seabed. The three antibiotics that would most likely be used include Oxytetracycline, Florfenicol and Trimethoprim Sulfa. All three have very low water solubility so would stay bound to any excess feed that deposits to the sea bed. The potential impact of using antibiotics relates to the consumption of it by wild salmon may be attracted to the excess feed on the seabed. While wild salmon could be attracted to the excess feed with antibiotics added, their suggested use of the upper 10 m of the water column during migration in the marine environment may decrease that possibility.

The key mitigation measures for the effect of the use of antibiotics on the WS VEC include:

- Reliance on the advice of the provincial veterinarian in relation to whether or not antibiotic use is necessary, and if needed, what minimum dose is required;
- Use of antibiotics with low water solubility; and
- Monitoring of fish feeding behaviour via underwater video camera(s) to minimize excess feed deposition to the seabed.

Grieg NL's Health Management Plan (Appendix K) provides information on procedures to maintain healthy fish in the sea cages. Additional details regarding mitigation measures are provided in Section 2.5.2.2 of the EIS.

This assessment assumes that the antibiotics in the excess feed on the seabed remain available to wild salmon for a number of months.

After implementation of mitigation measures, the use of antibiotics is predicted to have residual *negative* effects on the WS VEC that are *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *<1 month* to *1–12 months* (see Table 7.5). Based on these criteria ratings, the *reversible* residual *negative* effects of the use of antibiotics on the WS VEC are predicted to be *not significant* (see Table 7.6). The level of confidence associated with this prediction is *medium*.

### 7.2.1.4 Sea Cage Sites

***Lights on Sea Cages***

The primary potential impact of lights on the sea cages is attraction of wild salmon to the vicinities of the sea cages (Callier et al. 2017), thereby making them more vulnerable to the transfer of disease and/or parasites from sea cage salmon considering their proximity to the sea cages. See Section 7.2.1.1 for a discussion related to the effects of sea lice and disease transfer from sea cage salmon to wild salmon.

The key mitigation measures intended to minimize the potential effect of transfer of diseases and/or parasites to wild salmon due to their attraction to sea cage lighting include:

- Minimization of lighting on the sea cages
- Ongoing monitoring of health of fish in the sea cages;
- Implementation of biosecurity measures; and
- Routine husbandry practices.

Grieg NL's Fish Health Management Plan (Appendix K) and Section 2.5.2.2 of the EIS provide more details regarding mitigation measures associated with the health of fish in the sea cages.

After implementation of mitigation measures, the lighting on the sea cages is predicted to have residual *negative* effects on the WS VEC that are *negligible* to *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *13–36 months* (see Table 7.5). Based on these criteria ratings, the *reversible* residual *negative* effects of the presence of lighting on the sea cages on the WS VEC are predicted to be *not significant* (see Table 7.6). The level of confidence associated with this prediction is *medium*.

### 7.2.1.5 Use of Vessels

***Lights on Vessels***

The primary potential impact of lights on vessels at the sea cages sites is attraction of wild salmon to the vicinities of the sea cages (Callier et al. 2017), thereby making them more vulnerable to the transfer of disease and/or parasites from sea cage salmon considering their proximity to the sea cages. See Section 7.2.1.1 for a discussion related to the effects of sea lice and disease transfer from sea cage salmon to wild salmon.

The principal mitigations intended to minimize the potential effect of transfer of diseases and/or parasites to wild salmon due to their attraction to vessel lighting include:

- Minimization of lighting on vessels;
- Ongoing monitoring of health of fish in the sea cages;
- Implementation of biosecurity measures; and
- Routine husbandry practices.

Grieg NL's Fish Health Management Plan (Appendix K) and Section 2.5.2.2 of the EIS provide more details regarding mitigation measures associated with the health of fish in the sea cages.

After implementation of mitigation measures, the lighting on vessels at the sea cage sites is predicted to have residual *negative* effects on the WS VEC that are *negligible* to *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *13–36 months* (see Table 7.5). Based on these criteria ratings, the *reversible* residual *negative* effects of the presence of lighting on vessels at the sea cage sites on the WS VEC are predicted to be *not significant* (see Table 7.6). The level of confidence associated with this prediction is *medium*.

### 7.2.1.6 Production of Waste Materials

Wastes that will be generated at the sea cage sites include:

- Sanitary waste and wastewater;
- Fish waste;
- Fish mortalities;
- Uneaten fish feed;
- Petroleum products;
- Paints;
- Operational debris; and
- Cleaning products.

The potential effects of the production of organic waste material (i.e., attraction of wild salmon to the sea cages, thereby making them more vulnerable to disease and/or parasite transfer from farmed salmon) have been discussed above (e.g., Section 7.2.1.1).

Release of the other wastes types listed above to the marine environment could potentially have negative effects on the WS VEC; however, these releases would be accidental. The principal mitigation measures for the potential effects of the production of these wastes on the WS VEC include:

- Vessels will have internal tanks for freshwater, grey water, and sewer/waste waters;
- Vessels will carry portable waste tanks interchangeable with the barge systems;
- Management practices in place to reduce the amount, frequency and risk associated with the use of petroleum products;
- Reuse of petroleum products when possible (e.g. waste oil can be collected and burned);
- Choice of environmentally friendly petroleum products when possible (e.g., food grade grease/oil);
- Minimization of use paint products by ensuring that most painting is done either prior to deployment or during the time of site fallowing;
- Reduction of the amount of operational debris waste generated (e.g., buy feed and products in bulk, buy products with less packaging, etc.);
- Recycling when possible (e.g. cardboard, feed bags, aluminum cans, plastic bottles, e-waste, etc. and bring to shore on service vessel);
- Transference of on site waste to land for disposal in accordance with BPWMC;
- Implementation of management practices to reduce the amount and frequency of cleaning products; and
- Use of cleaning products that can enter the vessels' grey water tanks and are easily broken down.

Grieg NL's Waste Management Plan (Appendix J) and Section 2.5.2.2 of the EIS provide additional details regarding the mitigation measures.

After implementation of mitigations measures, the production of waste materials is predicted to have residual *negative* effects on the WS VEC that are *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *13–36 months* (see Table 7.5). Based on these criteria ratings, the *reversible* residual *negative* effects of the production of waste materials on the WS VEC are predicted to be *not significant* (see Table 7.6). The level of confidence associated with this prediction is *medium* to *high*.

## 7.3 Species at Risk VEC

The assessment of the Species at Risk (SAR) VEC considers effects of Project activities in the marine environment on six fish species (white shark, northern wolffish, spotted wolffish, Atlantic wolffish, American eel, and banded killifish), five bird species (Ivory Gull, Harlequin Duck, Red Knot, Barrow's Goldeneye, and Piping Plover), five marine mammal species (blue, North Atlantic right, fin, northern bottlenose, and Sowerby's beaked whale), and two sea turtle species (leatherback and loggerhead sea turtles). These species, including their likelihood of occurrence in the Study Area, were described in Section 4.2.5.2. Project activities which may interact with the SAR VEC are summarized below (Table 7.7).

**Table 7.7. Potential interactions of planned sea farm Project activities and the Species at Risk VEC.**

| Project Activities | Fish | Birds | Marine Mammals | Sea Turtles |
|---|---|---|---|---|
| **CONSTRUCTION** | | | | |
| **Towing Sea Cages** | | | X | X |
| **Sea Cage System Installation** | X | | X | X |
| **Vessel Traffic** | | | X | X |
| **OPERATIONS & MAINTENANCE** | | | | |
| **Transfer Fish to Sea** | | | X | X |
| **Feeding Fish** | X | | X | X |
| **Presence of Farmed Salmon** | X | | X | X |
| **Deposition from Sea Cages** | X | | | |
| **Fish Health Maintenance** | | | | |
| Use of Cleaner Fish | X | | | |
| Mortalities | X | | | |
| Thermolicer[a] | | | | |
| Therapeutant[a] | X | | | |
| Antibiotics[b] | X | | | |
| **Sea Cage Maintenance** | | | | |
| Net Cleaning | X | | X | X |
| Net Repair | | | X | X |
| **Sea Cage Sites** | | | | |
| Presence | X | X | X | X |
| Lights | X | X | | |
| **Use of Vessels**[c] | | | | |
| Presence | | X | X | X |
| Lights | X | X | | |
| Noise | | | X | X |
| Atmospheric Emissions | | | | |
| **Transfer Fish from Sea** | | | X | X |
| **Production of Waste** | X | | | |
| **DECOMMISSIONING & REHABILITATION** | | | | |
| **Towing Sea Cages** | | | X | X |
| **Sea Cage System Removal** | X | | X | X |
| **Vessel Traffic** | | | X | X |

[a] The use of the Thermolicer and therapeutants are adaptive mitigation measures for sea lice and will only be used as a last resort based on guidance from private and provincial veterinarians.
[b] Antibiotics will only be used as a last resort and will be based on guidance from private and provincial veterinarians.
[c] All Project vessels including those associated with personnel transfer and resupply.

Project activities in the terrestrial environment are limited to those at the RAS Hatchery site, which is located in the Marystown Marine Industrial Park. As described in Section 2.4.3.1, site clearing and most

of the grubbing for the RAS Hatchery has been completed and suitable habitat for birds has been cleared. Therefore, land birds considered at risk (listed in Table 4.14) are not assessed.

### 7.3.1 Fish

There are a number of potential interactions between the planned Project activities and the fish SAR (see Table 7.7). The assessment of the potential effects of planned Project activities on the Fish and Fish Habitat VEC in Section 7.1 is directly applicable to this assessment of those same activities on the fish SAR. Therefore, the reader is referred to the background information and principal mitigation measures regarding these interactions in Section 7.1. The potential effects of Project activities on fish SAR and associated mitigation measures are summarized in Table 7.8 below.

Of the six fish SAR considered here, the three wolffish species are demersal, the white shark and American eel are pelagic, and the banded killifish, if it occurs in the marine environment, remains in shallow estuarine waters. The principal interactions with Project activities vary between these three types of fish based on the habitat used.

For the wolffishes, the planned Project activities that affect the seabed have potential to cause effects: (1) sea cage system installation; (2) feeding fish; (3) deposition from the sea cages; (4) fish health maintenance: use of cleaner fish, mortalities, therapeutants, and antibiotics; (5) sea cage maintenance: net cleaning; (6) production of wastes; and (9) sea cage system removal. All three wolffish species are known to occur in Placentia Bay. Given the hard substrate nature of the sea cage sites, some with boulder and rubble cover, it is possible that they might occur at the sea cage sites.

For the white shark and American eel, the planned Project activities that are most likely to cause effects include: (1) feeding fish; (2) presence of farmed salmon; (3) fish health maintenance: use of cleaner fish, mortalities, therapeutants, and antibiotics; (5) sea cage maintenance; net cleaning; (6) sea cage sites: presence and lights; (7) use of vessels: lights; and (6) production of wastes. These planned Project activities are related to potential effects in the water column. Through tagging studies, it is documented that white sharks visit Placentia Bay, especially during recent years. American eels might also swim close to sea cage sites during adult migration to the Sargasso Sea where they reproduce, and during glass eel migration back to the rivers from the Sargasso Sea.

For the banded killifish, considering that its usual habitat is in freshwater and that it is occasionally found in shallow estuarine waters and not in offshore waters, it will not be considered in this assessment of planned Project activities on the fish SAR.

The assessment criteria ratings for the fish SAR are presented in Table 7.8. After implementation of mitigation measures, Project activities are predicted to have residual *negative* effects on the fishes of the SAR VEC that range from *negligible* to *minor* in magnitude over a geographic extent of *<1 km$^2$* to *1–10 km$^2$* for a duration of *<1 month* to *>72 months* (Table 7.8). Based on these criteria ratings, the *reversible* residual *negative* effects of Project activities on the fishes of the SAR VEC are predicted to be *not significant* (Table 7.9). The level of confidence associated with this prediction is *medium* to *high*.

**Table 7.8. Assessment of effects of planned sea farm Project activities on the Species at Risk VEC (fishes).**

| Valued Environmental Component: Species at Risk (Fishes) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Project Activity** | **Potential Positive (P) or Negative (N) Environmental Effect** | **Key Mitigation Measure(s)** | **Evaluation Criteria for Assessing Environmental Effects** | | | | | |
| | | | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| **CONSTRUCTION** | | | | | | | | |
| **Sea Cage System Installation** | Mooring anchors will cover portions of the seabed (N) | • Minimize the number and footprint of mooring anchors while maintaining mooring integrity | 0 | 1 | 6 | 5 | R | 2 |
| **OPERATIONS & MAINTENANCE** | | | | | | | | |
| **Feeding Fish** | Introduction of extra organic material into the marine environment (N) | • Feeding stops at ~80% fish satiation;<br>• Suitable siting of sea cages;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling;<br>• Fallowing of sea cage sites | 1 | 1 | 5 | 3 | R | 2 |
| **Presence of Farmed Salmon** | Attraction of wild fishes to the sea cages (N) | • Predator Control Plan;<br>• Reinforced netting at bottom of sea cages;<br>• Monitoring of farmed salmon behavior with underwater cameras | 1 | 1 | 6 | 3 | R | 2 |
| **Deposition from Sea Cages** | Accumulation of organic material on the seabed below and in the vicinity of the sea cages (N) | • Minimization of feed component through cessation of feeding at ~80% fish satiation;<br>• Siting of sea cages in locations with sufficient water currents to disperse organic material (i.e., feed, fish feces, biofoulants) falling from the sea cages;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling;<br>• Daily removal of fish mortalities from the sea cages | 1 | 1 | 6 | 3 | R | 2 |
| **Fish Health Maintenance** | | | | | | | | |
| Use of Cleaner Fish | Additional fish feces being deposited to the seabed (N);<br><br>Additional vectors for diseases and parasites (N); | • Minimization of feed component through cessation of feeding at ~80% fish satiation;<br>• Siting of sea cages in locations with sufficient water currents to disperse organic material (i.e., feed, fish feces, biofoulants) falling from the sea cages;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling;<br>• Monitoring fish for presence of disease and/or parasites | 1 | 1 | 6 | 3 | R | 2 |
| Fish Mortalities | Attraction of wild fish to the sea | • Daily removal of fish mortalities from sea cage | 1 | 1 | 6 | 3 | R | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | cages, including potential predators (N) | | | | | | | |
| Therapeutants[a] | Availability to wild invertebrates and fishes (N) | • Minimize dose of therapeutant;<br>• Use of low water-soluble therapeutant so that any excess remains in the sediment; | 1 | 1 | 1 | 1-2 | R | 2 |
| Antibiotics[b] | Availability to wild invertebrates and fishes (N) | • Minimize dose of antibiotic;<br>• Use of low water-soluble therapeutant so that any excess remains in the sediment | 1 | 1 | 1 | 1-2 | R | 2 |
| **Sea Cage Maintenance** | | | | | | | | |
| Net Cleaning | Deposition of extra organic material to the seabed (N) | • Siting of sea cages in locations with sufficient water currents to disperse biofoulants falling from the sea cages;<br>• Monitoring of the seabed using methods including ROV, drop camera, and surficial sediment sampling | 1 | 1 | 3 | 3 | R | 2 |
| **Sea Cage Sites** | | | | | | | | |
| Presence | Accumulation of biofoulants on sea cage system components (i.e., artificial reef effect) (N) | • Frequent cleaning of sea cages | 1 | 1-2 | 6 | 3 | R | 2 |
| Lights | Attraction of wild invertebrates and fishes to the sea cages (neutral) | • Minimize the amount of lighting on sea cages | 0-1 | 1 | 5 | 3 | R | 2 |
| **Use of Vessels**[c] | | | | | | | | |
| Lights | Attraction of wild invertebrates and fishes to the sea cages (N) | • Minimize the amount of lighting on vessels | 0-1 | 1 | 5 | 3 | R | 2 |
| **Production of Waste** | Contamination of wild invertebrates and fishes (N) | • Treatment of wastes;<br>• Avoidance of introducing wastes to the marine environment | 1 | 1 | 6 | 3 | R | 2 |
| **DECOMMISSIONING & REHABILITATION** | | | | | | | | |
| **Sea Cage System Removal** | Removal of mooring anchors will disturb portions of the seabed (N) | • Minimize dragging of mooring anchors along seabed during removal | 0-1 | 1 | 1 | 1-2 | R | 2 |

Key:

Magnitude:
0 = Negligible
1 = Minor
2 = Moderate
3 = Major

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = Continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1-km$^2$
2 = 1-10-km$^2$
3 = 11-100-km$^2$
4 = 101-1,000-km$^2$
5 = 1,001-10,000-km$^2$
6 = > 10,000-km$^2$

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not affected by human activity
2 = Evidence of existing effects

[a] The use of the Thermolicer and therapeutants are adaptive mitigation measures for sea lice and will only be used as a last resort based on guidance from private and provincial veterinarians.
[b] Antibiotics will only be used as a last resort and will be based on guidance from private and provincial veterinarians.
[c] All Project vessels including those associated with personnel transfer and resupply.

**Table 7.9. Significance of potential residual environmental effects of planned sea farm Project activities on the Species at Risk VEC (fishes).**

| Valued Environmental Component: Species at Risk (Fishes) | | | | |
|---|---|---|---|---|
| **Project Activity** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[a]** | |
| | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **CONSTRUCTION** | | | | |
| **Sea Cage System Installation** | NS | 3 | | |
| **OPERATIONS & MAINTENANCE** | | | | |
| **Feeding Fish** | NS | 2-3 | | |
| **Presence of Farmed Salmon** | NS | 2-3 | | |
| **Deposition from Sea Cages** | NS | 2-3 | | |
| **Fish Health Maintenance** | | | | |
| Use of Cleaner Fish | NS | 2-3 | | |
| Fish Mortalities | NS | 2-3 | | |
| Therapeutants[b] | NS | 2 | | |
| Antibiotics[c] | NS | 2 | | |
| **Sea Cage Maintenance** | | | | |
| Net Cleaning | NS | 2-3 | | |
| **Sea Cage Sites** | | | | |
| Presence | NS | 3 | | |
| Lights | NS | 2-3 | | |
| **Use of Vessels[d]** | | | | |
| Lights | NS | 2-3 | | |
| **Production of Waste** | NS | 2-3 | | |
| **DECOMMISSIONING & REHABILITATION** | | | | |
| **Sea Cage System Removal** | NS | 3 | | |

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 $km^2$.

Residual environmental Effect Rating:
S = Significant Negative Environmental Effect
NS = Not-significant Negative Environmental Effect
P = Positive Environmental Effect

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Level of Confidence: based on professional judgment:
1 = Low
2 = Medium
3 = High

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low
2 = Medium
3 = High

[a] Considered only in the case where 'significant negative effect' is predicted.
[b] The use of the Thermolicer and therapeutants are adaptive mitigation measures for sea lice and will only be used as a last resort based on guidance from private and provincial veterinarians.
[c] Antibiotics will only be used as a last resort and will be based on guidance from private and provincial veterinarians.
[d] All Project vessels including those associated with personnel transfer and resupply.

## 7.3.2 Birds

Few interactions between bird SAR and the Project are expected (see Table 7.7) because, with the exception of small numbers of Harlequin Ducks and perhaps Barrow's Goldeneye in winter, other species (i.e., Ivory Gull, Piping Plover, and Red Knot) are not expected to occur at the proposed sea cage sites or along the transit routes to the sea cage sites. The nearest reported Harlequin Duck nesting area is on Newfoundland's Northern Peninsula (COSEWIC 2013). The nearest moulting (summer) and wintering areas are Cape St. Mary's (COSEWIC 2013). This species' preferred moulting and wintering habitat is rocky, outer, marine coastlines (COSEWIC 2013). It forages near or over subtidal ledges and near exposed headlands and islets, feeding primarily on crustaceans and molluscs (COSEWIC 2013). These

foraging sites average 11 m from shore, in water less than 10 m in depth (COSEWIC 2013). As a result, Harlequin Duck is not expected to occur near the proposed sea cage sites. Barrow's Goldeneye has not been confirmed to nest or moult on insular Newfoundland or its marine waters (COSEWIC 2000). Individuals or very small numbers of this species have occasionally been reported to winter at a few locations along Newfoundland's coastline, of which St. Mary's Bay is the closest to the proposed sea cage sites (Schmelzer 2006). Its preferred wintering habitat is protected, rocky shorelines where it forages in shallow water for mussels and other invertebrates (Schmelzer 2006). Consequently, the chance of Barrow's Goldeneye occurring near the proposed sea cage sites is very small. Non-SAR bird species that may occur in the Study Area and which are more likely to interact with the Project (e.g., bald eagles) are assessed as part of the Sensitive Areas VEC in association with the Placentia Bay EBSA.

In general, the primary negative effect on birds associated with finfish aquaculture operations is the potential for entanglement in the sea cages and anti-predator nets (Belle and Nash 2008; Northbridge et al. 2013) and attraction to artificial lighting at night which may lead to birds colliding with vessels (Sagar 2013). In several studies, positive or neutral effects on bird abundance and species richness at aquaculture sites have been reported (Price et al. 2016).

#### 7.3.2.1 Entanglement

Grieg NL will have mitigation measures in place to minimize entanglement effects on bird SAR. Each sea cage will have bird nets which cover the entire top of the cage and prevent birds from entering the sea cage. The bird net and bird poles are part of the Aqualine Midgard sea cage system and are designed to provide sufficient tension to eliminate net sagging. Bird nets will be deployed ensuring mesh size will be sufficient to deter predators but minimize the risk of entanglement. The mesh will be dark in colour to make it visible to birds. If a bird does become entangled, Grieg NL will follow established procedures to release the bird (which will be developed in consultation with ECCC-CWS). Grieg NL will have a Migratory Bird Handling Permit issued by CWS in place and will follow reporting requirements. In addition, sea cages will be routinely cleaned (at least weekly), minimizing the build-up of fouling organisms that may attract diving birds.

#### 7.3.2.2 Attraction to Lights

Installation and removal of the mooring system and sea cages will occur during daylight hours and as such, lighting is not expected to affect birds during construction and decommissioning activities. During operation of the sea cage sites, there will be lighting on the feed/accommodation and satellite barges as well as lights marking the mooring system boundary. Grieg NL will minimize the amount of lighting to that needed for safe operations. In addition, downward-pointing and shaded lights on the barges will be used to the extent possible. Weather permitting, the barges will be searched for stranded birds daily and any stranded birds will be handled, released, and documented according to ECCC-CWS protocols. In addition, any catchment basins on the barges will be covered to prevent birds from entering.

#### 7.3.3.3 Assessment

With mitigation measures in place, the effects of Project activities (presence of sea cage sites, vessels, lights) is predicted to have *negative* residual effects on the birds of the SAR VEC that are *negligible* to *minor* in magnitude over a geographic extent of *<1 km*$^2$. Effects related to entanglement and attraction to lights may occur periodically throughout the Project (<1 *month*; Table 7.10). Based on these criteria ratings, the *reversible* residual *negative* effects of the presence of sea cage sites (including lights) on the birds of the SAR VEC are predicted to be *not significant* (Table 7.11). The level of confidence associated with this prediction is *high*.

**Table 7.10. Assessment of effects of sea farm Project activities on the Species at Risk VEC (birds).**

| Valued Environmental Component: Species at Risk (Birds) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Evaluation Criteria for Assessing Environmental Effects | | | | | |
| **Project Activity** | **Potential Positive (P) or Negative (N) Environmental Effect** | **Key Mitigation Measure(s)** | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| **OPERATIONS & MAINTENANCE** | | | | | | | | |
| **Sea Cage Sites** | | | | | | | | |
| Presence | Entanglement (N) | • Avoidance of sensitive areas<br>• Ensure mooring & buoy lines are tightened; no loose lines<br>• Use of bird (anti-predator) nets<br>• Routine net cleaning<br>• Monitoring of sea cages | 0-1 | 1 | 1 | 1 | R | 2 |
| Lights | Stranding (N) | • Minimize lighting if safe to do so | 0-1 | 1 | 1 | 1 | R | 2 |
| **Use of Vessels**[a] | | | | | | | | |
| Presence | Stranding (N)<br>Disturbance(N) | • Limit transit route vessel speed (≤10 knots)<br>• Avoid birds on water to extent possible<br>• Vessel search for stranded birds<br>• Implement stranding/release protocols<br>• Cover any vessel catchment areas | 0-1 | 1 | 1 | 1 | R | 2 |
| Lights | Stranding (N) | • Avoidance of sensitive areas<br>• Minimize lighting<br>• Use downward pointing/shaded lights<br>• Vessel search for stranded birds<br>• Implement stranding/release protocols<br>• Cover any vessel catchment areas | 0-1 | 1 | 1 | 1 | R | 2 |

Key:

| Magnitude: | Frequency: | Reversibility: | Duration: |
|---|---|---|---|
| 0 = Negligible | 1 = < 11 events/yr | R = Reversible | 1 = < 1 month |
| 1 = Minor | 2 = 11-50 events/yr | I = Irreversible | 2 = 1-12 months |
| 2 = Moderate | 3 = 51-100 events/yr | (refers to population) | 3 = 13-36 months |
| 3 = Major | 4 = 101-200 events/yr | | 4 = 37-72 months |
| | 5 = > 200 events/yr | | 5 = > 72 months |
| | 6 = Continuous | | |

| Geographic Extent: | Ecological/Socio-cultural and Economic Context: |
|---|---|
| 1 = < 1-$km^2$ | 1 = Relatively pristine area or area not affected by human activity |
| 2 = 1-10-$km^2$ | 2 = Evidence of existing effects |
| 3 = 11-100-$km^2$ | |
| 4 = 101-1,000-$km^2$ | |
| 5 = 1,001-10,000-$km^2$ | |
| 6 = > 10,000-$km^2$ | |

[a] All Project vessels including those associated with personnel transfer and resupply.

**Table 7.11. Significance of potential residual environmental effects of sea farm Project activities on the Species at Risk VEC (birds).**

| Valued Environmental Component: Species at Risk (Birds) | | | | |
|---|---|---|---|---|
| **Project Activity** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[a]** | |
| | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **OPERATIONS & MAINTENANCE** | | | | |
| **Sea Cage Sites** | | | | |
| Presence | NS | 3 | | |
| Lights | NS | 3 | | |
| **Use of Vessels[b]** | | | | |
| Presence | NS | 3 | | |
| Lights | NS | 3 | | |

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 $km^2$.

Residual environmental Effect Rating:
S = Significant Negative Environmental Effect
NS = Not-significant Negative Environmental Effect
P = Positive Environmental Effect

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Level of Confidence: based on professional judgment:
1 = Low
2 = Medium
3 = High

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low
2 = Medium
3 = High

[a] Considered only in the case where 'significant negative effect' is predicted.
[b] All Project vessels including those associated with personnel transfer and resupply.

### 7.3.3 Marine Mammals

As reviewed in Section 4.2.5.2, three species of baleen whales listed on Schedule 1 of *SARA* may occur in the Study Area—blue whales, North Atlantic right whales, and fin whales. Of these three species, only fin whales are expected to regularly occur in the Study Area. Additionally, two beaked whale species, northern bottlenose whales and Sowerby's beaked whales, may occur there but these species are considered quite rare and their primary habitat is deep water areas. Dolphins, harbour porpoises, and seals (along with humpback, sei and minke whales) that may occur in the Study Area are assessed as part of the Sensitive Areas VEC in association with the Placentia Bay EBSA.

There have been several studies of marine mammal interactions with aquaculture operations around the world (see reviews in Price et al. 2016 and Callier et al. 2017). In general, three primary types of effects have been identified: entanglement, loss of habitat, and disturbance from noise. Potential entanglement and loss of habitat for marine mammals are related to the physical presence of sea cages and associated mooring systems (see Table 7.7). Marine mammal SAR could experience disturbance related to noise and possibly the physical presence of vessels and equipment during most Project activities as indicated by the interactions in Table 7.7.

### 7.3.3.1 Presence of Sea Cages

***Entanglement***

Some marine mammals like dolphins, seals, and sea lions are attracted to fish farms and have been recorded to be more abundant around them than similar areas without fish farms (Sepulveda and Oliva 2005; Nelson et al. 2006; Robinson et al. 2008; Sanchez-Jerez et al. 2011; Northridge et al. 2013). In some cases, these animals are attracted to fish which occur in higher densities outside the sea cages and in other instances, the attraction is to the finfish inside of the sea cages (Güçlüsoy and Savas 2003). Marine mammals, particularly seals and sea lions, have become entangled in aquaculture gear and, in the case of finfish sea cages, many reported entanglements have occurred in anti-predator nets deployed around the primary sea cage net. It is unknown if baleen whales are attracted to fish farms. There are relatively few reports of baleen whale entanglements with aquaculture gear and most of the reports have been of entanglement in shellfish gear (see Table 8 *in* Price et al. 2016). However, in fall 2016, three entanglements of humpback whales in salmon aquaculture gear occurred in British Columbia (Price et al. 2016). The first of these entanglements was of a juvenile humpback whale which had a single anchor line wrapped through its mouth at a site that contained mooring buoys from a formerly active salmon farm. This humpback was successfully released. The second entanglement occurred at the same location when a humpback once again became entangled (around the tail stock) in a mooring buoy anchor line resulting in mortality. A third entanglement occurred at a second location in British Colombia, when a humpback breached the predator net of a salmon farm from underneath and drowned in the sea cage (P. Cottrell, DFO, pers. comm. *in* Price et al. 2016). Johnson et al. (2005) examined the types of fishing gear involved in the entanglement of 31 North Atlantic right whales and 30 humpback whales. Only one of these entanglements (juvenile right whale) was reported as aquaculture gear.

In Newfoundland, there have been no reported marine mammal entanglements in aquaculture gear (W. Ledwell, Whale Release and Strandings Group, pers. comm., 26 March 2018). However, the possibility exists that entanglements may occur. North Atlantic right whales may be particularly susceptible to entanglement in aquaculture gear given that one of the leading causes of mortality of this endangered species is fishing gear entanglement (along with ship strikes; see Section 4.2.5.2). One of the highest risks of fixed fishery gear for species like right whales is entanglement in anchoring and buoy lines, which are similar to some structures at seafarms. However, most anchors used at seafarms are fixed structures like plough anchors, attached to the gear with thick metal cables or high tensile strength line, and typically under high tension (Ögmundarson et al. 2011). These lines are not likely to pose entanglement risk (Price et al. 2016). They may, however, pose more risk to the animal from collisions resulting in injuries like lacerations (Winn et al. 2008; Baldwin et al. 2012). In the case of mussel farms, it is the slacker grow out lines, spat collecting lines and surface marker buoy lines that cause the most concern (Moore and Wieting 1999; Lloyd 2003; Keeley et al. 2009; Clement 2013). Clement (2013) suggests that if seafarm lines are kept tensioned, no loose ropes are left trailing in the water, and seafarms are located outside of migratory paths of marine mammals, the risk of entanglement is likely to be low.

Grieg NL will implement several mitigation measures designed to minimize the likelihood of marine mammals, including SAR, becoming entangled at its sea cage sites and to minimize the effects of any entanglements. Sea cage mooring and buoy lines will be kept tensioned and no loose ropes will be left trailing in the water. Additionally, proposed sea cage sites are not located in sensitive habitat for blue, North Atlantic right whale, and fin whales (or beaked whale SAR). Each sea cage is equipped with one or two video cameras with 360 degree viewing and which can be raised and lowered within the water column; this will allow for monitoring of entanglements. Any entanglement of marine mammal SAR (as well as other marine mammals) will be reported to DFO and action will be taken, in consultation with DFO (and the Whale Release and Strandings Group as appropriate), to free or remove the animal.

***Habitat Loss***

The physical presence of sea cages and mooring systems may result in limited habitat loss for marine mammal SAR species. As discussed in the assessment of effects on the FFH VEC, the anchors will cause effects on the benthic substrate and the biota living within and on it by covering the seabed. The maximum areas of seabed that will be impacted by the mooring anchors at the proposed semi-annual sites and the seasonal sites are 44 $m^2$ and 28 $m^2$, respectively. Of more direct relevance to marine mammal SAR species is the footprint of the sea cages and the mooring system. Each of the nine semi-annual sea cage sites have a sea cage boundary footprint of ~0.12 $km^2$ and the two seasonal sea cage sites have a sea cage boundary footprint of 0.06 $km^2$. In total, this results in ~1.2 $km^2$ of habitat that is potentially unavailable to marine mammal SAR. This likely represents the maximum loss of potential habitat for marine mammals given that the sea cages in one BMA are fallow (i.e., the sea cages are removed) at any given time of the year. It is possible that baleen whales could access at least a portion of the area underneath the 45 m deep sea cages as average water depths at each of the sea cage sites range from 80–218 m. However, it is anticipated that baleen whales would likely avoid the immediate area around the sea cages because of noise associated with operations (see below). Blue whales, North Atlantic right whales, and fin whales are not expected to be attracted to the fish in the sea cages nor fish outside of the sea cages given that these whales feed almost exclusively on zooplankton and in the case of fin whales small, shoaling fish.

***Assessment***

With mitigation measures in place, the presence of sea cage sites, is predicted to have *negative* residual effects on the marine mammal SAR VEC that are *negligible* to *minor* in magnitude over a geographic extent of *<1 $km^2$*. Effects related to potential habitat loss would be continuous throughout the Project (>72 *months;* Table 7.12). Based on these criteria ratings, the *reversible* residual *negative* effects of the presence of sea cage sites on the marine mammal SAR VEC are predicted to be *not significant* (Table 7.13). The level of confidence associated with this prediction is *medium* to *high*. In the highly unlikely event that an endangered North Atlantic right whale or blue whale experiences mortality as a result of entanglement in a sea cage, this would be considered a significant effect.

### 7.3.3.2 Project Activities Related to Disturbance and Potential Vessel Strikes

Project activities could disturb marine mammal SAR if these species occurred near the sea cage sites and/or along vessel transit routes from the RAS Hatchery, personnel transfer sites, and resupply sites to the proposed sea cage sites (see Table 7.7 for interactions). Disturbance would primarily be related to underwater noise from vessel operations but visual or other cues are also likely involved. However, there would also be noise during the installation of anchors at each sea cage site during the Construction Phase.

Marine mammal responses to vessels are variable and range from avoidance at long distances to little or no response or approach (Richardson et al. 1995). Responses depend on the speed, size, and direction of travel of the vessel relative to the marine mammal; slow approaches tend to elicit fewer responses than fast, erratic approaches (Richardson et al. 1995). Ship noise, through masking, can also reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (e.g., Richardson et al. 1995; Clark et al. 2009; Jensen et al. 2009; Gervaise et al. 2012; Hatch et al. 2012; Rice et al. 2014; Erbe et al. 2016; Jones et al. 2017; Putland et al. 2017). In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking (e.g., Branstetter et al. 2013, 2016; Finneran and Branstetter 2013). Sound could also be a potential source of stress for marine mammals (e.g., Wright et al. 2011; Atkinson et al. 2015).

**Table 7.12. Assessment of effects of planned sea farm Project activities on the Species at Risk VEC (marine mammal and sea turtles).**

| Valued Environmental Component: Species at Risk (Marine Mammals and Sea Turtles) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Project Activity** | **Potential Positive (P) or Negative (N) Environmental Effect** | **Key Mitigation Measure(s)** | **Evaluation Criteria for Assessing Environmental Effects** | | | | | |
| | | | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| **CONSTRUCTION** | | | | | | | | |
| **Towing Sea Cages** | Disturbance (N) | • Limit tow speed (<3 knots)<br>• Avoidance of sensitive areas | 0-1 | 2 | 2 | 1 | R | 2 |
| **Sea Cage System Installation** | Disturbance (N) | • Avoidance of sensitive areas | 0-1 | 3 | 2 | 2 | R | 2 |
| **Vessel Traffic** | Disturbance (N)<br>Injury /Mortality (N) | • Limit transit route vessel speed (≤10 knots)<br>• Maintain constant course and speed<br>• Avoid marine mammals/ sea turtles<br>• Avoidance of sensitive areas | 0-1 | 3 | 2 | 1 | R | 2 |
| **OPERATIONS & MAINTENANCE** | | | | | | | | |
| **Transfer Fish to Sea** | Disturbance (N) | -- | 0 | 1-2 | 2 | 1 | R | 2 |
| **Feeding Fish** | Disturbance (N) | -- | 0-1 | 1-2 | 2 | 1 | R | 2 |
| **Sea Cage Maintenance** | | | | | | | R | 2 |
| Net Cleaning | Disturbance (N) | -- | 0-1 | 2 | 2 | 1 | R | 2 |
| Net Repair | Disturbance (N) | -- | 0-1 | 1 | 2 | 1 | R | 2 |
| **Sea Cage Sites** | | | | | | | | |
| Presence | Entanglement (N)<br>Habitat loss (N) | • Avoidance of sensitive areas<br>• Ensure mooring & buoy lines are tightened; no loose lines<br>• Monitoring of sea cages and release of animals | 0-1 | 1 | 6 | 5[a] | R | 2 |
| **Use of Vessels**[b] | | | | | | | R | 2 |
| Presence | Injury /Mortality (N) | • Limit transit route vessel speed (≤10 knots); maintain constant course and speed<br>• Avoid marine mammals/ sea turtles<br>• Avoidance of sensitive areas | 0-1 | 1 | 2 | 1 | R | 2 |
| Noise | Disturbance (N) | • Avoidance of sensitive areas | 1 | 3 | 2 | 1 | R | 2 |
| **Transfer Fish from Sea** | Disturbance (N) | | 0 | 1 | 2 | 1 | R | 2 |
| **DECOMMISSIONING & REHABILITATION** | | | | | | | | |
| **Towing Sea Cages** | Disturbance (N) | • Limit tow speed (<3 knots)<br>• Avoidance of sensitive areas | 0-1 | 2 | 2 | 1 | R | 2 |
| **Sea Cage System Removal** | Disturbance (N) | • Avoidance of sensitive areas | 0-1 | 3 | 2 | 1 | R | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Vessel Traffic** | Disturbance (N)<br>Injury /Mortality (N) | • Limit transit route vessel speed (≤10 knots); maintain constant course and speed<br>• Avoid marine mammals/ sea turtles<br>• Avoidance of sensitive areas | 0-1 | 3 | 2 | 1 | R | 2 |

Key:

Magnitude:
0 = Negligible
1 = Minor
2 = Moderate
3 = Major

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = Continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1-km$^2$
2 = 1-10-km$^2$
3 = 11-100-km$^2$
4 = 101-1,000-km$^2$
5 = 1,001-10,000-km$^2$
6 = > 10,000-km$^2$

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not affected by human activity
2 = Evidence of existing effects

[a] Duration for entanglement effects (injury) is considered <1 month.
[b] All Project vessels including those associated with personnel transfer and resupply.

**Table 7.13. Significance of potential residual environmental effects of planned sea farm Project activities on the Species at Risk VEC (marine mammal and sea turtles).**

| Valued Environmental Component: Species at Risk (Marine Mammals and Sea Turtles) | | | | |
|---|---|---|---|---|
| **Project Activity** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[a]** | |
| | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **CONSTRUCTION** | | | | |
| **Towing Sea Cages** | NS | 3 | | |
| **Sea Cage System Installation** | NS | 3 | | |
| **Vessel Traffic** | NS | 3 | | |
| **OPERATIONS & MAINTENANCE** | | | | |
| **Transfer Fish to Sea** | NS | 3 | | |
| **Feeding Fish** | NS | 3 | | |
| **Sea Cage Maintenance** | | | | |
| Net Cleaning | NS | 3 | | |
| Net Repair | NS | 3 | | |
| **Sea Cage Sites** | | | | |
| Presence | NS | 2-3 | | |
| **Use of Vessels[b]** | | | | |
| Presence | NS | 2-3 | | |
| Noise | NS | 2-3 | | |
| **Transfer Fish from Sea** | NS | 3 | | |
| **DECOMMISSIONING & REHABILITATION** | | | | |
| **Towing Sea Cages** | NS | 3 | | |
| **Sea Cage System Removal** | NS | 3 | | |
| **Vessel Traffic** | NS | 3 | | |

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 $km^2$.

Residual environmental Effect Rating:
S = Significant Negative Environmental Effect
NS = Not-significant Negative Environmental Effect
P = Positive Environmental Effect

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Level of Confidence: based on professional judgment:
1 = Low
2 = Medium
3 = High

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low
2 = Medium
3 = High

[a] Considered only in the case where 'significant negative effect' is predicted.
[b] All Project vessels including those associated with personnel transfer and resupply.

Baleen whales are thought to be more sensitive to sound at low frequencies that are predominantly produced by vessels than are toothed whales (e.g., MacGillivray et al. 2014), possibly causing localized avoidance of the Project vessels and sea cage sites. Reactions of gray and humpback whales to vessels have been studied, but there is limited information available on the reactions of right whales and rorquals (e.g., fin and blue whales). North Atlantic right whales can often be approached by slowly moving vessels, but swim away from vessels that approach quickly (Watkins 1986). They tend to show little responses to close passages of small steady-moving boats when mating or feeding (Mayo and Marx 1990; Gaskin 1991). The responses of North Atlantic right whales in the Bay of Fundy to ships, sounds from conspecifics, and a signal designed to alert the whales were monitored using multi-sensor acoustic recording tags (Nowacek et al. 2004). The whales reacted overtly to the signal by swimming to the surface, likely increasing rather than decreasing the risk of collision with ships. The whales reacted mildly to controlled exposure to sounds of conspecifics, but showed no response to controlled sound exposure to ships as well as actual ships (Nowacek et al. 2004). Right whales have been known to

increase the source levels of their calls, shift their peak frequencies, or otherwise change their vocal behaviour in the presence of elevated ambient noise levels (e.g., Parks et al. 2007, 2011, 2012, 2016; Tenessen and Parks 2016). Rolland et al. (2012) suggested that ship noise causes stress in right whales; they showed that baseline levels of stress-related faecal hormone metabolites decreased in North Atlantic right whales with a 6-dB decrease in underwater noise from vessels.

Off New England, fin whales had shorter surfacing and dive times when whale-watch and other vessels were nearby (Stone et al. 1992). Watkins (1981) and Watkins et al. (1981) noted that fin whales showed little response to slowly moving vessels, but avoided boats that altered course or speed quickly. During marine mammal monitoring from a high-speed, catamaran car ferry transiting the Bay of Fundy during the summers of 1998–2002, the majority of baleen whales (including fin, humpback and minke whales) sighted from the ferry appeared to exhibit avoidance behaviour including heading away, changing heading, or diving (Dufault and Davis 2003). In the Ligurian Sea, fin whales were monitored in their feeding ground during close approaches by a small inflatable boat, moving with sudden speed and directional changes (Jahoda et al. 2003). Fin whales responded to the close approach of a small inflatable boat by apparently ceasing feeding, beginning to travel at increased speed, and reducing the amount of time spent on the surface; one hour after close approach, the fin whales had not resumed to pre-disturbance behaviours. The authors noted fin whale response may be, entirely or in part, a response to biopsy sampling, which was occurring as well. Fin whale sightings in the western Mediterranean were negatively correlated with the number of vessels in the area (Campana et al. 2015). Fin and blue whales in the St. Lawrence estuary either moved away from ships or remained near a vessel but changed direction or dove; the most marked reactions occurred when vessels approached quickly or erratically (Edds and Macfarlane 1987). Fin whales and blue whales have been shown to increase the source levels of their calls, shift their peak frequencies, or otherwise change their vocal behaviour in the presence of elevated noise levels such as from shipping (e.g., McKenna 2011; Castellote et al. 2012; Melcón et al. 2012). Physical presence of vessels, not just ship noise, has also been shown to disturb the foraging activity of blue whales (Lesage et al. 2017). McKenna et al. (2015) noted a dive response by blue whales when a vessel approached, but no lateral avoidance, which could lead to an increase in collision risk.

There is potential for Project vessels to strike marine mammal SAR resulting in injury or mortality. All six baleen whale species found in the NW Atlantic are documented to have been struck by ships (Jensen and Silber 2003), with fin whales being the most frequently struck followed by humpback and right whales (Laist et al. 2001; Jensen and Silber 2003; Panigada et al. 2006; Douglas et al. 2008). While it is not clear why whales are unable to avoid ship strikes, even when vessels are traveling slowly, there is evidence showing that strikes may be more likely in areas where large numbers of whales congregate to feed (Panigada et al. 2006) as well as evidence that vessel sound signatures are louder from the side and stern of the vessel than from the bow (Allen et al. 2012; McKenna et al. 2012), making detection of an approaching vessel more difficult for a whale in front of the vessel. Most lethal and severe injuries to large whales resulting from documented ship strikes have occurred when vessels were travelling at ≥14 knots (Laist et al. 2001).

Vessel strikes on marine mammal SAR are considered unlikely during this Project for three primary reasons: vessel speeds are restricted to <10 knots, Project vessels are relatively small, and marine mammal SAR occurrence in the Study Area (with the exception of fin whales) is considered rare. In addition, vessel crew will maintain watch for marine mammals and alter course and speed as appropriate to avoid marine mammals.

***Construction***

During Construction, sea cage collars will be towed from Marystown to the sea cage sites by a service vessel traveling at a slow speed (3 knots) and maintaining a steady course. The installation of the mooring system including anchors and sea cage nets at each site will require the use of two service vessels. Disturbance effects on marine mammal SAR are considered minimal given the localized and short-term nature of construction activities. Also, there is minimal risk of Project vessels striking marine mammal SAR given the slow travel speed of vessels.

Construction activities are predicted to have *negative* residual effects on the marine mammal SAR VEC that are *negligible* to *minor* in magnitude over a geographic extent of *1–10 km$^2$ to 11–100 km$^2$*. Disturbance effects related to construction activities would be periodic and short-term in duration *(<1 month* to *1–12 months;* Table 7.12). Based on these criteria ratings, the *reversible* residual *negative* effects of construction activities on the marine mammal SAR VEC are predicted to be *not significant* (see Table 7.13). The level of confidence associated with this prediction is *high*.

***Operations and Maintenance***

During Operations and Maintenance, it is possible that noise associated with the Project activities of transferring fish to sea, feeding fish, maintaining the sea cages (net cleaning and repair), and the use of numerous vessels may disturb blue whales, North Atlantic right whales, and fin whales (as well as northern bottlenose whales and Sowerby's beaked whales) should they occur nearby. At full production (steady state), a maximum of 27 vessels could be in use at any one time. Of these 27 vessels, 9 will be stationary barges that emit minimal underwater noise. There will be eight service vessels, three work boats, and three crew vessels servicing the sea cage sites in three active BMAs. In addition, there would be periodic use of a well boat, dead hold vessel, and feed supply vessel. These vessels will maintain constant course and speed whenever it is practical to do so. If marine mammal SAR do occur near Project vessels it is possible some whales may avoid the area by several kilometres. This avoidance will likely be short-term for vessels transiting to the sea cage sites. It is possible that some whales may avoid the area around sea cages for a longer duration given the continuous use of the area by vessels (except during fallowing).

Grieg NL will implement several mitigation measures designed to minimize the effects of vessel and sea cage operations. Vessel speeds will not exceed 10 knots and vessels will maintain constant course and speed whenever possible. Vessel crew will maintain watch for marine mammals and alter course and speed as appropriate to avoid marine mammals. Vessel crew will be prohibited from approaching marine mammals.

With mitigation measures in place, operation and maintenance activities are predicted to have *negative* residual effects on the marine mammal SAR VEC that are *negligible* to *minor* in magnitude over a geographic extent of *<1 km$^2$ to 11–100 km$^2$*. Disturbance effects related to during operation and maintenance activities would be periodic and short-term in duration *(<1 month;* Table 7.12). Based on these criteria ratings, the *reversible* residual *negative* effects of operation and maintenance activities on the marine mammal SAR VEC are predicted to be *not significant* (see Table 7.13). The level of confidence associated with this prediction is *medium* to *high*. In the highly unlikely event that an endangered North Atlantic right whale or blue whale experiences mortality as a result of a vessel strike, this would be considered a significant effect.

***Decommissioning and Rehabilitation***

Project activities associated with decommissioning and rehabilitation are very similar to construction of sea cages. As such, decommissioning activities are predicted to have *negative* residual effects on the marine mammal SAR VEC that are *negligible* to *minor* in magnitude over a geographic extent of *1–10 km$^2$ to 11–100 km$^2$*. Disturbance effects related to decommissioning activities would be periodic and short-term in duration *(<1 month;* Table 7.12). Based on these criteria ratings, the *reversible* residual *negative* effects of decommissioning activities on the marine mammal SAR VEC are predicted to be *not significant* (see Table 7.13). The level of confidence associated with this prediction is *high*.

## 7.3.4 Sea Turtles

As reviewed in Section 4.2.5.2, leatherback and loggerhead sea turtles, which are both listed as endangered on Schedule 1 of *SARA* may occur in the Study Area primarily during summer and early fall. Of these species only leatherbacks are expected to regularly occur in the Study Area. Proposed critical habitat for leatherbacks which occurs in the Study Area but south of the proposed sea cage sites is assessed as part of the Sensitive Areas VEC.

There has been limited study of sea turtle interactions with aquaculture operations (see a review in Price et al. 2016). Two primary types of potential effects have been identified: entanglement and vessel strikes. Potential entanglement and vessel strikes of sea turtles are related to the physical presence of sea cages and associated mooring system and Project vessels (see Table 7.7). Sea turtles could experience disturbance related to noise and possibly the physical presence of vessels and equipment during most Project activities as indicated by the interactions shown in Table 7.7. Habitat loss is considered negligible.

### 7.3.4.1 Presence of Sea Cages

Several studies have concluded that the greatest risk of aquaculture operations to sea turtles is entanglement (see Price et al. 2016 for a review). Sea turtles are generally thought to occur incidentally near sea cages and not as predatory threats (Nash et al. 2005; Helsley 2007). In Newfoundland, there have been three reported cases of leatherback sea turtle entanglements in mussel aquaculture gear and no reported entanglements in finfish aquaculture gear (W. Ledwell, Whale Release and Strandings Group, pers. comm., 26 March 2018). In 2009, a leatherback was found dead and rolled up in mussel farm lines (Ledwell and Huntington 2010). Two leatherbacks have been reported entangled in spat collection lines: one leatherback was found dead at depth (in 2010) while the second was found alive and released after being disentangled around the head and flippers (in 2013).

As noted for marine mammals, one of the highest risks of entanglement for sea turtles is anchoring and buoy lines associated with fixed fishery gear, which are similar to some structures at seafarms (Price et al. 2016). However, most anchors used at seafarms, including the proposed Project, are fixed structures like plough anchors, attached to the gear with thick metal cables or high tensile strength line, and typically under high tension (Ögmundarson et al. 2011). These lines are not likely to pose entanglement risk for sea turtles but sea turtles may experience injury by striking the lines (Price et al. 2016). The risk of sea turtle entanglement is likely to be low if seafarm lines are kept tensioned, no loose ropes are left trailing in the water, and seafarms are located outside of migratory paths (Clement 2013).

Grieg NL will implement several mitigation measures designed to minimize the likelihood of sea turtles becoming entangled at its sea cage sites and to minimize the effects of any entanglements or interactions with gear. Sea cage mooring and buoy lines will be kept tensioned and no loose ropes will be left trailing

in the water. Additionally, proposed sea cage sites are not located in sensitive habitat for sea turtles. Each sea cage is equipped with one or two video cameras with 360 degree viewing and which can be raised and lowered within the water column; this will allow for monitoring of entanglements. Any entanglement of sea turtles will be reported to DFO and action will be taken, in consultation with DFO (and the Whale Release and Strandings Group as appropriate), to free or remove the animal.

With mitigation measures in place, the presence of sea cage sites, is predicted to have *negative* residual effects on the sea turtle SAR VEC that are *negligible* to *minor* in magnitude over a geographic extent of *<1 km²*. Potential effects related to interactions with sea cages and mooring systems would be infrequent and short-term (*<1 month;* Table 7.12). Based on these criteria ratings, the *reversible* residual *negative* effects of the presence of sea cage sites on the sea turtle SAR VEC are predicted to be *not significant* (see Table 7.13). The level of confidence associated with this prediction is *medium* to *high*.

### 7.3.4.2 Project Activities Related to Vessel Strikes and Disturbance

Sea turtles are capable of hearing the low-frequency sounds produced by vessels (e.g., Dow Piniak et al. 2012) but unlike marine mammals they are not known to vocalize underwater. Project activities could disturb sea turtles if they occurred in close proximity to the sea cage sites and/or along vessel transit routes from the RAS Hatchery, personnel transfer sites, and resupply sites to the proposed sea cage sites (see Table 7.7 for interactions). Disturbance would primarily be related to underwater noise from vessel operations but visual or other cues are also likely involved. There are limited data available on sea turtle behavioural response to vessels, however, they are regularly observed within several hundred metres of large seismic vessels during periods with and without operational airgun arrays (Holst et al. 2006; Weir 2007; Holst and Smultea 2008).

There is potential for Project vessels to strike sea turtles resulting in injury or mortality. Propeller and collision injures from boats and ships are common in sea turtles, at least in U.S. waters (NMFS 2008). However, vessel strikes of sea turtles are not considered a key concern for this Project because vessel speeds are restricted to <10 knots, Project vessels are relatively small, and vessel crew will maintain watch for sea turtles and alter course and speed as appropriate to avoid sea turtles.

***Construction***

During Construction, sea cage collars will be towed from Marystown to the sea cage sites by a service vessel traveling at a slow speed (3 knots) and maintaining a steady course. The installation of the mooring system including anchors and sea cage nets at each site will require the use of two service vessels. Disturbance effects on sea turtles are considered minimal given the localized and short-term nature of construction activities. Also, there is little to no risk of Project vessels striking sea turtles during construction given the slow travel speed and limited use of vessels.

Construction activities are predicted to have *negative* residual effects on the sea turtle SAR VEC that are *negligible* to *minor* in magnitude over a geographic extent of *1–10 km²*. Disturbance effects related to construction activities would be periodic and short-term in duration *(<1 month* to *1–12 months;* Table 7.12). Based on these criteria ratings, the *reversible* residual *negative* effects of construction activities on the sea turtle SAR VEC are predicted to be *not significant* (see Table 7.13). The level of confidence associated with this prediction is *high*.

***Operations and Maintenance***

During Operations and Maintenance, it is possible that noise associated with the Project activities of transferring fish to sea, feeding fish, maintaining the sea cages (net cleaning and repair), and the use of numerous vessels may disturb sea turtles should they occur nearby. At full production (steady state), a maximum of 27 vessels could be in use at any one time. Of these 27 vessels, 9 will be stationary barges that emit minimal underwater noise. There will be eight service vessels, three work boats, and three crew vessels servicing the sea cage sites in three active BMAs. In addition, there would be periodic use of a well boat, dead hold vessel, and feed supply vessel. These vessels will maintain constant course and speed whenever it is practical to do so. If sea turtles do occur near Project vessels it is possible some turtles may avoid the immediate area. This avoidance will likely be short-term for vessels transiting to the sea cage sites. It is possible that some sea turtles may avoid the area around sea cages for a longer duration given the continuous use of the area by vessels (except during fallowing).

Grieg NL will implement several mitigation measures designed to minimize the effects of vessel and sea cage operations. Vessel speeds will not exceed 10 knots. Vessel crew will maintain watch for sea turtles and alter course and speed as appropriate to avoid interactions. Vessel crew will be prohibited from approaching sea turtles.

With mitigation measures in place, operation and maintenance activities are predicted to have *negative* residual effects on the sea turtle SAR VEC that are *negligible* to *minor* in magnitude over a geographic extent of *<1 $km^2$ to 11–100 $km^2$*. Disturbance effects related to during operation and maintenance activities would be periodic and short-term in duration *(<1 month;* Table 7.12). Based on these criteria ratings, the *reversible* residual *negative* effects of operation and maintenance activities on the sea turtle SAR VEC are predicted to be *not significant* (see Table 7.13). The level of confidence associated with this prediction is *medium* to *high*.

***Decommissioning and Rehabilitation***

Project activities associated with decommissioning and rehabilitation are very similar to construction of sea cages. As such, decommissioning activities are predicted to have *negative* residual effects on the sea turtle SAR VEC that are *negligible* to *minor* in magnitude over a geographic extent of *1–10 $km^2$ to 11–100 $km^2$*. Disturbance effects related to decommissioning activities would be periodic and short-term in duration *(<1 month;* Table 7.12). Based on these criteria ratings, the *reversible* residual *negative* effects of decommissioning activities on the sea turtle SAR VEC are predicted to be *not significant* (see Table 7.13). The level of confidence associated with this prediction is *high*.

## 7.4 Sensitive Areas VEC

Components of the Sensitive Areas (SA) VEC in the Study Area that may interact with planned Project activities include the Placentia Bay Extension EBSA and proposed leatherback sea turtle critical habitat. No sensitive areas were identified for the RAS Hatchery site which has already been cleared for construction. The effects of potential interactions between planned activities associated with the sea farm components of the Project and the SA VEC are discussed and assessed here.

The principal features which led to Placentia Bay being declared an EBSA are detailed in Section 4.2.6 and summarized here. Placentia Bay hosts a high aggregation of ichthyoplankton, particularly those of Atlantic cod, cunner, American plaice and capelin, in the western and northern portions of the Bay. Identified ichthyoplankton high-aggregation areas overlap all 11 proposed sea cage sites. Placentia Bay is characterized by high pelagic and demersal fish species diversity, as well as shellfish and other marine

invertebrates. It also has the largest Atlantic cod spawning stock within the Northwest Atlantic. Placentia Bay is also an important area for feeding and/or migration for large aggregations of marine mammals and sea turtles, particularly during the spring and summer months. Harbour seals occur there year-round and Placentia Bay hosts the highest densities of river otters in the province. The western and northern portions of Placentia Bay are among the most important for marine mammals, including the Rushoon, Merasheen and Red Island BMAs. Placentia Bay supports high numbers of birds, and has four IBAs for nesting, feeding and overwintering. The largest, the Placentia Bay IBA, is closest to the proposed sea cage sites in the Red Island and Long Harbour BMAs. Overall, Placentia Bay features high primary and secondary production, as well as important breeding areas which are highly sensitive to disturbance.

Critical habitat for leatherback sea turtles was recently proposed for the southern portion of Placentia Bay, the northern extent of which is near the Rushoon BMA (see Section 4.2.6). The principal features which led to the proposed designation include the quantity and quality of gelatinous prey items, acoustic environment and water quality. Leatherbacks typically occur within Atlantic Canadian waters during late-spring through fall, with peak use of proposed critical habitat areas during the summer and fall.

Accidental events, such as spills, are assessed in Section 7.7. Potential interactions between planned marine Project activities and the SA VEC are presented in Table 7.14.

**Table 7.14. Potential interactions of planned sea farm Project activities and the Sensitive Areas VEC.**

| Project Activity | Valued Environmental Component: Sensitive Areas |
|---|---|
| **CONSTRUCTION** | |
| **Towing Sea Cages** | X |
| **Sea Cage System Installation** | X |
| **Vessel Traffic** | X |
| **OPERATIONS & MAINTENANCE** | |
| **Transfer Fish to Sea** | |
| **Feeding Fish** | |
| **Presence of Farmed Salmon** | X |
| **Deposition from Sea Cages** | X |
| **Fish Health Maintenance** | |
| **Sea Cage Maintenance** | |
| **Sea Cage Sites** | X |
| **Use of Vessels**[a] | |
| Presence | X |
| Lights | |
| Noise | X |
| Atmospheric Emissions | X |
| **Transfer Fish from Sea** | |
| **Production of Waste** | X |
| **DECOMMISSIONING & REHABILITATION** | |
| **Towing Sea Cages** | X |
| **Sea Cage System Removal** | X |
| **Vessel Traffic** | X |

[a] All Project vessels including those associated with personnel transfer and resupply.

### 7.4.1 Construction

#### 7.4.1.1 Towing Sea Cages

A multi-service vessel will be used to tow up to a maximum of 12 sea cage collars at one time in a single line configuration, accompanied by two service vessels. The sea cage collars are wider than the multiservice vessel, with a diameter of 50 m (vs. 11.5 m vessel width), and the service vessels each have a width of 7.3 m (see Section 2.4.4). Sea cages will be towed from Marystown to the proposed sea cage sites, with a maximum potential transit distance of ~100 km (e.g., from Marystown to the Ship Island, Butler Island or Brine Islands proposed sea cage sites).

The potential impact of towing sea cages on the SA VEC relates to negative interaction or interference with the EBSA and proposed leatherback sea turtle critical habitat features by vessels and/or sea cages while en route to the proposed sea cage sites. Specifically, the potential exists for ship strikes of marine mammals or sea turtles which may aggregate within the EBSA, and acoustic disturbance of sensitive habitat.

The key mitigation measures for the effect of towing sea cages on the SA VEC include:

- Limiting tow speed to <3 knots (5.6 km/h); and
- Avoiding sensitive areas while towing (e.g., the proposed sea cage sites are located away from IBAs and outside of proposed leatherback sea turtle critical habitat; and vessels will abide by safe distance regulations for specific breeding seabird colony areas).

Details regarding mitigation measures are provided in Section 2.5.

As indicated in Table 7.15, after implementation of the mitigations noted above, towing sea cages is predicted to have residual *negative* effects on the SA VEC that are *negligible* in magnitude over a geographic area of *<1 km$^2$* for a duration of *<1 month*. Based on these criteria ratings, the *reversible* residual *negative* effects of towing sea cages on the SA VEC are predicted to be *not significant* (Table 7.16). The level of confidence associated with this prediction is *high*.

#### 7.4.1.2 Sea Cage Installation

Sensitive habitat, such as important areas for ichthyoplankton and IBAs within the Placentia Bay Extension EBSA, and proposed leatherback sea turtle critical habitat, may be subject to negative effects by vessels and/or mooring anchors (noise, habitat change) during sea cage installation. The effect of sea cage installation on the SA VEC is dependent on the locations of proposed sea cage sites relative to sensitive habitat. The key mitigation measure for potential effects is avoidance of sensitive areas for sea cage installation to the extent possible (e.g., sea cage sites located away from IBAs and outside of proposed leatherback sea turtle critical habitat).

Sea cage installation is predicted to have residual *negative* effects on the SA VEC that are *negligible* to *minor* in magnitude over a geographic area of *<1 km$^2$* for a duration of *<1 month* (Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of sea cage installation on the SA VEC are predicted to be *not significant* (Table 7.16). The level of confidence associated with this prediction is *high*.

**Table 7.15. Assessment of effects of planned sea farm Project activities on the Sensitive Areas VEC.**

| Valued Environmental Component: Sensitive Areas | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Project Activity** | **Potential Positive (P) or Negative (N) Environmental Effect** | **Key Mitigation Measure(s)** | **Evaluation Criteria for Assessing Environmental Effects** | | | | | |
| | | | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| **CONSTRUCTION** | | | | | | | | |
| **Towing Sea Cages** | Interaction or interference with sensitive habitat by vessels and/or sea cages (N) | • Limit tow speed (<3 knots)<br>• Avoidance of sensitive areas | 0 | 1 | 2 | 1 | R | 2 |
| **Sea Cage System Installation** | Interaction or interference with sensitive habitat by vessels and/or mooring anchors (N) | • Avoidance of sensitive areas | 0-1 | 1 | 2 | 1 | R | 2 |
| **Vessel Traffic** | Interaction or interference with sensitive habitat (N) | • Limit vessel speed<br>• Transiting vessels to abide by safe distance regulations for breeding seabird colony areas | 0-1 | 2-3 | 2 | 1 | R | 2 |
| **OPERATIONS & MAINTENANCE** | | | | | | | | |
| **Presence of Farmed Salmon** | Attraction of marine predators to the sea cages, making them more vulnerable to entanglement or disease/parasite transfer (N) | • Ongoing monitoring of health of fish in the sea cages<br>• Implementation of biosecurity measures<br>• Predator avoidance nets<br>• Routine husbandry practices<br>• Development and implementation of Fish Health Management Plan by Grieg NL | 1 | 1 | 6 | 3 | R | 2 |
| **Presence of Sea Cage Sites** | Entanglement (N)<br>Habitat loss (N) | • Avoidance of sensitive areas<br>• Ensure mooring & buoy lines are tightened; no loose lines.<br>• Monitoring of sea cages and release of animals | 0-1 | 1 | 6 | 5[a] | R | 2 |
| **Deposition from Sea Cages** | Nutrification or depositional build-up (N) | • Suitable cage locations<br>• Scheduled fallowing<br>• Routine cleaning<br>• Excess feed avoidance<br>• Regular monitoring | 1 | 1 | 6 | 3 | R | 2 |
| **Use of Vessels**[b] | | | | | | | | |
| Presence | Interaction or interference with sensitive habitat (N) | • Limit transit route vessel speed (≤10 knots)<br>• Transiting vessels to abide by safe distance regulations for breeding seabird colony areas<br>• Barges anchored | 1 | 1 | 6 | 3 | R | 2 |
| Noise | Interference with sensitive habitat (N) | • Barges anchored & only operating generators<br>• Transiting vessel noise similar to typical marine | 0-1 | 1-3 | 6 | 3 | R | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | human activity in area<br>• Avoidance of proposed leatherback critical habitat<br>• Limit vessel speed<br>• Monitoring for sea turtles | | | | | | |
| Atmospheric Emissions | Polluting of sensitive habitat (e.g., IBAs) (N) | • Vessel emissions within normal range<br>• Barges anchored<br>• Engine design of newly constructed service vessels minimizes emissions | 0 | 1 | 6 | 3 | R | 2 |
| **Production of Wastes** | Polluting of sensitive habitat (N) | • Treatment of wastes<br>• Avoidance of introducing wastes to the aquatic environment | 0-1 | 1 | 6 | 3 | R | 2 |
| **DECOMMISSIONING & REHABILITATION** | | | | | | | | |
| **Towing Sea Cages** | Interaction or interference with sensitive habitat by vessels and/or sea cages (N) | • Limit tow speed (<3 knots)<br>• Avoidance of sensitive areas | 0 | 2 | 2 | 1 | R | 2 |
| **Sea Cage System Removal** | Interaction or interference with sensitive habitat by vessels and/or mooring anchors (N) | • Avoidance of sensitive areas | 0 | 1 | 3 | 1 | R | 2 |
| **Vessel Traffic** | Interaction or interference with sensitive habitat (N) | • Limit vessel speed<br>• Transiting vessels to abide by safe distance regulations for breeding seabird colony areas | 0-1 | 2-3 | 1 | 1 | R | 2 |

Key:

Magnitude:
0 = Negligible
1 = Minor
2 = Moderate
3 = Major

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = Continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1-$km^2$
2 = 1-10-$km^2$
3 = 11-100-$km^2$
4 = 101-1,000-$km^2$
5 = 1,001-10,000-$km^2$
6 = > 10,000-$km^2$

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not affected by human activity
2 = Evidence of existing effects

[a] Duration of entanglement effects (injury) is considered <1 month.
[b] All Project vessels including those associated with personnel transfer and resupply.

**Table 7.16. Significance of potential residual environmental effects of planned marine Project activities on the Sensitive Areas VEC.**

| Valued Environmental Component: Sensitive Areas | | | | |
|---|---|---|---|---|
| **Project Activity** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[a]** | |
| | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| **CONSTRUCTION** | | | | |
| **Towing Sea Cages** | NS | 3 | | |
| **Sea Cage System Installation** | NS | 3 | | |
| **Vessel Traffic** | NS | 3 | | |
| **OPERATIONS & MAINTENANCE** | | | | |
| **Presence of Farmed Salmon** | NS | 2–3 | | |
| **Deposition from Sea Cages** | NS | 2–3 | | |
| **Presence of Sea Cage Sites** | NS | 2–3 | | |
| **Use of Vessels[b]** | | | | |
| Traffic | NS | 2–3 | | |
| Noise | NS | 2–3 | | |
| Atmospheric Emissions | NS | 3 | | |
| **Production of Wastes** | NS | 2–3 | | |
| **DECOMMISSIONING & REHABILITATION** | | | | |
| **Towing Sea Cages** | NS | 3 | | |
| **Sea Cage System Removal** | NS | 3 | | |
| **Vessel Traffic** | NS | 3 | | |

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 $km^2$.

Residual environmental Effect Rating:
S = Significant Negative Environmental Effect
NS = Not-significant Negative Environmental Effect
P = Positive Environmental Effect

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Level of Confidence: based on professional judgment:
1 = Low
2 = Medium
3 = High

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low
2 = Medium
3 = High

[a] Considered only in the case where 'significant negative effect' is predicted.
[b] All Project vessels including those associated with personnel transfer and resupply.

### 7.4.1.3 Vessel Traffic

Project-related vessel traffic during the construction period would include a multi-service vessel towing sea cages and two service vessels. Vessel traffic transiting between Marystown and proposed sea cage sites, between proposed sea cage sites, or manoeuvering in the immediate vicinity of proposed sea cage sites may disturb marine mammals which aggregate within the EBSA, or leatherback sea turtles within the EBSA and/or proposed leatherback critical habitat. Based on known response of marine mammal and sea turtle response to vessels (see Sections 7.3.3 and 7.3.4, respectively) effects are considered localized and temporary. Seabirds inhabiting or nesting within the EBSA's IBAs may be disturbed by close vessel passage. The effects of vessel traffic during the construction period are mitigated by:

- Limiting vessel speed to <3 knots (5.6 km/h) for towing and ≤10 knots (18.5 km/h) for transiting; and
- Abiding by safe distance regulations for specific breeding seabird colony areas.

Mitigation measures are further detailed in Section 2.5.

After implementation of mitigation measures, vessel traffic during the construction phase of the Project is predicted to have residual *negative* effects on the SA VEC that are *negligible* to *minor* in magnitude over a geographic area of *1–10 km²* to *11–100 km²* for a duration of *<1 month* (see Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of vessel traffic during construction on the SA VEC are predicted to be *not significant* (see Table 7.16). The level of confidence associated with this prediction is *high*.

### 7.4.2 Operation and Maintenance

#### 7.4.2.1 Presence of Farmed Salmon

The main potential effect of the presence of farmed salmon in the sea cages is the potential for disease and parasite transfer (see Section 7.1.2.2), followed by the attraction of marine predators to the sea cage sites, potentially including birds (seabirds as well as bald eagles and osprey), wild fish, cetaceans, harbour seals, grey seals, and river otters. The attraction of marine fauna to the sea cages increases their risk of entanglement (e.g., sharks, marine mammals) and the possibility of disease or parasite transfer to wild fishes. See Section 7.1.2.2 for the effects assessment of sea lice and disease transfer from farmed fishes to wild fishes. The key mitigation measures for the effects of the presence of farmed salmon on the SA VEC include:

- Ongoing monitoring of health of fish in the sea cages;
- Implementing biosecurity measures;
- Utilizing predator avoidance nets;
- Maintaining routine husbandry practices; and
- Implementation of the Fish Health Management Plan.

Mitigation measures are further detailed in Sections 2.5.

After implementation of mitigation measures, the presence of farmed salmon is predicted to have residual *negative* effects on the SA VEC that are *minor* in magnitude over a geographic area of *<1 km²* for a duration of *13–36 months* (see Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of farmed salmon presence on the SA VEC are predicted to be *not significant* (see Table 7.16). The level of confidence associated with this prediction is *medium* to *high*.

#### 7.4.2.2 Deposition from Sea Cages

The effects of deposition from sea cages are detailed in Section 7.1.2.3. The potential accumulation of organics material deposited in the vicinity of sea cage sites could potentially alter or render sensitive habitat unusable (e.g., important spawning, nursery or feeding habitat that lead to the designation of the Bay as an EBSA), smother sensitive benthic organisms, or lead to nutrification and attract species which may negatively alter the local habitat (e.g., fish spawning and nursery habitat that supports fish species diversity and density within the EBSA). The key mitigation measures for the effects of deposition from sea cages on the SA VEC include:

- Selecting sea cage site locations with sufficient current velocity and direction and adequate depth to minimize depositional build-up;
- Selecting sea cage site locations with >50% hard bottom substrate type;

- Ensuring sea cages are located away from sensitive areas and an adequate distance away from other human activities in Placentia Bay (e.g., sewage outfalls);
- Scheduling fallowing periods for sea cage sites to decrease the accumulation of organic materials or the attraction of wild fauna;
- Using biodegradable detergents during routine cleaning, after harvesting and during fallowing;
- Minimizing biofouling through routine sea cage cleaning via ROV;
- Avoiding the presence of excess feed by utilizing automatic feeding systems which will cease feed delivery upon ~80% salmon satiation; and
- Regularly monitoring for aquatic invasive species and reporting observations to DFO.

Details regarding mitigation measures are provided in Section 2.5.

After implementation mitigation measures, deposition from sea cages is predicted to have residual *negative* effects on the SA VEC that are *minor* in magnitude over a geographic area of *<1 km²* for a duration of *13–36 months* (see Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of deposition from sea cages on the SA VEC are predicted to be *not significant* (see Table 7.16). The level of confidence associated with this prediction is *medium* to *high*.

### 7.4.2.3 Presence of Sea Cage Sites

As discussed previously (Sections 7.3.3.1 and 7.3.4.1), there is potential for marine mammals and sea turtles to become entangled at the sea cage sites. There will also be a minor loss of habitat. Several mitigation measures designed to minimize the likelihood of marine mammals, including SAR, becoming entangled at its sea cage sites and to minimize the effects of any entanglements will be implemented. Sea cage mooring and buoy lines will be kept tensioned and no loose ropes will be left trailing in the water. Additionally, proposed sea cage sites are not located in sensitive habitat for blue, North Atlantic right whale, and fin whales (or beaked whale SAR). Each sea cage is equipped with one or two video cameras with 360 degree viewing and which can be raised and lowered within the water column; this will allow for monitoring of entanglements. Any entanglement of marine mammal SAR (as well as other marine mammals) will be reported to DFO and action will be taken, in consultation with DFO (and the Whale Release and Strandings Group as appropriate), to free or remove the animal.

With mitigation measures in place, the presence of sea cage sites, is predicted to have *negative* residual effects on the SA VEC that are *negligible* to *minor* in magnitude over a geographic extent of *<1 km²*. Effects related to potential habitat loss would be continuous throughout the Project (*>72 months;* Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of the presence of sea cage sites on the SA VEC are predicted to be *not significant* (Table 7.16). The level of confidence associated with this prediction is *medium* to *high*.

### 7.4.2.4 Use of Vessels

***Presence***

Project-related vessel presence and associated traffic during the operation and maintenance period will include barges at sea cage sites, crew change, supply, feed and dead hold vessels, well boat, service vessels, multi-service vessel, and work boat(s). Vessel traffic may affect marine mammals, leatherback sea turtles, or breeding and non-breeding seabirds. The effects of vessel presence on the SA VEC are mitigated by:

- Limiting vessel speed to ≤10 knots (18.5 km/h);
- Vessels will maintain constant course and speed whenever possible;
- Vessels will alter course and speed as appropriate to avoid marine mammals and sea turtles;
- Anchoring barges while on site; and
- Abiding by safe distance regulations for breeding seabird colony areas.

Mitigation measures are further detailed Sections 2.5.

After implementation of the mitigation measures noted above, vessel traffic during the operation and maintenance phase of the Project is predicted to have residual *negative* effects on the SA VEC that are *minor* in magnitude over a geographic area of *<1 km²* for a duration of *13–36 months* (see Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of vessel traffic during construction on the SA VEC are predicted to be *not significant* (see Table 7.16). The level of confidence associated with this predication is *medium* to *high*.

***Noise***

Underwater noise from Project vessels could result in avoidance behaviour by marine fauna which may otherwise aggregate in and near the sea cage sites as a component of the Placentia Bay Extension EBSA. Increased sound levels could also disturb leatherback critical habitat. Effects of Project vessel noise on marine mammals and sea turtles were reviewed in Sections 7.3.3.2 and 7.3.4.2, respectively, and disturbance effects are considered local and temporary.

Key mitigation measures for the effects of noise on the SA VEC include:

- Barges anchoring and only operating generators while on site at sea cages;
- Utilizing vessels which produce operational noise within the normal range of typical marine anthropogenic activity in Placentia Bay;
- Avoiding proposed leatherback sea turtle critical habitat (e.g., proposed crew change vessel routes do not enter the proposed critical habitat, and service vessel routes may briefly transit within only the northwestern-most portion of the habitat within/adjacent to the Rushoon BMA);
- Limiting vessel transit speeds to ≤10 knots (18.5 km/h);
- Vessel crew maintaining watch for sea turtles and altering course as needed to avoid interactions; and
- Prohibiting the approach of marine mammals and sea turtles by vessel crew.

Mitigation measures are further described in Section 2.5.

After implementation of the above mitigations, noise is predicted to have residual *negative* effects on the SA VEC that are *negligible* to *minor* in magnitude over a geographic extent of *<1 km²* to *11–100 km²* for a duration of *13–36 months* (see Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of atmospheric emissions on the SA VEC are predicted to be *not significant* (see Table 7.16). The level of confidence associated with this prediction is *medium* to *high*.

***Atmospheric Emissions***

Atmospheric emissions during marine operations and maintenance would include those produced by attendant barge and other Project-related vessels. Atmospheric emissions from Project-related vessels

could in theory impact IBAs within Placentia Bay, the presence of which are one of the factors which led to the Bay being designated as an EBSA. The primary mitigations measures for the effect of atmospheric emissions on the SA VEC include:

- Avoiding IBAs and areas near IBAs;
- Ensuring, as a minimum that atmospheric emissions from Project vessels are within the normal range of typical marine vessels in eastern NL;
- Abiding by safe distance regulations for breeding seabird colonies;
- Anchoring feed/accommodation barges; and
- Designing newly constructed service vessels to minimize emissions and comply with the new Tier Three Regulations of Transport Canada and Annex VI of MARPOL 73/78.

Atmospheric emissions are predicted to have residual *negative* effects on the SA VEC that are *negligible* over a geographic extent of *<1 km²* for a duration of *13–36 months* (see Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of atmospheric emissions on the SA VEC are predicted to be *not significant* (see Table 7.18). The level of confidence associated with this prediction is *high*.

### 7.4.2.5 Production of Wastes

As indicated in Table 2.19, wastes that will be generated at the sea cage sites during operation and maintenance may include sanitary waste and wastewater, fish waste, fish mortalities, uneaten fish feed, petroleum products, paints, operational debris, and cleaning products. Potential effects and mitigation measures for fish waste, fish mortalities and uneaten fish feed were discussed in Section 7.1.2.3. Mitigation measures for the potential effects of production of wastes on the SA VEC include:

- Assuring vessels are in good working order and have internal tanks for freshwater, grey water and sewer/waste waters;
- Abiding by management practices to reduce the amount, frequency and risk associated with the use of petroleum products;
- Reusing petroleum products when possible (e.g., waste oil can be collected and burned);
- Choosing environmentally-friendly petroleum products when possible (e.g., food-grade grease/oil);
- Minimizing the use of paint products by ensuring that painting is done prior to deployment;
- Reducing the amount of operational debris waste generated (e.g., buy products with less packaging);
- Recycling when possible (e.g., cardboard, aluminum cans, plastic bottles, e-waste, etc.);
- Transferring on-site waste to land for disposal in accordance with BPWMC;
- Waste management consistent with industry best practices and MARPOL 73/78 Annexes IV/V;
- Ensuring no waste is thrown overboard;
- Using cleaning products that can enter the vessels' grey water tanks and be easily broken down;
- Prohibiting bilge dumping;
- Initiating pollution prevention training and orientation, and maintaining an ongoing environmental awareness program.
- Vessels carrying portable waste tanks interchangeable with the barge systems;

- Implementing management practices to reduce the amount and frequency of use of on board cleaning products; and
- Refueling barges in accordance with the *Canada Shipping Act* and Transport Canada procedures.

Further details regarding these mitigation measures in Section 2.5 and Grieg NL's Waste Management Plan (Appendix J).

The production of wastes during operation and maintenance is predicted to have residual *negative* effects on the SA VEC that are *negligible* to *minor* in magnitude over a geographic area of *<1 km²* for a duration of *13–36 months* (see Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of the production of wastes on the SA VEC are predicted to be *not significant* (see Table 7.16). The level of confidence associated with this prediction is *medium* to *high*.

### 7.4.3 Decommissioning and Rehabilitation

#### 7.4.3.1 Towing Sea Cages

The same potential effects and mitigation measures for towing sea cages apply during decommissioning and rehabilitation as during construction for the SA VEC (see Section 7.4.1.1). The residual *negative* effects of towing sea cages on the SA VEC are *negligible* in magnitude over a geographic area of *1–10 km²* for a duration of *<1 month* (see Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of towing sea cages on the SA VEC during this Project phase are predicted to be *not significant* (see Table 7.16). The level of confidence associated with this prediction is *high*.

#### 7.4.3.2 Sea Cage System Removal

The potential effects and mitigation measures for sea cage system removal on the SA VEC are identical to those for sea cage system installation. The residual *negative* effects of sea cage system removal on the SA VEC are *negligible* in magnitude over a geographic area of *<1 km²* for a duration of *<1 month* (see Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of sea cage system removal on the SA VEC are predicted to be *not significant* (see Table 7.16). The level of confidence associated with this prediction is *high*.

#### 7.4.3.3 Vessel Traffic

Potential effects and mitigation measures for vessel traffic on the SA VEC during decommissioning and rehabilitation are equivalent to those for vessel traffic during construction. Vessel traffic during the decommissioning and rehabilitation phase of the Project is predicted to have residual *negative* effects on the SA VEC that are *negligible* to *minor* in magnitude over a geographic extent of *1–10 km²* to *11–100 km²* for a duration of *<1 month* (see Table 7.15). Based on these criteria ratings, the *reversible* residual *negative* effects of vessel traffic during decommissioning and rehabilitation on the SA VEC are predicted to be *not significant* (see Table 7.16). The level of confidence associated with this predication is *high*.

## 7.5 Socio-economic VECs

The EIS Guidelines provide guidance regarding the socio-economic aspects requiring consideration for the proposed Project. The existing socio-economic environment in which the Project would be built and

operated has been described in the EIS according to the Guidelines in terms of Land and Resource Use (Section 4.4), Heritage Resources (Section 4.5), Communities (Section 4.6) and Economy, Employment and Business (Section 4.7).

The Component Study entitled *The Cultural, Recreational and Commercial Importance of the Waters of Placentia Bay* (Grattan et al. 2018 *in* Volume 3) was also prepared as part of the EIS process. This Component Study examined the cultural, recreational and commercial value of the waters of Placentia Bay and the potential effects of the proposed Project on these aspects. It included examinations of fisheries (recreational, commercial and indigenous), tourism, marine navigation (commercial and recreational), and unique areas of ecological sensitivity and habitat enhancement efforts.

The extensive discussions that senior personnel from Grieg NL have had with stakeholders since 2015 have also served to identify the socio-economic interests of the residents of the Burin Peninsula and the shores of Placentia Bay (Appendix D). Grieg NL's proposed Project is seen as having potential socio-economic implications that are important to the residents of the Burin Peninsula, particularly those within the Study Area. Over the past few years, the Burin Peninsula has seen a high level of out-migration, economic decline and need of long-distance commute for work (Section 4.7). Employment questions were consistently raised during consultation meetings conducted by Grieg NL (P. Power, Human Resources Manager, Grieg NL, pers. comm., 20 February 2018).

### 7.5.1 Research and Analysis Overview

The research and analysis for the Component Study including consultation found that, with mitigation measures such as liaison and continued consultation, there would be negligible effects on fisheries or navigation, possibly some benefits to increasing tourism and introducing eco-tourism, and identified operational practices for sensitive areas. The review of the existing socio-economic environment has demonstrated that there is unused capacity in the Study Area for recreation and tourism, including eco-tourism. The current extent and level of tourism does not reflect the natural beauty and long history and heritage of the Study Area. There is also unused capacity in the education facilities, housing market, and recreational facilities in the Study Area. There is engaged community leadership, both at the municipal council level and the volunteer community, with many of the communities equipped with thoughtful and forward-looking Integrated Community Sustainability Plans. At the same time, there are also a declining and ageing population, closed businesses, and the need for economic opportunity.

The Project proposed by Grieg NL is not the 'boom and bust' activity accompanied by an influx of temporary workers that has often been the experience of Burin Peninsula residents. This Project is the start of a long-term industry that should continue for years.

### 7.5.2 Assessment of Effects

As outlined in Section 3.3, socio-economic VECs selected for this EIS include:

- Demographics; and
- Economy: Training, Employment and Business

The interactions between planned project activities and the socio-economic VECs are indicated in Table 7.17.

**Table 7.17. Potential interactions of Project activities and socio-economic VECs.**

| Project Activities | Valued Environmental Components | |
|---|---|---|
| | **Demographics** | **Economy: Training, Employment and Business** |
| CONSTRUCTION | | |
| Construction of the RAS Hatchery | X | X |
| Fabrication of the sea cages | X | X |
| Construction of project vessels and barges | X | X |
| Preparation for marine operations (e.g. feed storage) | | X |
| Installation of sea cages, barges in BMAs | | X |
| Production of Wastes | | X |
| OPERATIONS & MAINTENANCE | | |
| Operation of RAS Hatchery | X | X |
| Operation of Sea Cage Sites | X | X |
| Production of Wastes | | X |
| DECOMMISSIONING & REHABILITATION | | |
| Removal of Equipment and Infrastructure | | X |
| Production of Wastes | | X |

### 7.5.2.1 Demographics VEC

The population of the Burin Peninsula has been declining for the past 15 years, reflecting a province-wide rural trend. There were 5,000 fewer people on the Peninsula in 2016 than in 2001. A recent review of population trends in the province by the GNL showed that the population of the Burin Peninsula (Zone 16) decreased by 26% between 1991 and 2007. The decline slowed to 7.6% over the next 10 years (2007–2017). It is predicted that there will be a ~24% decline over the next 20 years (GNL 2018a).

Newfoundland and Labrador faces considerable demographic challenges in relation to its labour force. An ageing population combined with a low birth rate has resulted in more people reaching retirement age than there are younger people to replace them in the work force, a trend that is worsening over time. The Province's typical working age population (15–64) is projected to decrease by 6% within the next seven years, while the population over 65 is expected to increase by 32% in this same time period (GNL 2015; Statistics Canada 2018a).

In 2018, nearly 7,000 people are expected to leave the work force while less than 5,000 will enter it. About 25 years ago, there were 100 new entrants for every 50 people exiting the workforce. Currently, it is estimated that for every 100 new entrants to the work force, there are ~125 people exiting it (GNL 2015a; Statistics Canada 2018). This gap is expected to widen over the 2025 forecast period although as significant numbers of people retire from the labour market, there will be more job openings for qualified younger people.

Demographics involve more than numbers. Families form a large portion of the population on the Burin Peninsula. There were 6,718 families among the nearly 20,000 people living on the Burin Peninsula in 2016 (average family size of 2.4). Of these, 75% were married couples, 11% were common-law couples and 13% were single parent families. Among the total number of families, ~41% had children at home (Statistics Canada Census 2018b).

Since the cod moratorium in 1992, there has been considerable long-distance commuting for work in the province, resulting in family members being separated for weeks at a time. It was suggested during the consultations on the Burin Peninsula in February 2018 that the downturn in the economy had changed practices by some of the employers in western Canada. Their decision to no longer pay for employee flights between the province and the work location may have caused families to leave the Burin Peninsula and possibly the province (H. Murphy, Resident, Parker's Cove, pers. comm., 20 February 2018).

The Municipal Plan for the Town of Fortune recognizes that this essential practice of long-distance commute can be detrimental to a community (HMJ 2015). It states the following:

> *"Finally, and very importantly, a substantial number of people work away from their home communities, commuting on a longer work cycle to opportunities outside the province and in the capital region. Although the income brought to the home communities is very important, an unfortunate side effect is that the social fabric of the community is weakened, as some adults who travel away become naturally not much connected to the events and organizations at home."*

***Mitigation Measures and Enhancement***

Measures are being taken to mitigate and help balance the supply and demand of labour in the Province's marketplace. The Province's *Population Growth Strategy* (GNL 2015) is focused on increasing immigration, including the return of Newfoundlanders who left home to work elsewhere.

The addition of a new industry with year-round employment to the Burin Peninsula would be helpful in stemming the out-migration caused by economic reasons. Grieg NL has focused their communication initiatives about the Project on the Burin Peninsula and encouraged interest in work on the Project in their presentations. Approximately 1,200 people attended a Grieg NL information session in Marystown about Project employment and more than 2, 000 resumes have been submitted at the Grieg NL Project office (Appendix D).

***Residual Effects and Significance***

The assessment of residual effects for the Demographics VEC (as well as the Economy, Employment, and Business VEC) is shown in Table 7.18. The assessment has been based on the attributes and effects ranking described in Section 3.7.5 and reflects mitigation measures already put in place. The attribute of Reversibility has not been ranked because reversibility is not applicable if Project effects are positive. Significance is also shown for each VEC.

As a result of the Project effects and the mitigation measures that will be put in place, the effect on demographics are predicted to be *positive* as an increase in employment will facilitate residents remaining and/or returning to the Burin Peninsula. The magnitude will be *high* as the Project should bring sustained changes within the geographic extent at the *local* (i.e., Burin Peninsula) and *regional* level (i.e., Study Area). In terms of duration and frequency, the RAS Hatchery and the sea cages will be operated on a *continuous* basis for many years (i.e., *long-term*). The level of confidence in the information developed for the EIS and certainty of the predicted effect on demographics are both *high*. An increase in the local/regional economy will encourage some residents to remain but may not attract some families who are now established in other communities, either in the province or elsewhere, hence the effectiveness of enhancement of the economic condition is ranked as *moderate*. Overall, the residual effects of the Project on demographics are assessed as *positive* and *moderate.*

**Table 7.18. Socio-economic VECs residual effects assessment summary.**

| Socio-economic VEC | Direction | Magnitude | Geographic Extent | Duration | Frequency | Level of Confidence | Certainty | Mitigation or Enhancement Success | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Demographics | Positive | High | Local/Regional | Long term | Continuous | High | High | Moderate | Moderate |
| Training | Positive | High | Local | Long term | Continuous | High | High | High | Mod/High |
| Employment | Positive | High | Local/Regional | Long term | Continuous | High | High | High | Mod/High |
| Business: new or expanded | Positive | High | Regional | Long term | Continuous | High | High | Moderate | High |

Note: Local refers to the Burin Peninsula, Regional to the Study Area which encompasses all of Placentia Bay.

### 7.5.2.2 Economy: Training, Employment, and Business VEC

The Economy: Training, Employment, and Business VEC considers in detail training, employment, and business opportunities associated with the Project.

***Training***

All core education and training for Project occupations and positions (Section 2.6) are available at facilities and institutions within the Province. The core skills and knoweldge required for the RAS Hatchery and sea cage site operations are available through programs provided by public and private education and training insitutions in the Province. The Department of Advanced Education, Skills and Labour (AESL) and its Literacy and Institutional Services Division are responsible for post-secondary education and training in the Province, with direct support to Memorial University and its Fisheries and Marine Institute and Grenfell Campus, and the College of the North Atlantic. The Department, which has offices throughout the province including Marystown, is also responsible for regulating and monitoring 23 private training institutions in the province as well as international education (GNL 2018b).

The Fisheries and Marine Institute already offers several key training programs related to aquaculture. Enrolment in the 2014 and 2015 school years indicate 135 potential recruits with diplomas in food technology and marine environmental technology, and advanced diplomas in areas like food safety, sustainable aquaculture and water quality (Appendix X). It is expected that new training programs will come online as needed, possibly in concert with the College of the North Atlantic which has facilities throughout the province.

*Mitigation Measures/Enhancements*

Grieg NL has initiated working relationships with Memorial University and its Fisheries and Marine Institute, as well as with the College of the North Atlantic and private colleges on the Burin Peninsula to develop a multi-year training plan that is tied to the schedules and plans for operation of the RAS Hatchery and sea cage sites. Grieg NL has also initated discussions with Keyin College, a private college with facilities in Burin/Marystown, regarding its core curriculum and availability for potential customized on-site and site-adjacent orientation and training. Keyin College has proposed an Aquaculture Program to Grieg NL.

The Project workforce onboarding approach will include a combination of training and education at institutions and facilities within the Province, and added technical orientation and hands-on training for job-specific equipment, operational and safety specifications and standards. Customized training will be provided for operating equipment and systems unique to this Project in accordance with Grieg NL's operating standards. These are proprietary to Grieg NL's contractors' equipment manufacturers and suppliers (P. Power, Human Resources Manager, Grieg NL, pers. comm., March 2018).

Grieg NL intends for training and orientation to be provided on the Burin Peninsula, on-site at the Marine Industrial Park, with the inclusion of local institutions and facilities wherever possible. In select situations, to comply with standards and to ensure direct learning and experience, orientation and training will be provided at out-of-province operating aquaculture sites and original equipment manufacturers plants in Norway, Israel, America, western Canada and other sites (P. Power, Human Resources Manager, Grieg NL, pers. comm., March 2018).

*Residual Effects and Significance*

The assessment of residual effects for the training component of the Economy, Employment and Business VEC is shown in Table 7.18. The assessment has been based on the attributes and effects ranking described in Section 3.7.5 and reflects the mitigation measures/enhancements already put in place.

As a new, long -term business endeavour, Project effects on training are predicted to be *positive* and *high* in magnitude as the Project should bring sustained changes within the geographic extent at the *local* and *regional* levels. In terms of duration and frequency, the RAS Hatchery and the sea cages will be operated on a *continuous* basis for many years (i.e., *long-term*). The level of confidence in the information developed for the EIS and certainty in the predicted effect on training are both *high*. It is anticipated that there will be more training options offered by both public and private colleges and increased enrollment; hence, the effectiveness of enhancement of training opportunities ranked as *high*. Overall, the residual effects of the Project on training are assessed as *positive* and *moderate* to *high*.

***Employment***

Grieg NL has developed an initial description of the anticipated workforce for all stages of the Project (Appendix X). The company anticipates that the construction phase, which will involve the building of the RAS Hatchery and fabrication of the sea cages, will require more than 200 skilled workers for technical and engineering positions, and skilled trades (see Table 2.21). With the current downturn in the construction industry in the province, it is expected that a sufficient labour pool will be available on the Burin Peninsula itself or within the Placentia Bay area (Table 7.19).

During the operations phase, Grieg NL expects to directly hire 170 workers, with additional hires by contractors and suppliers (see Table 2.22). While some positions relate to administration and maintenance, most are technical and specific to the industry.

There is considerable interest among Burin Peninsula residents in potential employment with the Project. A job fair in Marystown during October 2016 attracted over 1,200 people (see Appendix D). Without formal solicitation for positions with the Project, Grieg NL has already received almost 2,500 resumes at their Marystown office, expressing interest in both construction and marine operations work. The following is a breakdown of the 2,449 job inquiries:

- 938 females and 1,511 males expressed interest in employment;
- 407 of the applicants expressed interest in all aspects of the work (i.e., construction and long-term operations);
- Interest in construction work was expressed by 1,370 applicants (1,156 males and 214 females); and
- Interest in operational work was expressed by 1,686 applicants (880 males and 806 females).

**Table 7.19. Population aged 25–64 years by highest educational attainment, Province and Burin Peninsula, 2016.**

| Highest Education Level | Newfoundland & Labrador | | | | | | Burin Peninsula | |
|---|---|---|---|---|---|---|---|---|
| | Total | | Male | | Female | | Total | |
| | Count | % | Count | % | Count | % | Count | % |
| No certificate, diploma or degree | 45,170 | 16 | 23,965 | 17 | 21,205 | 14 | 3,186 | 30 |
| High school diploma or equivalent | 65,210 | 22 | 30,300 | 21 | 34,910 | 23 | 1,989 | 19 |
| Apprenticeship or trades certificate or diploma | 36,075 | 12 | 26,475 | 19 | 9,605 | 6 | 2,589 | 24 |
| College or other non-university certificate or diploma | 81,955 | 28 | 34,175 | 24 | 47,780 | 32 | 2,180 | 20 |
| University certificate or diploma below bachelor level | 6,680 | 2 | 2,970 | 2 | 3,710 | 2 | 34 | 0.4 |
| Bachelor's degree | 34,555 | 12 | 13,960 | 10 | 20,595 | 14 | 490 | 4 |
| University certificate, diploma or degree above bachelor level | 18,230 | 6 | 7,800 | 5 | 10,430 | 7 | 160 | 1 |
| **Total (all education levels)** | **287,875** | | **139,645** | | **148,235** | | **10,628** | |

Source: Statistics Canada (2018a).

Of the 2,449 applicants, 1,672 are from the Burin Peninsula, 173 are from the Placentia Bay area, 289 applicants indicated that they are originally from the Burin Peninsula but now live in other parts of Canada and wish to return home, and 315 applicants are from other parts of the Province.

*Mitigation Measures/Enhancements*

The communities and residents of the Burin Peninsula, particularly Marystown, have experienced the 'boom and bust' effects of many previous projects, which frequently required large, temporary work forces. The proposed Project anticipates that the majority of the workforce will be from the Burin Peninsula and, while there is a start-up construction phase, the work will be done at an existing industrial site, utilizing many of the traditional building skills available on the Peninsula. Grieg NL has indicated their expectation of best efforts regarding local employment, as well as training and procurement, to their major suppliers, and will monitor efforts and success for continuous improvement.

Grieg NL is committed to diversity in its workplaces and extends this commitment to its contractors and subcontractors. Project tender-related documents will inform bidders of their obligation to assist with maximizing the involvement of women and reporting the results of efforts and outcomes. Grieg NL has developed and issued a women's employment policy for the Project entitled *Placentia Bay Atlantic Salmon Aquaculture Project Women's Employment Plan, 2016* (WEP; see Appendix Y). The WEP includes measures to address employment equity and diversity in both the recruitment and retention of workers.

Grieg NL has developed a Code of Conduct and Ethics that supports women in the workplace, and has already initiated and will continue to enforce policies and practices to address retention (Appendix Y).

Any recruitment or hiring information will emphasize gender diversity, and specific efforts will be made to ensure women are well-represented in photographs or drawings of project work.

Retention of women in industries that have traditionally been male-dominated is a challenge. Grieg NL will continue to work with relevant groups and associations in the community to establish and maintain a positive and effective approach to employment diversification.

The aquaculture industry, which is still relatively new in NL, currently employs fewer than 500 people, but that is expected to change in the coming years (GNL 2017a,b). The sector is a strategic growth area for the Province and new projects are in development. The aim is to double current levels of salmon production to 50,000 mt, and triple mussel production to 10,750 mt while creating a new employment target of 1,100 person years of employment (GNL 2017d).

The Province and NAIA, working in partnership with federal government and provincial education partners, have developed a work plan to grow the aquaculture industry. Human resource development is one part of that plan. NAIA is currently completing a Labour Force Strategic Review for the aquaculture industry (GNL 2017c).

*Residual Effects and Significance*

As a new, long-term business endeavour, Project effects on employment are predicted to be *positive*. The effects will be *high* in magnitude as the Project should bring sustained changes within the geographic extent at the *local* and *regional* levels. In terms of duration and frequency, the RAS Hatchery and the sea cages will be operated on a *continuous* basis for many years (i.e., *long-term*). The level of confidence in the information developed for the EIS and certainty of the predicted effects on employment are both *high*. It is anticipated that, in addition to the direct employment with the Greig NL office, RAS Hatchery and sea cage sites, there will be considerable indirect employment with suppliers. Hence, the effectiveness of enhancement of the economic condition is ranked as *high*. Overall, the residual effects of the Project on employment are assessed as *positive* and *moderate* to *high*.

***Business***

The Project will require that a wide range of services be purchased by Grieg NL and its suppliers and contractors. The typical and expected range of services and supplies requiring procurement from businesses are provided in Table 4.77.

Most of the businesses in the Province are located in the St. John's metropolitan area on the Avalon Peninsula, located about three and a half hours by vehicle from Marystown. In 2017, just over half (53%) of businesses in the Province were located on the Avalon Peninsula. Only 3.2% were located on the Burin Peninsula and 5.7% in the nearby Clarenville-Bonavista region (GNL 2018c). There is a cluster of businesses in the Avalon Isthmus area serving primarily oil and gas and mining industrial operations in the immediate area. Several of these are familiar with major construction and fabrication endeavours (M. Butland, Owner, Butland Communications, pers. comm., 25 April 2018).

The number of businesses on the Burin Peninsula has declined over the last decade, from 699 in 2007 to 504 by the end of 2017 (i.e., ~28% decrease; GNL, 2018c). The decrease was more drastic on small businesses on the Burin Peninsula (i.e., ~40% decrease in small businesses with fewer than five employees). These figures reflect an overall declining trend in business numbers in rural areas.

*Mitigation Measures/Enhancement*

There is some business capacity in the region to serve the Project. Grieg NL has made a commitment to support as many of these local businesses as possible. There are opportunities for existing public and private businesses (J. Bradley, Business Development Officer, Canada Business Network, pers. comm., 9 March 2018) including:

- Hardware supplies;
- General freight trucking;
- Employment placement agencies;
- Automobile sales, parts and repair services;
- Industrial equipment rental and leasing for construction and operation;
- Engineering services;
- Commercial banking;
- Printing;
- Media broadcast;
- Petroleum and petroleum products;
- Regulation, licensing and inspection;
- Durable goods;
- Metal work;
- Building materials;
- Furniture and furnishings;
- Office supplies;
- Surveying and mapping;
- Seafood processing, production, preparation and packaging;
- Accommodations and food services;
- Wholesale and retail supplies; and
- Real estate and rentals.

Grieg NL's approach to procurement will include a combination of services and supplies provided by companies in the Province, either directly or through partnerships and joint ventures with international companies. The company will establish business relationships and operations in NL wherever possible to maximize provincial economic returns.

Grieg NL has initiated working relationships with its core suppliers (e.g., Aqualine, AquaMaof) and others related to the schedules and plans for operation of the RAS Hatchery and sea cage sites. In order to comply with standards and to ensure best practices, it will be necessary, in select situations, for Grieg NL to procure materials, equipment and operating systems from out-of-province suppliers, including original equipment manufacturers. Grieg NL intends that procurement by contractors will occur on the Burin Peninsula, on-site or site-adjacent, employing local companies and businesses wherever possible. Grieg NL will encourage major suppliers to locate facilities in the Study Area.

Grieg NL initiated contact with economic development groups throughout the Burin Peninsula as early as 2015 (Appendix D) in order to outline the project schedule and the services and materials that would be needed for the Project. Grieg NL has maintained contact with these groups to ensure they have timely and accurate Project information. Grieg NL has also provided this information at trade shows and conferences around Placentia Bay and elsewhere in the province (Appendix D). In addition, Grieg NL has met with many potential suppliers both through appointments and as drop-ins at the Project office in Marystown.

Grieg NL will continue to be active within the business community on the Burin Peninsula (e.g., through continued liaison with economic development groups, the Burin Peninsula Chamber of Commerce, the CBDC).

Grieg NL will endeavour to provide a timely and thorough outline of its supply and service needs in a form that reaches businesses throughout the Burin Peninsula, the Study Area and the province. Examples from elsewhere, such as Scotland, indicate a ripple effect from aquaculture, with an expanding circle of suppliers and effects.

Aquaculture is not new to the province or to Placentia Bay, which has supported small scale cod grow out operations and mussel farming in the past. However, the Grieg NL Project will be the start of a different era for the aquaculture industry for Placentia Bay considering its large scale, its advanced technology and operational practices, and its culture of a different species, Atlantic salmon.

As noted earlier, significant growth in the aquaculture industry is anticipated. The Budget 2018 document highlights the joint Provincial Government and the NAIA work plan entitled *The Way Forward on Aquaculture: Sector Work Plan in Newfoundland and Labrador*. This plan includes the increase of commercial salmon production to 50,000 mt and commercial mussel production to 10,750 mt. If achieved, this plan would create an estimated additional 1,100 person years of employment in the provincial economy. The work plan outlines 28 specific action items to grow the industry.

There are already indications of this growth. In addition to Grieg NL's proposed Project, another company, Marine Harvest, is actively consolidating existing aquaculture companies in the Baie D'Espoir area. These plans, plus the strong support from the provincial government and the NAIA, are attracting interest from new groups and suppliers who are considering partnerships and joint ventures to service both the Grieg NL Project and other emerging aquaculture developments. One new supplier has recently bought property in Grand Bank with the intention of positioning itself to service aquaculture projects in both Placentia Bay and in the Baie D'Espoir area on the south coast (C. Collier, Chair, Grand Bank Development Corporation, pers. comm., 16 March 2018).

The proposed Grieg NL Project has already prompted research in the Province, including the development of techniques to raise lumpfish to be used as cleaner fish for sea lice on farmed salmon, the investigation of possible markets for harvested lumpfish, and the idea of using the ensilage as soil enhancement or a feed additive. Efforts continue to finds ways and products that will make use of every part of the harvested fish. These efforts, in turn, could also lead to new business opportunities.

*Residual Effects and Significance*

As a new, long term business endeavour, Project effects on business will be *positive*. The effects are predicted to be *high* in magnitude as the Project should bring sustained changes at the *local* and *regional* level. In terms of duration and frequency, the RAS Hatchery and the sea cage sites will be operated on a *continuous* basis for many years (i.e., *long-term*). The level of confidence in the information developed for the EIS and certainty about the predicted effect on business opportunities are both *high*. The major project facilities, the RAS Hatchery and the sea cages will be procured from proven, international suppliers. However, Grieg NL has indicated that there is still a wide range of services that will be necessary and that the company will use an active approach toward procurement that encourages local procurement; hence, the effectiveness of enhancement of the economic condition is ranked as *moderate*. Overall the residual effects of the Project on business are assessed as *positive* and *high*.

***Conclusions of the Socio-economic Assessment***

Based on the assessment of the potential effects of planned Project activities on the Demographics VECs and the Economy, Employment and Business VEC, the effects of the proposed Grieg NL project are *positive* and *significant*.

## 7.6 Cumulative Effects

A cumulative effects assessment of the Project on the environment relative to the primary biophysical VECs: (1) Fish and Fish Habitat; (2) Wild Salmon; (3) Species at Risk; and (4) Sensitive Areas and of the Socioeconomic VEC, Economy: Training, Employment and Business is provided below. Cumulative environmental effects of the Project are considered where the potential exists for overlap with other projects or activities within or near the Study Area. A qualitative approach to this assessment has been undertaken given the inherent issues with cumulative effects assessment (Duinker et al. 2012). As the footprint area for the RAS Hatchery has already been cleared, the focus of the cumulative effects relates to the sea farm component of the Project. The primary activities with potential for overlap with sea farm Project activities include vessel traffic and existing aquaculture projects and potential research or rehabilitation projects. These components, along with sewage and industrial outfalls, and proposed developments, are assessed for each primary VEC that could potentially be most affected.

### 7.6.1 Environmental Components

The primary environmental components constituting the focus of the cumulative environmental effects assessment include:

- Vessel traffic within Placentia Bay, including:
    - Marine shipping and associated pilot vessels;
    - Ferries;
    - Fishing vessels;
    - Tour vessel;
    - Recreational vessels;
    - Research activities;
    - Canadian Coast Guard vessels;
- Existing aquaculture sites within and near Placentia Bay;
- Sewage outfalls within Placentia Bay;
- Effluent outfalls associated with Vale Long Harbour Nickel Processing Facility and North Atlantic Refining Limited Oil Refinery in Come by Chance; and
- Proposed developments within Placentia Bay.

The above components are described and their selection justified in Section 7.6.3, Selected Projects and Activities, below.

### 7.6.2 Geographic and Temporal Boundaries

#### 7.6.2.1 Geographic Boundaries

The geographic boundaries of the cumulative environmental effects assessment include the marine waters within and in the immediate vicinity of Placentia Bay as well as the communities on the Burin Peninsula and shores of Placentia Bay (see Section 7.6.1, Environmental Components).

### 7.6.2.2 Temporal Boundaries

As described in Section 3.6.1, the temporal boundaries of the cumulative environmental effects assessment include the construction (i.e., sea cage towing and installation), operation and maintenance, and decommissioning and rehabilitation (i.e., sea cage and associated equipment/material removal) phases for the sea farm component of the Project. Sea cage site construction is anticipated to require <1 month (up to 12 cages may be towed/installed during a one to two-day period) and installation of moorings and cages will be completed within six years of the start of construction. Operation and maintenance is expected to occur at full production for a minimum of ten years, although this phase will likely occur longer as a result of continuous facility maintenance and site fallowing. Decommissioning and rehabilitation for all Project components is estimated to be completed over two years, with the sea farm portion likely requiring approximately one month, providing the duration is similar to that of the construction phase.

## 7.6.3 Selected Projects and Activities

### 7.6.3.1 Description

***Vessel Traffic***

Vessel traffic within Placentia Bay is described in Section 4.4.4, Marine Navigation. The Canadian Coast Guard traffic separation scheme dictates the vessel traffic lanes that may be utilized by large vessels (i.e., ships ≥20 m in length overall or combined ship and towed/pushed object length). These lanes occur within the eastern portion of Placentia Bay, including near the Long Harbour BMA (see Figure 4.66 *in* Section 4.4.4). Participation in the traffic separation scheme is not required for recreational vessels or smaller commercial vessels, which may transit throughout Placentia Bay. Typical annual vessel movements of commercial and recreational vessels within Placentia Bay are presented in Table 4.38 *in* Section 4.4.4).

*Marine Shipping and Associated Vessels*

*Vale Long Harbour Nickel Processing Facility*

Vale built a commercial-scale hydrometallurgical facility in Long Harbour, which began operations during 2014 (Vale 2017). The Long Harbour nickel processing facility will employ ~475 people at full production, and is an integrated operation with the Voisey's Bay mine and concentrator. Nickel concentrate is shipped from Voisey's Bay to Long Harbour, where it is processed into finished nickel and associated copper and cobalt products (Vale 2017). During a given year, the Long Harbour facility typically receives eight visits by the ice-strengthened bulk carrier MV *Umiak*, and two to three bulk carriers carrying reagents (see Section 4.4.4). Vessel traffic may increase up to 14 vessels per year in the near future (S. Hunt, LHPP Operations, pers. comm., 11 April 2018).

*Newfoundland Transshipment Terminal, Whiffen Head*

Constructed and in operation since 1998, the Newfoundland Transshipment (Limited) Terminal in Whiffen Head, near Arnold's Cove, is a world-class transshipment facility for eastern Canadian offshore oil production (NTL 2018). The Terminal was designed to handle crude oil production from the oilfields offshore Newfoundland and Labrador, and operates four suezmax shuttle (tanker) vessels and two tugs, *Placentia Pride* and *Placentia Hope*, which pilot/escort all laden tankers to the Terminal (NTL 2018).

The Terminal receives ~350 tankers per year, including ~110 dedicated 150,000 dwt (deadweight metric tonnes) shuttle tankers (NLRC 2007).

*North Atlantic Refining Limited Oil Refinery, Come by Chance*

The Oil Refinery in Come by Chance was constructed by Shaheen Resources in 1973, which went bankrupt in 1976 (Fitzpatrick 2017). The facility was then non-operational until being restarted and maintained by Newfoundland Processing Limited during 1986–1994, after which it was sold to the Vitol Refining Group. Vitol ran the facility until the Refinery was sold to Harvest Energy (Harvest Operations Corporation) during 2006, which was bought by the Korea National Oil Corporation (KNOC) in 2009. The Oil Refinery underwent extensive upgrades under the KNOC, and was recently sold to SilverRange Financial Partners LLC of New York during September 2017. SilverRange has committed to further upgrades at the facility, including measures to reduce sulphur dioxide emissions. The facility is capable of handling 115,000 barrels-per-day of crude oil (Fitzpatrick 2017). The Refinery's marine terminal receives ~325 tankers per year, and operates two tugs (NLRC 2007).

*Port of Argentia*

The Port of Argentia supplies services for marine industrial and research activities between North America and Western Europe (PA 2018). Capable of accepting vessels up to 300 m in length and 11 m draught, the Port of Argentia serves local, national and international marine freight, light, medium and heavy industrial, oil and gas and research and development projects (PA 2018). The Port of Argentia features three wharves, including the Navy Dock, Fleet Dock, and the private Marine Atlantic Terminal (see Ferries, below) (Vale 2008).

*Marystown Shipyard and Cow Head Steel Fabrication Facility*

The Marystown Shipyard was in operation from the late 1960s until 2015, with a second, larger facility constructed in Cow Head during the early 2000s to serve the offshore oil industry (TM 2018). The Marystown Shipyard has been dormant since 2015 (S. Synard, Mayor, Town of Marystown, pers. comm., 14 March 2018). A relatively small project began at Cow Head during late-2017, which is expected to continue until the end of 2019 (Mayor and Councillors, Town of Marystown, pers. comm., 14 March 2018). The current owner, Peter Kiewit and Sons, intends to sell the Facility, although sales negotiations have been unsuccessful to date (Fitzpatrick and Farrell 2018).

*Ferries*

Ferry vessel traffic within Placentia Bay includes the seasonal Marine Atlantic service between North Sydney and Argentia, and local ferry service between Petit Forte and South East Bight.

*CN Ferry Terminal, Argentia*

Marine Atlantic's private ferry wharf is located at the Port of Argentia (see Port of Argentia, above), north of the Navy Dock (PA 2018). The wharf is available for other use during the off-season (October–May) with prior approval from Marine Atlantic (PA 2018). The Argentia–North Sydney ferry route operates from mid-June to late-September, with the MV *Atlantic Vision* transiting in and out of Placentia Bay once per day, weather permitting (Marine Atlantic 2018).

*Local Ferry, Petit Forte to South East Bight*

One ferry, the MV *Norcon Oceanus*, operates year-round with service between Petit Forte and South East Bight (TW 2018). The ferry can transport up to 36 passengers at a time, and transits between the two communities two to three times per day, every day except Tuesdays (TW 2018). There will be additional vessel traffic in and out of Petit Forte as this location will be used for Grieg NL sea farm crew changes, expected to be once/week for each sea cage site.

*Fishing Vessels*

*Commercial*

Commercial fisheries within Placentia Bay are described in Section 4.4.2, Commercial Fisheries. Commercial fisheries vessels utilized within Placentia Bay during 2010 and 2015 included the <35', 35–44.9' and 45–64.9' class lengths, with the majority of catch taken by vessels <45' in length (see Table 4.28 *in* Section 4.4.2.3). During 2004–2005, there were 293 transits in Placentia Bay by fishing vessels of non-specified class lengths, 1,296 by recreation and fishing vessels >65', and 1,012 by unspecified vessel types <65' (see Table 4.38 *in* Section 4.4.4). The majority of non-specific length class fishing vessel traffic were inbound and outbound (i.e., vessels entering or leaving Placentia Bay), while virtually all of the length-specific vessel movements were in-zone (i.e., vessel movements that begin and end within Placentia Bay).

*Recreational*

Recreational fisheries and boating within Placentia Bay are described in Section 4.4.2.5. In Newfoundland and Labrador, recreational boating typically may be conducted utilizing non-motorized vessels, such as kayaks, or relatively low-powered open boats or vessels equipped with one to several outboard motors, sailboats and yachts. Vessels may or may not have VHF radios to access marine information. As noted above, the majority of the >1,000 annual movements by recreation and fishing vessels >65' and non-specific vessels <65' were in-zone during 2004–2005 (see Table 4.38 *in* Section 4.4.4).

*Tour Vessel*

As described in Section 4.4.3.4, Cabins and Islands, Woody Island Resort is the only large marine tour operator in the area. This Resort is operational during the summer months, utilizing a single tour vessels to transport visitors from Garden Cove to Woody Island.

*Recreational Vessels*

*Hunting*

Within Placentia Bay, vessel-based hunting occurs for seabirds, especially murres, and seals. Vessels include those typically used for recreational fishing (see Fishing Vessels – Recreational, above). Seabird hunting is described in Section 4.4.2.8, Seabird Bycatch and Hunting.

*Pleasure Craft*

Pleasure craft boating within Placentia Bay may include non-motorized vessels, such as kayaks, row-boats or dories, or motorized vessels such as those equipped with one or more outboard motors,

yachts, sailboats or Sea-Doo's. Pleasure craft are also utilized by residents and visitors travelling to cabins or seasonal homes throughout the Bay's islands, including those in communities previously abandoned during Resettlement (see Sections 4.4.2.5, Recreational Fisheries, 4.4.3, Tourism, Outfitters, Cabins and Recreation, and 4.4.3.5, Recreation).

*Research Activities*

*DFO RV Survey*

DFO RV surveys were only conducted during the spring months (March–May) in recent years (see Section 4.4.2.3, Potential Fisheries in the Study Area). During a given year, one to two Canadian-flagged vessels, RV *Alfred Needler* or RV *Teleost*, may be present within Placentia Bay, conducting the spring survey or calibrations (see Table 4.34 *in* Section 4.4.2.7). The *Needler* and *Teleost* have a length overall and breadth of 50.3 m x 11.16 m, and 63 m x 14 m, respectively (MarineTraffic 2018). Three approximately two-week DFO RV surveys and a one-week calibration exercise are typically planned occur within Placentia Bay per year.

*DFO-Industry Collaborative Post-Season Snow Crab Trap Survey*

This survey is described in Section 4.4.2.7, DFO-Industry Collaborative Post-Season Snow Crab Trap Survey. The annual survey typically occurs between early-September and November, with approximately 900 participating snow crab harvesters randomly sampling up to 73 stations within Placentia Bay, several of which are <10 km from proposed sea cage sites within the four BMAs.

*Green Crab Removal to Prepare Eelgrass Restoration Sites*

The Coastal Restoration Project in Placentia Bay is described in Section 4.4.2.7, Coastal Restoration Project–Placentia Bay. Conditions permitting, ten fishers per year harvest green crab at nine eelgrass restoration preparation sites, beginning in June and possibly continuing until late-March. The sites are in central-western, northern and central-eastern Placentia Bay, within the vicinity of the Rushoon and Long Harbour BMAs, >5 km distant from proposed sea cage sites (see Figure 4.9 *in* Section 4.2.3.1).

*Sentinel Fisheries*

Sentinel fisheries within Placentia Bay are described in Section 4.4.2.7, Inshore Sentinel Program–Red Harbour (Placentia Bay) Sentinel Site. The inshore cod fisheries science program is conducted by fixed gear fishing enterprises, with harvesters residing from Baine Harbour to Jean de Baie eligible to apply for the Red Harbour sentinel fishery.

*Canadian Coast Guard Vessels*

As a high-level traffic zone, the Canadian Coast Guard provides Placentia Bay with Vessel Traffic Services. See Section 4.4.4, Marine Navigation, for a description of Canadian Coast Guard services provided in the Bay. During 2004-2005, 231 unspecified government vessels transited in to, out of and within Placentia Bay (see Table 4.38 in Section 4.4.4).

***Existing Aquaculture Sites***

*Within Placentia Bay*

Current and previously existing aquaculture projects within Placentia Bay are described in Section 4.4.2.4, Aquaculture. There are currently four active aquaculture site licences in Placentia Bay, two held by Merasheen Mussel Farms Inc., located near Merasheen Island and farming blue mussel and oyster, and two held by Joseph Keating of Baie Sea Farms Limited, near Crawley Island, Long Harbour, farming blue mussel. These four sites are within the Merasheen and Long Harbour BMAs, respectively, although they do not overlap with the proposed sea cage site locations (see Figure 4.60 *in* Section 4.4.2.4).

*Beyond Placentia Bay, along Newfoundland's Southern Coast*

The only other aquaculture projects located on Newfoundland's south coast are along the Connaigre Peninsula (see Figure 4.60 *in* Section 4.4.2.4). As of December 2015, these aquaculture projects are predominantly salmonid grow-out or hatchery sites, with two sites dedicated to shellfish (values are number of licenced sites) (DFLR 2017):

- Sites including Atlantic salmon = 70;
    - Atlantic salmon = 53;
    - Atlantic salmon and Steelhead trout = 8;
    - Atlantic salmon and Atlantic cod = 7;
    - Atlantic salmon, steelhead trout, cunner and lumpfish = 1;
        - Note: species listed for each aquaculture licence are provided in acronym format by DFLR, with an accompanying acronym legend. The acronym "LU" was not included in DFLR's legend and could not be located on the DFLR website (DFLR 2017), but is presumed by the proponent to represent "lumpfish" for the above licenced site.
    - Atlantic salmon and rainbow trout = 1;
- Steelhead trout = 17;
- Steelhead trout and Arctic char = 1;
- Arctic char = 2;
- Blue mussel = 2; and
- Atlantic cod and cunner = 1.

Grieg NL proposes to implement various mitigation measures that will minimize its cumulative effect impact (e.g., use of triploid female Atlantic salmon, use of cleaner fish to control sea lice, use of newest sea cage technologies; see Section 2.5). The mitigation measures proposed by Grieg NL will minimize the potential for genetic interaction between farmed salmon and wild salmon as well as disease/parasite outbreaks. There is a chance of added cumulative effect to ecological interaction but not the freshwater systems. There could be some competition for resources in the marine environment between escaped triploid female salmon and wild salmon but this effect too should be relatively limited given the wild salmon focus on migration between the rivers and waters offshore Newfoundland.

***Sewage Outfalls***

Existing sewage outfalls within Placentia Bay are described in Section 4.2.2.7, Water Quality. The majority of known or possible outfall sites within the outfall database of the Water Resources Portal

maintained by the Government of Newfoundland and Labrador Department of Municipal Affairs and Environment are located within the Rushoon BMA, with additional unknown outfall(s) within the Long Harbour BMA (see Figure 4.5).

***Effluent Outfalls***

Both the Vale Long Harbour Nickel Processing Facility (see Section 4.2.2.7) and the North Atlantic Refining Limited Oil Refinery in Come by Chance discharge effluent to Placentia Bay. In both cases, the effluent has been treated prior to its discharge to the marine environment, and environmental effects monitoring (EEM) programs have been implemented to monitor the effluents and any potential effects they might have on the marine environment.

***Proposed Developments***

Environmental assessment projects within Placentia Bay that are currently under review are summarized in this subsection (GNL 2018d).

The Argentia Gold Corporation proposes to establish and operate an 80,000 sq. ft. hydroponic facility for the production of cannabis for medical purposes at the Argentia Industrial Park. The facility would use an existing building that is already connected to the municipal water and sewer systems, along with existing roads. The facility would be hermetically sealed, and there is currently no indication that shipping would be conducted by marine vessels.

Metro Environmental Services Incorporated is proposing to establish an industrial composting facility on the Argentia Access Road to process organic waste from commercial and industrial sources in Newfoundland, and provide an organic fertilizer product to the eastern Newfoundland market. Facility operations would be completely self-contained and land-based. Organic waste and produced fertilizer would be shipped overland via truck.

J and E Enterprises Ltd. is proposing to use locally available kelp for reclamation and possible soil production at the Green Hill quarry, which requires reclamation and rehabilitation. There would not be an increase in marine activities related to this proposal, as the kelp source will include that which is already removed and stockpiled annually at the Small Craft Harbours Facility in the nearby community of St. Bride's. The undertaking would occur in conjunction with ongoing quarry activities, therefore the risk of pollutants shall be no more than that which already exists under current Green Hill quarry operations.

It is anticipated that the salmon produced by Grieg NL sea farms will be processed at the OCI plant in St. Lawrence. This will likely change plant usage from seasonal to full time and may also result in additional processing at the OCI plant in Fortune. These changes could lead to an increase in employment, possibly training if new equipment and processes are needed, hence affecting the economy on the Peninsula.

### 7.6.3.2 Justification of Selection

The projects and activities selected for assessment of cumulative effects were chosen due to their present and ongoing nature, their presence within the Study Area, and the possibility of overlap with Project activities.

### 7.6.4 Mitigation Measures

Monitoring and mitigation measures for the biophysical VECs are described in Section 2.5 and summarized in Sections 6.0 and 7.0 relative to each VEC interaction assessed for the Effects of the Environment on the Project and the Effects of the Project on the Environment, respectively. The mitigation measures and enhancements for the socio-economic VEC are described in Section 7.5. These measures are also applicable to cumulative environmental effects, relative to the primary VECs as appropriate.

### 7.6.5 Assessment of Significance of Residual Cumulative Effects

#### 7.6.5.1 Fish and Fish Habitat VEC

The fish and fish habitat VEC is described in Section 4.2.3, assessed in Section 7.1, and presented in detail in LGL (2018b). After the application of mitigation measures and given the high level of vessel traffic regularly occurring within Placentia Bay, while there is potential for cumulative disturbance effect it is predicted that the sea farm Project activities will not result in a noticeable change for the fish and fish habitat VEC regarding the transit frequency, in-water noise level or emissions from vessel traffic within the Study Area, nor is Project-related vessel traffic anticipated to interfere with other aquaculture projects within or near the Bay. The fish and fish habitat VEC in the Study Area was previously subject to over a dozen concurrently operating shellfish and finfish aquaculture sites, the majority of which have since ceased operations. The currently active licenced aquaculture sites have been present within Placentia Bay for years and utilize completely different equipment to farm and harvest shellfish species as compared to the Project salmon nets, leading to minimal cumulative effect on the fish and fish habitat VEC from the presence of multiple aquaculture sites. Therefore, it is anticipated that there will be *negligible* cumulative effects on the fish and fish habitat VEC from vessel traffic and other aquaculture projects. No new sewage outfalls will be created in association with the sea farm component of the Project, and as noted in Section 7.6.3.1, Proposed Developments, no developments currently under consideration have a marine component, therefore there is no cumulative effect on the fish and fish habitat VEC from these two factors. Any cumulative effects associated with the fish and fish habitat VEC are predicted to be *not significant*, with a *medium* to *high* level of confidence associated with this prediction.

#### 7.6.5.2 Wild Salmon VEC

The wild salmon VEC is discussed and assessed in detail in Sections 4.2.4 and 7.2, and in LGL (2018a). See Section 7.6.5.1, Fish and Fish Habitat VEC, for a summary of predicted cumulative effects or lack thereof relating to vessel traffic, other aquaculture projects, sewage outfalls and proposed developments, which are also applicable to the wild salmon VEC. There is some potential for cumulative disease or pathogen transfer for wild salmon that may be attracted to Project sea farm activities and other aquaculture projects near Placentia Bay. However, Grieg NL will be constantly monitoring the health of fishes in its sea cages, applying mitigation measures and treatment methods as needed to safely detect and control disease or pathogen occurrence for Project sea farm salmon. Some of these mitigation measures and treatment methods, including the use of cleaner fish to control sea lice, are unique to the proposed Project compared to other finfish aquaculture currently being conducted on the south coast of Newfoundland. Grieg NL's proposed approach should limit cumulative effects. Cumulative effects from Project sea farm activities are predicted to be *minor* and *not significant* for the wild salmon VEC, with a *medium* level of confidence.

#### 7.6.5.3 Species at Risk VEC

The species at risk VEC is described and assessed in Sections 4.2.5 and 7.3, respectively. The potential exists for increased interaction with, avoidance by or attraction of species at risk within the Study Area due to cumulative vessel traffic or aquaculture project effects, although as discussed in Sections 7.6.5.1 and 7.6.5.2, vessel traffic and the presence of multiple aquaculture projects are not anticipated to result in noticeable changes as compared to recent and current anthropogenic activity within the Study Area after the implementation of monitoring and mitigation measures. There is no anticipated cumulative effect from sewage outfalls or proposed developments for the species at risk VEC (see Section 7.6.5.1). It is predicted that cumulative effects from Project sea farm activities on the species at risk VEC will be *negligible* and *not significant*, with a *medium* to *high* level of confidence.

#### 7.6.5.4 Sensitive Areas VEC

Sensitive areas within Placentia Bay are described in Section 4.2.6 and assessed in Section 7.4. As described in Sections 7.6.5.1–7.6.5.3, after the implementation of mitigation measures and given the past, present and future anthropogenic activities and projects within the Study Area, cumulative effects from sea farm Project activities are predicted to be *negligible* and *not significant* for the sensitive areas VEC, with a *medium* to *high* level of confidence.

#### 7.6.5.5 Economy: Training, Employment and Business

The VEC is described in Section 4.7 and shows that there is capacity, need and opportunity for increased training, employment and business on the Burin Peninsula and in the Study Area. The assessment of the effects of the Grieg NL project are provided in Section 7.5 and indicate that effects are anticipated to be positive, and moderate to high in significance for the Study Area. Cumulative effects from Project activities are predicted to be *minor* to *moderate* for the Study Area and Burin Peninsula respectively, positive, with a *high* level of certainty.

### 7.7 Accidents and Malfunctions

A series of potential accident and malfunction scenarios for the Project, including credible "worst case scenarios" and "emergency scenarios" were described in Section 2.8 and summarized in Table 2.25. In developing these scenarios, the assumption has been made that preventative actions have either not been taken or have been unsuccessful, resulting in an accident or malfunction that has caused potentially negative environmental effects. During Project operations, every effort would be made to implement appropriate preventative measures. The potential effects of accident and malfunctions scenarios on each biophysical VEC are assessed below.

#### 7.7.1 Wild Atlantic Salmon and Fish and Fish Habitat VECs

The potential effects of the accidental event and malfunction scenarios on the Wild Salmon and Fish and Fish Habitat VECs are assessed together in this section given that wild salmon is a component of the FFH VEC. While potential effects on both VECs are summarized together in the three assessment tables (Tables 7.20–7.22), separate statements of significance are provided for each VEC. The statements of significance for FFH do not include effects on wild Atlantic salmon. As described in Section 2.8, the Rushoon BMA was selected as the location for marine accidental event scenarios because of its proximity to several of the most productive salmon rivers in Placentia Bay and its relatively high exposure to weather and sea conditions compared to the other two semi-annual BMAs.

Table 7.20 presents the potential interactions between the accidental event scenarios and the WS and FFH VECs. Interactions between the various components of fish habitat and fish life history stages and the scenarios are shown.

**Table 7.20. Potential interactions between accidental events and the Wild Salmon and Fish and Fish Habitat VECs.**

| Accidental Event Scenario | Valued Environmental Components: Wild Atlantic Salmon/Fish and Fish Habitat | | | |
|---|---|---|---|---|
| | Water | Sediment | Plankton | Benthos |
| Sea Cage Fish Escape – Emergency Scenario- 160,000 salmon and 16,000 lumpfish | | | | |
| Sea Cage Fish Escape – Worst-case Scenario – 2 million salmon and 200,000 lumpfish | | | | |
| Mass Mortality of Sea Cage Fish - Emergency Scenario – 1,000 salmon | | | | x |
| Mass Mortality of Sea Cage Fish - Worst-case Scenario – 6 million salmon and 600,000 lumpfish | | | | x |
| Spill – Emergency Scenario – 1 kg feed | | x | | x |
| Spill – Emergency Scenario – 100 L diesel fuel | x | | x | |
| Spill – Emergency Scenario – 1,000 L formic acid | x | | x | |
| Spill – Worst-case Scenario – 600 mt feed, 30,000 L diesel fuel, 1,000 L formic acid, 5 $m^3$ sewage, 75 mt ensilage | x | x | x | x |

| Accidental Event Scenario | Valued Environmental Component: Wild Atlantic Salmon/Fish and Fish Habitat | | | |
|---|---|---|---|---|
| | Invertebrate and/or Fish Life History Stage | | | |
| | Eggs and Larvae | Juveniles[a]/ Wild Smolt | Adult Pelagic/Mature Wild Salmon | Adult Demersal |
| Sea Cage Fish Escape – Emergency Scenario- 160,000 salmon and 16,000 lumpfish | | x | x | x |
| Sea Cage Fish Escape – Worst-case Scenario – 2 million salmon and 200,000 lumpfish | | x | x | x |
| Mass Mortality of Sea Cage Fish - Emergency Scenario – 1,000 salmon | | x | x | x |
| Mass Mortality of Sea Cage Fish - Worst-case Scenario – 6 million salmon and 600,000 lumpfish | | x | x | x |
| Spill – Emergency Scenario – 1 kg feed | | x | | x |
| Spill – Emergency Scenario – 100 L diesel fuel | x | | x | |
| Spill – Emergency Scenario – 1,000 L formic acid | x | | x | |
| Spill – Worst-case Scenario – 600 mt feed, 30,000 L diesel fuel, 1,000 L formic acid, 5 $m^3$ sewage, 75 mt ensilage | x | x | x | x |

[a] Often closely associated with the seabed.

### 7.7.1.1 Fish Escape – Emergency Scenario

This fish escape emergency scenario of 160,000 salmon and 16,000 lumpfish escaping from a sea cage in the Rushoon BMA during spring/early summer could affect the WS VEC and fishes of the FFH VEC, including wild lumpfish. This scenario can be considered to include the chronic escapes of small numbers of farmed salmon from sea cages. In some cases, continuous escapes of a small number of diploid farmed salmon can be more harmful than intermittent escapes of a large number of fish (i.e., acute releases) (Baskett et al. 2013; DFO 2013; Verspoor et al. 2015). The primary potential effects, which are assessed in detail include:

- Breeding between farmed salmon and wild salmon;
- Breeding between cleaner fish lumpfish and wild lumpfish;
- Ecological interactions between farmed salmon and wild salmon;
- Ecological interaction between cleaner fish lumpfish and wild lumpfish; and
- Spread of any disease and/or parasites associated with fishes in the sea cages to wild fishes.

A review of the literature relevant to these potential effects is discussed below, followed by a summary of the key mitigation measures designed to minimize the potential effects, and an assessment of the potential residual effects of the emergency scenario of a fish escape on the WS and FFH VECs.

***Genetic and Ecological Interactions between Farm Fish and Wild Fish***

*Atlantic Salmon*

Most Atlantic salmon are anadromous, meaning that mature fish migrate from the marine environment into freshwater systems to spawn. After hatching, Atlantic salmon spend several months to several years in their natal freshwater habitat, developing through various life history stages. Once development to smolt stage has occurred, salmon migrate downstream to the ocean, typically in late spring/early summer, to begin the marine phase of their life history. Once at sea, Atlantic salmon typically exhibit large-scale migrations, overwintering in feeding grounds off Labrador and western Greenland (COSEWIC 2010). Upon sexual maturation, the salmon return to their natal freshwater habitat to spawn. Some individuals may spawn more than once in their lifetime (i.e., repeat spawners) whereas others may only spawn once. Some stocks have been known to return to spawn after only a few months at sea, whereas others return after spending one winter (i.e., grilse) or more at sea. Low marine survival for overwintering salmon is considered one of the greatest threats to wild Atlantic salmon abundance in Newfoundland and Labrador (DFO 2017b). Mature salmon typically return to freshwater during May to October. Based on data collected at counting fences established on some of the scheduled salmon rivers in Newfoundland, most returning Atlantic salmon migrate upstream during late June to mid-July (Dempson et al. 2017). Spawning usually occurs in October and November (Scott and Scott 1988; COSEWIC 2010), after which spent salmon will either return to sea or stay in freshwater until the following spring (COSEWIC 2010).

Specific Atlantic salmon migratory corridors in Placentia Bay have not been identified in the literature. However, a study planned for Placentia Bay in 2018 is intended to provide some information on the migratory corridors in the bay (B. Dempson, DFO Research Scientist, pers. comm., 12 April 2018). During migrations between the rivers and the ocean, salmon typically swim in the upper 10 m of the water column, sometimes as close as 2–3 m from the surface (Renkawitz et al. 2012; Thorstad et al. 2012; Godfrey et al. 2015).

According to COSEWIC (2010), the number of mature Atlantic salmon in the South Newfoundland population, as estimated in 2007, ranged between 21,866 and 29,711. The preliminary 2017 estimate of the number of mature Atlantic salmon in Placentia Bay stocks, which are a component of the South Newfoundland population, is 2,828–5,099 (G. Veinott, DFO Research Scientist, pers. comm. 4 May 2018). However, these estimates will likely change as DFO processes more of the 2017 angling data and refines its exploitation rates for 2017. The final 2016 estimated range of the number of mature Atlantic salmon in Placentia Bay stocks is 4,981–9,388. Note that these estimated numbers are based on the island wide exploitation rates and angling data from SFA 10 (G. Veinott, DFO Research Scientist, pers. comm. 4 May 2018).

Decades of artificial selection and domestication of farmed salmon have produced fish that are genetically distinct from their wild counterparts (Clifford et al. 1998). Farmed salmon are selected for traits that increase their economic value, including higher growth rate, greater disease resistance and higher fillet quality (Hindar and Fleming 2007). Aquaculture operations on the south coast of Newfoundland have been using New Brunswick's Saint John River strain of farmed salmon since 1991 (DFO 2013). Recently, there has been interest in using European-origin farmed salmon because of their higher growth rates and other attributes that result in more economic benefit (Verspoor et al. 2015). Since European-origin farmed salmon have never been utilized in Newfoundland, there is no available information concerning the genetic interactions between farmed European salmon and wild Newfoundland salmon.

Interactions between escapees and wild salmon can result in negative genetic and ecological effects on the wild salmon (Naylor et al. 2005; Ferguson et al. 2007; Verspoor et al. 2015; Glover et al. 2017). Morphological, behavioural and ecological traits can be affected as a result of breeding between farmed Atlantic salmon and wild salmon, thereby potentially causing negative impact on the character, abundance, and survivability of wild salmon stocks (Cairns 2001; Ferguson et al. 2007; Jensen et al. 2010; Verspoor et al. 2015).

Hybrid salmon resulting from the breeding of farmed fish with wild fish may have reduced fitness (i.e., outbreeding depression) and ability to adapt to environmental conditions (including resistance to disease) compared to wild Atlantic salmon. This can directly affect survivability (DFO 2013). The effects of interbreeding on the fitness and ability of hybrids to adapt to their local surroundings is unpredictable, however, and may not be fully realized until the arrival of second generation hybrids (Verspoor et al. 2015). Escaped farmed salmon may also compete with wild salmon during spawning in freshwater systems (DFO 2013; Fjelldal et al. 2014), thereby reducing the number of successful wild salmon spawning events and affecting wild salmon stock abundances.

The risks associated with direct genetic interactions between farmed and wild salmon are related to the number of farmed salmon escapees, the number of escape events, the subsequent prevalence of interbreeding over successive generations, the seasonal timing of the escape and the age of escapees (Verspoor et al. 2015; Bridger et al. 2015). In some cases, continuous escapes of a small number of farmed salmon (i.e., chronic releases) can be more harmful than intermittent escapes of a large number of fish (i.e., acute releases) (Baskett et al. 2013; DFO 2013; Verspoor et al. 2015). Regardless, the greater the number of escaped salmon, the greater the associated risk of genetic introgression[16] of gene variants to wild salmon stocks (Keyser et al. 2018).

Based on studies of other farmed strains of salmon (e.g., New Brunswick, Norway), there is potential for unpredictable, negative genetic interactions between farmed and wild Atlantic salmon (Hindar et al. 1991; DFO 2013; Verspoor et al. 2015). Note that the farmed salmon discussed here in relation to genetic and ecological interaction are diploid fish (i.e., fish that contain a complete set of chromosomes from each parent) unless otherwise stated. Diploidy is the natural genetic state of wild salmon. Triploidy, on the other hand, refers to fish with an extra set of chromosomes. This genetic state is induced in salmon eggs to make resultant salmon sterile. While triploid male salmon may undergo development of secondary sexual characteristics and subsequently attempt to spawn with diploid wild female salmon in freshwater, sterile female triploid salmon are considered less likely to interact ecologically with diploid wild male salmon (Glover et al. 2016). Most of the offspring that result from spawning between triploid male fish and diploid female wild fish die before first feeding (Benfey 2015). Most of the genetic and ecological

[16] Introgression is defined as the transference of genes from one species to another resulting in hybridization of offspring.

interactions observed between farmed and wild salmon involve escaped diploid salmon. Cotter et al. (2000) conducted an experimental release of diploid and triploid salmon to determine differences in rate of return to freshwater. They found that triploid fish returned at a rate four times lower than that of diploid fish.

Triploids, in comparison to diploids, tend to have a higher rate of skeletal deformities and impaired vision from the development of cataracts (Benfey 2015; Verspoor et al. 2015). However, special feed containing phosphorous and the amino acid histidine have helped to alleviate these morphological abnormalities (Taylor et al. 2013, 2015, Sambraus et al. 2017; Smedley et al. 2018).

Some studies suggest that the use of sterile triploid salmon in aquaculture will help to prevent genetic and ecological interactions between wild and farmed salmon. Glover et al. (2016) recently examined the ploidy of farmed salmon escapees that were captured in the Norwegian recreational salmon angling fishery during 2007–2014. This was the first study to investigate the frequency of diploid and triploid farmed salmon escapees in rivers. Individual salmon from 17 rivers underwent microsatellite DNA genotyping to determine ploidy. Only 7 of the 3,794 (0.18%) Atlantic salmon examined were triploid, five males and two females. Five of the seven triploids were caught in the lower stretches or estuarine sections of the river (i.e., not in the upper areas where the spawning grounds were located). Based on the low ratio of triploids to diploids caught in the rivers, the authors concluded that sterile triploid salmon do not appear to be as motivated to enter freshwater as diploid farmed salmon, particularly the females. If this is indeed the case, then the farming of triploid female salmon could reduce potential genetic and ecological impacts of farmed salmon escapees.

It has been documented that farmed Atlantic salmon escapees, in this case diploids, sometimes enter rivers that have natural spawning grounds for wild salmon stocks, and mate with wild salmon (Lura and Saegrov 1991; Webb et al. 1991; Carr et al. 1997; Saegrov et al. 1997; Clifford et al. 1998; Fleming et al. 2000; Milner and Evans 2003; Butler et al. 2005; Fiske et al. 2006; Skaala et al. 2006; Hindar and Diserud 2007; Morris et al. 2008; Madhun et al. 2015; Skilbrei et al. 2015). Aquaculture operations on the south coast of Newfoundland have reportedly had high numbers of escaped diploid farmed salmon, with some entering rivers located close to sea cages (Morris et al. 2008; DFO 2017b; Keyser et al. 2018). Specific distances between the sea cages from which farmed salmon escaped and the rivers entered were not provided in these studies. However, Keyser et al. (2018) indicated that the distribution of rivers in which escaped farmed salmon were detected was well within the reported dispersal distance of escaped farmed salmon (Hansen and Youngson 2010). Keyser et al. (2018) indicated that the majority of escaped farmed salmon in their study in Norway were recaptured within 150 km of the release site but that some were recaptured as far as 800 km away. Genetic techniques to trace farmed salmon back to their respective aquaculture operation have also been developed (Norris et al. 1999; Glover 2010), allowing the identification of farmed salmon found in the wild and of the farm from which the fish originated. These techniques can hold aquaculture operators accountable for unreported escapes.

Even with the implementation of the best available containment measures to prevent farmed salmon from escaping from sea cages, it is considered a frequent and inevitable occurrence (Glover et al. 2017). Some potential causes of fish escape from sea cages include severe weather/storm events, holes in the netting of sea cages, predator attacks on the sea cages, and factors related to human/operational error (Jensen et al. 2010; Jackson et al. 2015; Thorvaldsen et al. 2015). Bridger et al. (2015) reviewed aquaculture equipment and standard procedures used to mitigate escapes of farmed fish from sea cages. The primary reasons for escape identified by Bridger et al. (2015) include structural deficiencies of the sea cage and mooring components, human error in fish handling and farm management practices, and predator attacks on sea cages.

The genetic structure of the South Newfoundland Atlantic salmon population has been described by Verspoor (2005), Adams (2007), and Palstra et al. (2007) *in* COSEWIC (2010). They suggest that there are fewer genetic differences among the fish in the South Newfoundland population compared with other populations on the island. Bradbury et al. (2014) examined genetic spatial structure of wild Newfoundland salmon populations, including the South Newfoundland population, to investigate how habitat and climate have influenced it. They conducted modelling using the input variables watershed size (i.e., basin area, average river width), winter severity (i.e., temperature, annual snowfall), pH, and temperature climate (i.e., temperature, annual precipitation) to determine which factors most influenced genetic divergence among wild salmon populations. Watershed size, in particular freshwater habitat area (i.e, basin area), was found to be the most important factor influencing wild salmon population genetic structure. Verspoor et al. (2015) suggest that there is greater risk of genetic effects from farmed salmon escapees on wild salmon populations that are considered at risk (e.g., threatened), since smaller depressed stocks (i.e., lower abundances) will be more vulnerable to impacts of genetic contribution (i.e., genetic drift) than larger healthier stocks.

In southern Newfoundland, farmed salmon escapes were reported in four of the six years between 2010 and 2015 (DFO 2017a). In August 2015, an unknown number of salmon escaped sea cages that had holes in the netting due to damage caused by predator strikes. Approximately 200 salmon were recovered during this event. In September 2013, there was a single large event involving 20,500 escaped farmed salmon. The escape event was due to extreme weather which resulted in collapsed sea cages. A directed marine recapture fishery and an experimental freshwater fishery were conducted. Small numbers of escapes were reported in 2012 as a result of damage to the netting caused by sharks and tuna. No recapture efforts were conducted during these events in 2012. In 2010, 100–200 farmed salmon escaped due to a harvesting release. No recapture attempts were made to recover the salmon during this escape event (DFO 2017a).

As noted above, in 2013, there was a single large escape event in an aquaculture operation on the south coast of Newfoundland (DFO 2017b). Genetic analyses of wild juvenile salmon from Fortune Bay and Bay d'Espoir were conducted in 2015 and 2016. In 2015, 159 diploid escapees were detected, but none were detected in 2016. The analyses provided evidence that in 17 of the 18 sampling locations, 35% of all juveniles were either farmed salmon or first- or second-generation hybrids. It was determined that some of the hybrids were capable of reproducing. There were also older individuals (escapees prior to 2013) found among the detected hybrids. In general, smaller stocks of salmon were found to have greater levels of hybridizations than larger stocks (DFO 2017b). DFO (2017b) indicated that further follow-up monitoring will be conducted. Note that these escapes involved sea cages that were not Aqualine Midgard system cages proposed for the Grieg NL Project.

Competition for food and space is also a potential ecological interaction between escaped farmed salmon and wild salmon, principally in freshwater systems but also, to a lesser degree, in the marine environment. Escaped farmed salmon have demonstrated phenotypic plasticity through their ability to survive in the wild. Several studies have shown that diploid farmed salmon and farm-wild hybrid fish are capable of surviving natural environmental conditions (Fleming et al. 2000; Hamoutene et al. 2015b; Lush et al. 2018). Studies conducted by Hislop and Webb (1992), Einum and Fleming (1997), Fleming et al. (2000) , McGinnity et al. (2003), and Skaala et al. (2012) determined that escaped farmed salmon have a similar diet to wild salmon which could potentially create competition for food resources (Jensen et al. 2010). Since juvenile farmed salmon grow faster and are more aggressive than juvenile wild salmon (DFO 2013; Verspoor et al. 2015), they could potentially outcompete juvenile wild salmon. Further compounding the size differences between farmed and wild salmon, farmed triploid Atlantic salmon typically grow faster than farmed diploid fish (Fiskeridirektoratet 2016). The key aspects related to the potential for competition for food and space between escaped farm salmon and wild salmon are how

escaped salmon would be distributed in Placentia Bay and how long wild salmon remain in the Placentia Bay during migrations between rivers and feeding areas in the offshore marine environment.

*Lumpfish*

The majority of lumpfish in the NL waters occur in NAFO Divisions 3P (including Placentia Bay) and 4R (west coast of Newfoundland) (Simpson et al. 2016). Male lumpfish typically achieve sexual maturity at age 2–3 years (Albert et al. 2002 and Hedeholm et al. 2014 *in* Simpson et al. 2016) while female lumpfish in Newfoundland waters reach sexual maturity at age 5–6 years (Grant 2001 *in* Simpson et al. 2016). Lumpfish are primarily pelagic but they become demersal during reproduction (Fahay 2007 *in* Simpson et al. 2016). The males move inshore during the spring and select potential nest sites in shallow subtidal areas where water depth is typically 3–5 m. The female lumpfish move inshore after the males, resulting in batch spawning at the shallow nest sites in May/June (Collins 1976 *in* Simpson et al. 2016). After spawning is completed, including the hatching of young, lumpfish move to deeper offshore waters in late summer and early fall. Tagging studies suggest that adults return to the same spawning grounds each year (Bagge 1967, Schopka 1974, Blackwood 1982, 1983, and Lee and Christian 2002 *in* Simpson et al. 2016).

According to Simpson et al. (2016), genetic analyses have identified three genetic groupings of lumpfish: (1) a western Atlantic group, including Canada; (2) an eastern Atlantic group (Iceland and Norway); and (3) a Baltic Sea group. This suggests a single designatable unit for lumpfish in Canadian waters although variation within Canadian waters was not investigated. Overall trends in lumpfish population size in the Northwest Atlantic are generally unknown. Natural and anthropogenic threats to lumpfish abundance include changes in water temperature and salinity, physical destruction of spawning/nesting habitat, pollution in shallow water nursery grounds, and directed and bycatch fishing of adult females for the roe.

At this time, there are no commercial suppliers of lumpfish in Canada. Within Newfoundland, Memorial University of Newfoundland's OSC has been working with the aquaculture industry to domesticate and develop lumpfish broodstock. Grieg NL's R&D project entitled "*Rognkjeks/Lumpfish Broodstock Collection, Domestication and Spawning Techniques*" is currently entering its fifth year at OSC. As part of this R&D project, 24 wild lumpfish were collected in 2015 and 48 wild lumpfish were collected in 2016 from local fishermen in Newfoundland. All broodstock lumpfish were collected at three Newfoundland locations: (1) Witless Bay (eastern Avalon Peninsula); (2) Bay Bulls (eastern Avalon Peninsula); and (3) Champney's West (Trinity Bay) (Appendix S). The OSC have successfully domesticated and maintained three successive year classes from these broodstock. In 2017, 81% of their egg production was from cultured broodstock (see Appendix S).

Other industry partners have progressed to the point that a facility on the Connaigre Peninsula in Belleoram has been built to hold young (1-g) lumpfish transferred from the OSC for use by industry in this area. The capacity on the island is currently available with the OSC and the Belleoram facility to raise lumpfish to 20 g; however, a commercial third-party supplier is needed in Newfoundland to supply the industry with the quantity of lumpfish required to meet recommended stocking densities of ~10% of the total salmon per cage (D. Boyce, OSC, pers. comm., March 2018). Grieg NL intends to work with a third-party supplier to develop a lumpfish hatchery on the Burin Peninsula. With a domesticated broodstock currently held at the OSC, Grieg NL will work with the OSC, much as other industries have, to obtain lumpfish during the initial years of production until the third-party lumpfish hatchery is constructed and operational.

Grieg NL will obtain juvenile lumpfish of optimal size for deployment in the sea cages in the spring/summer of each year. Grieg NL will stock the sea cages with lumpfish once they reach 20–50 g

(~5–10 months old) and harvest them 12–16 months later at 17–26 months of age. The lumpfish used as cleaner fish in the sea cages are not expected to reach sexual maturity prior to harvesting, therefore any escapes of lumpfish from the sea cages will result in sexually immature fish entering the marine environment. In other words, lumpfish that escape from sea cages cannot immediately breed with wild lumpfish, although they could presumably compete ecologically with juvenile wild lumpfish.

*Mitigation Measures*

In the event of an accidental escape of fish from sea cages, Grieg NL is required to contact DFO and DFLR before initiating any recapture effort as per the COC. Any attempt to recapture escaped fish requires DFO approval. The key mitigation measures intended to minimize the potential genetic and ecological effects of the escape of 160,000 salmon and 16,000 lumpfish from a single sea cage on the WS and FFH VECs include:

- The use of triploid all-female Atlantic salmon in the sea cages to ensure farm salmon sterility and decrease the probability of escaped farm salmon moving into freshwater systems;
- The use of Newfoundland broodstock lumpfish as cleaner fish in the sea cages to avoid any genetic effect of breeding between cleaner fish and wild lumpfish;
- Sea cage sites located distant from the mouths of scheduled and non-scheduled Placentia Bay salmon rivers to decrease the probability of interaction between farm salmon and wild salmon;
- Implementation of the Emergency Response Plan by trained Grieg NL personnel; and
- Recapture efforts, if recommended by DFO.

Sections 2.5.2.2 and 2.8.1 provide more details related to these mitigation measures.

***Disease/Parasite Transfer from Sea Cage Fishes to Wild Fishes***

Marine sea cage aquaculture of Atlantic salmon may also result in the transfer of sea lice and pathogens from the farmed salmon to wild salmon.

Two of the most common sea louse species that infect farmed and wild Atlantic salmon in Atlantic Canada are the parasitic copepods *Lepeophtheirus salmonis* and *Caligus elongatus*. Sea lice are problematic for fish farmers so controlling them is a high priority area of aquaculture research (Rittenhouse et al. 2016). In addition to the external damage that they cause to salmon, they are capable of facilitating the transfer of pathogens which can lead to disease and increased mortality in both farmed and wild salmon (Jensen et al. 2010; DFO 2014a; Verspoor et al. 2015). If not controlled, particularly during infestations, sea lice on farmed salmon can increase the abundance of sea lice in the vicinity of sea cages and the probability of sea lice infesting migrating wild salmon passing through the area (Jensen et al. 2010; DFO 2014a; Saksida et al. 2015). It is not necessary that farmed fish escape cages to spread sea lice and/or pathogens and disease to wild salmon (Verspoor et al. 2015). Based on current science information, the free-living stages of sea lice can disperse distances of tens of kilometres (DFO 2014a).

Although there is little information in the primary literature regarding the resistance of triploid Atlantic salmon to pathogens, anecdotal evidence from fish farmers indicates that triploid fish may be less resistant to pathogens and parasites, potentially resulting in increased disease transmission to wild salmon (DFO 2013; Benfey 2015). Cases of infectious salmon anemia (ISA) were reported in Atlantic salmon in Newfoundland during 2012–2017, the most recent case occurring in October and November of 2017 (CFIA 2017). ISA is a serious disease for salmon and is required to be reported to the CFIA immediately upon discovery.

While parasite and disease transfer between farmed salmon and wild salmon has been identified as an issue with aquaculture, less is known about parasite/disease transmission between farmed salmon and wild non-salmonid fishes (Uglem et al. 2014). Transmission of parasites and pathogens between farmed salmon and wild fishes is likely density-dependent. Generally, the higher the host fish densities, the greater the potential for the spread and persistence of parasites and pathogens to host fishes (Krkošek 2017).

Lumpfish and Atlantic salmon are susceptible to some of the same diseases (e.g., vibriosis, pseudomoniasis). Close mixing of lumpfish with salmon creates favourable conditions for the emergence and transfer of diseases in both lumpfish and salmon so consideration must be given to general processes by which disease emerges in aquaculture (Murray 2016 *in* Powell et al. 2017). The development of selected lumpfish lines that show increased disease resistance is therefore a strategy that would benefit salmon aquaculture.

*Mitigation Measures*

The best way to minimize the chances of disease/parasite transfer from escaped sea cage fishes to wild fishes is to maintain healthy fishes in the sea cages. The key mitigation measures for fish health maintenance include:

- Implementation of biosecurity measures;
- Routine husbandry practices;
- Health checks and procedures;
- Use of specialized feed and feeding procedures;
- Sea lice control procedures;
- Water quality monitoring;
- Harvesting lumpfish at the same time that salmon are harvested (i.e., no reuse of cleaner fish);
- Vaccinations; and
- Regular removal and treatment of dead fish from sea cages.

The Fish Health Management Plan (Appendix K) and Sections 2.5.1.2 and 2.5.2.2 of the EIS provide more details related to these mitigation measures.

***Assessment***

*Wild Salmon VEC*

In the case of a sea cage fish escape resulting in 160,000 farmed salmon and 16,000 lumpfish entering the marine environment at the Rushoon BMA in spring/early summer, the primary concern relates to potential genetic and ecological interaction between the farmed salmon and the wild salmon. Note that the 2017 estimated maximum number of mature wild salmon in Placentia Bay stocks is 5,099 (G. Veinott, DFO Research Scientist, pers. comm. 4 May 2018). The timing of this scenario, spring/early summer, also coincides with when wild smolt leave the rivers and mature adult wild salmon are returning to the rivers to spawn. The primary concern about the effect of escaped juvenile lumpfish on wild salmon is that of disease transfer to wild salmon considering that both are susceptible to some of the same fish diseases.

Despite the large difference in numbers of escaped farmed salmon and the most recent DFO estimation of the number of mature wild salmon in Placentia Bay stocks, the triploid all-female farmed salmon are not

expected to interact either genetically or ecologically with the wild salmon. The triploidy renders the females sterile, thereby negating the possibility of genetic introgression, and the sterile females appear not to enter river systems, thereby minimizing the potential for ecological interaction with wild salmon in the freshwater system. Competition for resources between the escaped triploid all-female farmed salmon and the wild salmon in Placentia Bay itself would likely be minimal given that migrating wild salmon focus on either getting to the open ocean on the offshore to feed or returning to natal rivers to spawn. Theoretically, salmon and lumpfish escapees could distribute throughout the Study Area (i.e., area of Placentia Bay, ~7,600 $km^2$). Wild salmon migration typically occurs during a two- to three-month period, so from a temporal perspective, the potential for ecological interaction between the farmed salmon and the wild salmon within the Placentia Bay is limited, assuming that the migrating wild salmon spend minimal time in the Placentia Bay marine environment.

Assuming that the triploid all-female egg induction process is 100% effective (see Stofnfiskur Triploid and Egg Verification in Appendix I), the emergency scenario of a sea cage fish escape is predicted to have residual *negative* effects on the WS VEC that are *minor* in magnitude over a geographic extent of *1,001–10,000 $km^2$* for a duration of *1–12 months* (Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of the escape of 160,000 farmed salmon and 16,000 lumpfish on the WS VEC are predicted to be *not significant* (Table 7.22). The level of confidence associated with this prediction is *medium*.

*Fish and Fish Habitat VEC*

The potential effect of an escape of juvenile lumpfish is not of concern with respect to genetic integrity of and ecological interaction with wild lumpfish given their sexual maturity status and their broodstock is from Newfoundland waters (i.e., same designatable unit). Competition for resources between escaped lumpfish and wild lumpfish may occur throughout the Study Area but given that lumpfish diet focuses on the omnipresent zooplankton and ichthyoplankton, effects of such competition should be relatively benign. Both males and female lumpfish leave coastal areas and return to the open ocean once spawning and hatching is completed so the duration of their time in Placentia Bay is typically two to three months. The transfer of disease and/or parasites from sea cage fishes to wild fishes is the key potential effect with respect to the FFH VEC. As indicated above, maintaining fish health in the sea cages is the overall mitigation for the effect of transfer of disease/parasites to wild fishes. Additionally, lumpfish will not be reused between sea cages—i.e., lumpfish are harvested the same time as salmon. This minimizes the potential for disease and/or parasite transfer.

With mitigation measures in place, the emergency scenario of a sea cage fish escape is predicted to have residual *negative* effects on the FFH VEC that are *minor* in magnitude over a geographic extent of *1,001–10,000 $km^2$* for a duration of *1–12 months* (Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of the escape of 160,000 farmed salmon and 16,000 lumpfish on the FFH VEC are predicted to be *not significant* (Table 7.22). The level of confidence associated with this prediction is *medium*.

**Table 7.21. Assessment of potential residual environmental effects of accidental events on the Wild Salmon and Fish and Fish Habitat VECs.**

| Valued Environmental Components: Wild Salmon/Fish and Fish Habitat | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Accidental Event Scenario** | **Principal Potential Positive (P) or Negative (N) Environmental Effect** | **Key Mitigation Measures** | **Evaluation Criteria for Assessing Environmental Effects** | | | | | | |
| | | | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| Sea Cage Fish Escape – Emergency Scenario- 160,000 salmon and 16,000 lumpfish | Ecological interaction between sea cage fish and wild fish (N);<br>Genetic introgression between sea cage fish and wild fish (N);<br>Spread of disease and/or parasites from sea cage fish to wild fish (N) | • Use of triploid all-female Atlantic salmon in sea cages;<br>• Use of Newfoundland broodstock lumpfish as cleaner fish in the sea cages;<br>• Locating sea cage sites at some distance from the mouths of salmon rivers;<br>• Recapture efforts, on the advice of DFO;<br>• Emergency Response Plan;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices;<br>• Health checks and procedures;<br>• No reuse of cleaner fish;<br>• Use of specialized feed and feeding procedures;<br>• Sea lice control procedures;<br>• Water quality monitoring;<br>• Vaccinations;<br>• Regular removal and treatment of dead fish. | 1 | 5 | 1 | 2 | R | 2 |
| Sea Cage Fish Escape – Worst-case Scenario – 2 million salmon and 200,000 lumpfish | Ecological interaction between sea cage fish and wild fish (N);<br>Genetic introgression between sea cage fish and wild fish (N);<br>Spread of disease and/or parasites from sea cage fish to wild fish (N) | • Use of triploid all-female Atlantic salmon in sea cages;<br>• Use of Newfoundland broodstock lumpfish as cleaner fish in the sea cages;<br>• Locating sea cage sites at some distance from the mouths of salmon rivers;<br>• Recapture efforts, on the advice of DFO;<br>• Emergency Response Plan;<br>• No release of cleaner fish;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices;<br>• Health checks and procedures;<br>• Use of specialized feed and feeding procedures;<br>• Sea lice control procedures;<br>• Water quality monitoring;<br>• Vaccinations;<br>• Regular removal and treatment of dead fish. | 1 | 5 | 1 | 2 | R | 2 |
| Mass Mortality of Sea Cage Fish - Emergency Scenario – 1,000 salmon – due to low DO and elevated water temperatures | Attraction of wild fishes to the sea cages (N);<br>Extra deposition of organic material to the seabed (N) | • Emergency Response Plan;<br>• Rapid removal of dead fish from the sea cage; | 1 | 2 | 1 | 1 | R | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mass Mortality of Sea Cage Fish - Worst-case Scenario – 6 million salmon and 600,000 lumpfish – due to ISA | Spread of disease and/or parasites from sea cage fish to wild fish (N)<br><br>Attraction of wild fishes to the sea cages (N);<br><br>Extra deposition of organic material to the seabed (N) | • Emergency Response Plan;<br>• Rapid removal of dead fish from the sea cages;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices;<br>• Health checks and procedures;<br>• Use of specialized feed and feeding procedures;<br>• Sea lice control procedures;<br>• Water quality monitoring;<br>• Vaccinations;<br>• Regular removal and treatment of dead fish. | 1-2 | 3 | 1 | 1 | R | 2 |
| Spill – Emergency Scenario - 1 kg feed | Additional organic material being deposited to the seabed in the vicinity of the sea cage (N) | • Spill Management Plan;<br>• Emergency Response Plan | 0 | 1 | 1 | 1 | R | 2 |
| Spill – Emergency Scenario – 100 L Diesel Fuel | Contamination of upper water column (N);<br><br>Sub-lethal and lethal effects on invertebrates and fishes (N) | • Spill Management Plan;<br>• Emergency Response Plan | 1 | 1-2 | 1 | 1 | R | 2 |
| Spill – Emergency Scenario – 1,000 L Formic Acid | Contamination of upper water column (N);<br><br>Sub-lethal and lethal effects on invertebrates and fishes (N) | • Spill Management Plan;<br>• Emergency Response Plan | 0 | 1 | 1 | 1 | R | 2 |
| Spill – Worst-case Scenario – 600 mt feed, 30,000 L diesel fuel, 1,000 L formic acid, 5 $m^3$ sewage, 75 mt ensilage | Additional organic material being deposited to the seabed in the vicinity of the sea cage (N);<br><br>Contamination of upper water column and biota within it (N);<br><br>Sub-lethal and lethal effects on invertebrates and fishes (N) | • Spill Management Plan;<br>• Emergency Response Plan | 1-2 | 3 | 1 | 1 | R | 2 |

Key:

Magnitude:
0 = Negligible
1 = Minor
2 = Moderate
3 = Major

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = Continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1-$km^2$
2 = 1-10-$km^2$
3 = 11-100-$km^2$
4 = 101-1,000-$km^2$
5 = 1,001-10,000-$km^2$
6 = > 10,000-$km^2$

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not affected by human activity
2 = Evidence of existing effects

**Table 7.22. Significance of potential residual environmental effects of accidental events on the Wild Salmon and Fish and Fish Habitat VECs.**

| Valued Environmental Components: Wild Salmon/Fish and Fish Habitat | | | | |
|---|---|---|---|---|
| **Accidental Event Scenario** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[a]** | |
| | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| Sea Cage Fish Escape – Emergency Scenario-160,000 salmon and 16,000 lumpfish | NS | 2 | | |
| Sea Cage Fish Escape – Worst-case Scenario – 2 million salmon and 200,000 lumpfish | NS | 2 | | |
| Mass Mortality of Sea Cage Fish - Emergency Scenario – 1,000 salmon | NS | 2-3 | | |
| Mass Mortality of Sea Cage Fish - Worst-case Scenario – 6 million salmon and 600,000 lumpfish | NS | 2 | | |
| Spill – Emergency Scenario - 1 kg feed | NS | 3 | | |
| Spill – Emergency Scenario – 100 L Diesel Fuel | NS | 2 | | |
| Spill – Emergency Scenario – 1,000 L Formic Acid | NS | 2-3 | | |
| Spill – Worst-case Scenario – 600 mt feed, 30,000 L diesel fuel, 1,000 L formic acid, 5 $m^3$ sewage. 75 mt ensilage | NS | 2 | | |

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 $km^2$.

Residual environmental Effect Rating:
S = Significant Negative Environmental Effect
NS = Not-significant Negative Environmental Effect
P = Positive Environmental Effect
Level of Confidence: based on professional judgment:
1 = Low
2 = Medium
3 = High

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence
Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low
2 = Medium
3 = High

[a] Considered only in the case where 'significant negative effect' is predicted.

### 7.7.1.2 Fish Escape – Worst-case Scenario

This worst-case scenario for the escape of 2 million salmon and 200,000 lumpfish from all sea cages in the Rushoon BMA during spring/early summer could potentially result in effects on the Wild Salmon VEC and fishes of the FFH VEC, including wild lumpfish. The principal potential effects include:

- Breeding between farmed salmon and wild salmon;
- Breeding between cleaner fish lumpfish and wild lumpfish;
- Ecological interactions between farmed salmon and wild salmon;
- Ecological interaction between cleaner fish lumpfish and wild lumpfish; and
- Spread of any disease and/or parasites associated with fishes in the sea cages to wild fishes.

Background information on these various potential effects of sea cage fish escape has already been provided in the previous assessment (Section 7.7.1.1) and is not repeated here. The key mitigation measures intended to minimize the potential effects and the assessment of the potential residual effects of the worst-case scenario of a fish escape on the WS and FFH VECs are provided. Note again that the Tables 7.20–7.22 refer to both the WS VEC and the FFH VEC. However, separate statements of significance are provided for the two VECs.

The interactions (see Table 7.20) between the fish escape worst-case scenario and the two VECs, and the assessment criteria ratings are also the same for both scenarios (see Table 7.21). The principal mitigations intended to minimize the potential genetic and ecological effects of the escape of two million salmon and 200,000 lumpfish from all sea cages in the Rushoon BMA on the WS and FFH VECs include:

- The use of triploid all-female Atlantic salmon in the sea cages to ensure farm salmon sterility and decrease the probability of escaped farm salmon moving into freshwater systems;
- The use of Newfoundland broodstock lumpfish as cleaner fish in the sea cages to avoid any genetic effect of breeding between cleaner fish and wild lumpfish;
- Sea cage sites located distant from the mouths of scheduled and non-scheduled Placentia Bay salmon rivers to decrease the probability of interaction between farm salmon and wild salmon;
- Implementation of the Emergency Response Plan by trained Grieg NL personnel; and
- Recapture efforts, if recommended by DFO.

The principal mitigations intended to minimize the potential spread of diseases and parasites from escaped fish on the WS and FFH VECs include:

- Implementation of biosecurity measures;
- Routine husbandry practices;
- Health checks and procedures;
- Use of specialized feed and feeding procedures;
- Sea lice control procedures;
- Water quality monitoring;
- No reuse of lumpfish;
- Vaccinations; and
- Regular removal and treatment of dead fish.

The Emergency Response Plan (Appendix T) and Section 2.5 of the EIS provide more details related to these mitigations.

***Assessment***

*Wild Salmon VEC*

In the case of a sea cage fish escape resulting in two million farmed salmon and 200,000 lumpfish entering the natural marine environment at the Rushoon BMA in spring/early summer, the primary concern relates to potential genetic and ecological interaction between the farmed salmon and the wild salmon. Note that the 2017 estimated maximum number of mature wild salmon in Placentia Bay stocks is 5,099 (G. Veinott, DFO Research Scientist, pers. comm. 4 May 2018). The timing of this scenario, spring/early summer, also coincides with when wild smolt leave the rivers and mature adult wild salmon are returning to the rivers to spawn. The key concern about effect of escaped juvenile lumpfish on wild

salmon is that of disease transfer to wild salmon considering that both are susceptible to some of the same fish diseases.

Despite the even larger numbers of escaped farmed salmon in this worst-case scenario, the triploid all-female farmed salmon are not expected to interact either genetically or ecologically with the wild salmon. The triploidy renders the females sterile, thereby negating the possibility of genetic introgression, and the sterile females appear not to enter river systems, which minimizes the likelihood of ecological interaction with wild salmon in the freshwater system. Competition for resources between the escaped triploid all-female farmed salmon and the wild salmon in Placentia Bay itself could be higher than for the emergency scenario, but again likely minimal given that wild salmon are focused on either getting to the open ocean in the offshore to feed or returning to natal rivers to spawn. Theoretically, salmon and lumpfish escapees could distribute throughout the Study Area. Wild salmon migration typically occurs during a two- to three-month period so from a temporal perspective, the potential for ecological interaction between the farmed salmon and the wild salmon within the 7,600 $km^2$ of Placentia Bay is limited, assuming that the migrating wild salmon spend minimal time in the Placentia Bay marine environment.

The probability of simultaneous escapes of all fish from all 36 sea cages in the Rushoon BMA is considered extremely low. Assuming that the triploid all-female egg induction process is 100% effective (see Stofnfiskur Triploid and Egg Verification in Appendix I), the worst-case scenario of a sea cage fish escape is predicted to have residual *negative* effects on the WS VEC that are *minor* in magnitude over a geographic extent of *1,001–10,000 $km^2$* for a duration of *1–12 months* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of the escape of two million farmed salmon and 200,000 lumpfish on the WS VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium*.

*Fish and Fish Habitat VEC*

As is the case with the emergency escape scenario, the potential effect of an escape of juvenile lumpfish is not of concern with respect to genetic integrity of and ecological interaction with wild lumpfish given their sexual maturity status and their broodstock is from Newfoundland waters (i.e., same designatable unit). Competition for resources between escaped lumpfish and wild lumpfish may occur throughout the Study Area but given that lumpfish diet focuses on the omnipresent zooplankton and ichthyoplankton, effects of such competition should be relatively benign. Both males and female lumpfish leave coastal areas and return to the open ocean once spawning and hatching is completed so the duration of their time in Placentia Bay is typically two to three months. The transfer of disease and/or parasites from sea cage fishes to wild fishes is the key potential effect with respect to the FFH VEC. As indicated above, maintaining fish health in the sea cages is the overall mitigation for the effect of transfer of disease/parasites to wild fishes.

The simultaneous escapes of all fish from all 36 sea cages in the Rushoon BMA has a very low probability of occurrence. With mitigation measures in place, the worst-case scenario of a sea cage fish escape is predicted to have residual *negative* effects on the FFH VEC that are *minor* in magnitude over a geographic extent of *1,001–10,000 $km^2$* for a duration of *1–12 months* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of the escape of two million farmed salmon and 200,000 lumpfish on the FFH VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium*.

### 7.7.1.3 Mass Mortality – Emergency Scenario

This emergency scenario for mass mortality of 1,000 salmon in a sea cage in the Rushoon BMA during August may affect the Wild Salmon VEC and fishes of the FFH VEC, including wild lumpfish. This emergency scenario considers low oxygen levels and higher water temperatures as the primary causes of the mass mortality. The key potential effects include:

- Attraction of wild fishes to the sea cage, with focus on large predators such as sharks and tuna; and
- Deposition of additional organic matter from the sea cage to the seabed in the immediate vicinity.

***Attraction of Wild Fishes to the Sea Cage***

A potential effect of a mass mortality of 1,000 salmon in the sea cage would be attraction of wild biota like sharks and tunas which could result in breaches of sea cage nets. Small numbers of escapes from sea cages on the south coast of Newfoundland were reported in 2012 as a result of damage to the netting caused by sharks and tuna. In August 2015, an unknown number of salmon escaped sea cages in southern Newfoundland that had holes in the netting due to damage caused by predator strikes (DFO 2017a). During consultations for the Project, fishers indicated that they have seen a marked increase in the number of sharks and tuna in Placentia Bay during the past four to five years (Grattan et al. 2018 *in* Volume 3).

***Deposition of Additional Organic Material***

If the 1,000 dead fish occurring as a result of the mass mortality emergency scenario were not removed quickly, the decaying fish may increase deposition of organic material from the sea cage to the seabed. Accumulation of organic material in the marine system can negatively impact the ecosystem by contributing to organic enrichment of the benthic systems (i.e., BOD matter) (Strain and Hargrave 2005 *in* Taranger et al. 2015; Hamoutene et al. 2015b; Verhoeven et al. 2016; Salvo et al. 2017).

***Mitigation Measures***

The primary mitigation measures intended to minimize the potential effects of the mass mortality of 1,000 salmon in a single sea cage on the WS and FFH VECs include:

- A Predator Control Plan, required as part of Grieg NL's aquaculture license application, will include methods to monitor, deter and exclude marine predators from the sea cages sites; and
- Use of an automatic pumping system to remove as quickly as possible dead fish from the sea cages and transfer them to an ensilage tank.

Section 2.5.2.2 of the EIS provides more details related to these mitigation measures associated with a smaller mass mortality.

***Assessment***

*Wild Salmon VEC*

In the event of a mass mortality of 1,000 farmed salmon in a single sea cage at the Rushoon BMA in August, the primary concern related to wild salmon is the attraction of wild biota to the sea cage, specifically sharks and tunas which are capable of causing damage to the sea cage net, potentially leading to escapement of fish from the sea cage. However, rapid response resulting in timely removal of the dead fish should substantially decrease the potential of a predator strike.

After application of mitigation measures, the emergency scenario of mass mortality in a sea cage is predicted to have residual *negative* effects on the WS VEC that are *minor* in magnitude over a geographic extent of *1–10 km$^2$* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of the mass mortality of 1,000 farmed salmon on the WS VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium* to *high*.

*Fish and Fish Habitat VEC*

In the event of a mass mortality of 1,000 farmed salmon in a single sea cage at the Rushoon BMA in August, the primary concerns related to fish and fish habitat is also the attraction of wild biota to the sea cage. This attraction could potentially result in larger wild fishes, such as sharks and tunas, causing damage to the sea cage net, and increase the risk of disease/parasite transfer to the wild fishes. The additional accumulation of organic matter from decaying fish on the seabed in the immediate vicinity of the sea cage is also a possible effect. However, the mitigation measures will decrease the potential of both types of potential effects.

After application of mitigation measures, the emergency scenario of mass mortality in a sea cage is predicted to have residual *negative* effects on the FFH VEC that are *minor* in magnitude over a geographic extent of *1–10 km$^2$* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of the mass mortality of 1,000 farmed salmon on the FFH VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium* to *high*.

### 7.7.1.4 Mass Mortality – Worst-case Scenario

This worst-case scenario for mass mortality of 6 million salmon and 600,000 lumpfish in all 36 sea cages in the Rushoon BMA during July could affect the Wild Salmon VEC and fishes of the FFH VEC. This worst-case scenario includes Infectious Salmon Anemia (ISA) and a subsequent depopulation order as the primary cause of the mass mortality. The key potential effects include:

- Transfer of ISA to wild salmonids (e.g., wild salmon, sea-run trout);
- Attraction of wild fishes to the sea cage including large predators such as sharks and tunas; and
- Deposition of additional organic matter from the sea cages to the seabed.

Background information on attraction of wild fishes and additional deposition has already been provided in the previous assessment of the effects of the emergency scenario of mass mortality on the WS and FFH VECs. Some background information on ISA is provided below. The principal mitigations intended to

minimize the potential effects and the assessment of the potential residual effects of the worst-case scenario of a mass mortality on the WS and FFH VECs are also provided.

ISA is an important viral disease of farmed Atlantic salmon that has caused considerable financial losses for salmon farmers around the world, including Atlantic Canada (Johansen et al. 2011; Gagné and LeBlanc 2017). It is listed as a notifiable disease by the World Organization for Animal Health, and to this day, culling of infected cages or farms remains the current practice in many countries to mitigate the spread of the virus. In Atlantic Canada, ISAV was first detected in 1996 and continues to be detected. While some outbreaks seemed to have arisen from isolated infections of unknown source, others were local clusters resulting from horizontal spread of infection (Gagné and LeBlanc 2017).

According to Nylund (2007 *in* Johansen et al. 2011), there is no documented evidence that the ISA virus has been transferred from farmed salmon to wild salmon. There may be potential for its transmission from farmed to wild fish but it is not known whether this has actually caused any impact on wild fish populations.

Cases of ISA were reported in farmed Atlantic salmon in Newfoundland during 2012–2017, the most recent case occurring in October and November of 2017 (CFIA 2017). ISA is a serious disease for salmon and is required to be reported to the CFIA immediately upon discovery. According to the CFIA, fish species other than Atlantic salmon known to be susceptible to ISA include the salmonids rainbow trout and brown trout, both of which could potentially include sea-run fish. Fish species that may be susceptible to ISA include Arctic char and Atlantic herring. There are currently no treatment options available for ISA although there is a preventative vaccine.

***Mitigation Measures***

The principal mitigation measures intended to minimize the potential effects of the mass mortality of six million salmon and 600,000 lumpfish in 36 sea cages on the WS and FFH VECs include:

- Implementation of the Emergency Response Plan (Appendix T); and
- Immediate response to a mass mortality which will include the use of backup vessels provided by OCI in combination with the well boat to collect all mortalities from the sea cage.

In the event of such a mass mortality in an entire BMA, it would be Grieg NL's obligation to act as expeditiously as possible to reduce any further effect on sea cage sites in other BMAs while following all regulatory requirements. Grieg NL would implement its mass mortality response procedures which includes the notification of regulatory agencies and activation of a depopulation order, if required. Back up vessels supplied by OCI in combination with well boats would be used to collect all mass mortalities from the sea cages using equipment and procedures similar to those used during harvesting.

The Emergency Response Plan (Appendix T) and Section 2.8.2 of the EIS provide more details related to these mitigation measures.

***Assessment***

*Wild Salmon VEC*

In the event of a mass mortality of six million farmed salmon and 600,000 lumpfish at the Rushoon BMA in July, the primary concern related to wild salmon is to minimize the spread of the ISA virus responsible

for the mass mortality. Mortalities causing attraction of wild biota to the sea cage, specifically sharks and tunas which are capable of causing damage to the sea cage net, is also an important concern. In a scenario such as this, it is important to remove fish mortalities from the marine environment as soon as possible. Considering the size of the mass mortality, it would likely take a number of days to remove all mortalities from the 36 sea cages. It is important to note that such a scale of mass mortality is very unlikely to occur given the separation between sea cage sites in the Rushoon BMA.

After application of mitigation measures, the worst-case scenario of mass mortality in multiple sea cages is predicted to have residual *negative* effects on the WS VEC that are *minor* to *moderate* in magnitude over a geographic extent of *11–100 km$^2$* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of the mass mortality of six million farmed salmon and 600,000 lumpfish on the WS VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium*.

*Fish and Fish Habitat VEC*

As with the WS VEC, the primary concerns related to the worst-case mass mortality scenario would be the potential spread of ISA to the marine environment and the potential attraction of large predators to the sea cages.

Given the unlikelihood of occurrence of the worst-case mass mortality scenario, and after application of mitigation measures, the worst-case scenario of mass mortality in multiple sea cages is predicted to have residual *negative* effects on the FFH VEC that are *minor* to *moderate* in magnitude over a geographic area of *11–100 km$^2$* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of the mass mortality of six million farmed salmon and 600,000 lumpfish on the WS VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium*.

### 7.7.1.5 Feed Spill – Emergency Scenario

This emergency scenario for a spill of 1 kg of feed will likely result in the deposition of the feed to the seabed. The main ingredient in fish feed is marine contents (fish oil, fish meal, algae), vegetables and minerals. Some feed companies also use smaller amounts of hydrolyzed protein. All the feed will be CFIA approved.

Given the small amount of feed spilled in this emergency scenario, it is unlikely that mitigation measures to recover the feed would be implemented, and the feed would simply deposit on the seabed. There would be minimal interaction with the WS and FFH VECs.

***Wild Salmon VEC Assessment***

The emergency scenario of a 1 kg feed spill at a single sea cage is predicted to have residual *negative* effects on the WS VEC that are *negligible* in magnitude over a geographic area of *<1 km$^2$* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of a spill of 1 kg of feed on the WS VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *high*.

***Fish and Fish Habitat VEC Assessment***

The emergency scenario of a 1 kg feed spill at a single sea cage is predicted to have residual *negative* effects on the FFH VEC that are *negligible* in magnitude over a geographic area of *<1 km²* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of a spill of 1 kg of feed on the FFH VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *high*.

### 7.7.1.6 Diesel Fuel Spill – Emergency Scenario

This emergency scenario for a spill of 100 L of diesel fuel during refueling at a single sea cage in the Rushoon BMA during the summer could potentially result in sub-lethal and/or lethal effects on the WS and FFH VECs. However, given the size of the spill, effects would be localized.

Although lighter oils, such as marine diesel fuel, are less persistent in the marine environment after a spill compared to heavy oil (higher volatility resulting is faster vaporization), they are potentially more toxic to aquatic organisms due to the chemicals associated in in their composition having higher bioavailability (Neff 1979 *in* Geraudie et al. 2016). Marine diesel contains a mixture of polycyclic aromatic hydrocarbons (PAHs) which are known for their deleterious effects in fishes and invertebrates (Aarab et al. 2004 *in* Geraudie et al. 2016). While only a relatively small fraction of the diesel fuel dissolves and becomes bioavailable, the water-soluble fraction (WAF) contains a mixture of PAHs, monoaromatic hydrocarbons often referred to as BTEX (benzene, toluene, ethylbenzene, xylenes), phenols and heterocyclic compounds containing nitrogen and sulfur (Saeed and Al-Mutairi 1999 *in* Rodrigues et al. 2010). The accumulation of soluble petroleum hydrocarbons in fish is extremely rapid (Gravato and Santos 2002 *in* Rodrigues et al. 2010). According to Stephens et al. (1997 *in* Rodrigues et al. 2010), larval stages of invertebrates and fishes are more sensitive to exposure to the WAF than adult stages because of their relatively undeveloped organs during ontogeny and their larger surface area resulting in greater uptake of the hydrocarbons. The effects of exposure to the WAF can be both sub-lethal and lethal.

There has been extensive study of the effects of hydrocarbon spills on fish habitat (Armstrong et al. 1995, Rice et al. 1996 *in* C-NLOPB 2010). The FFH VEC includes plankton because it is a source of food for larvae and some adult fish thus, effects of diesel fuel spill on plankton could affect fish. Dispersion and dissolution cause the soluble, lower molecular weight hydrocarbons to move from the slick into the upper water column. Effects of spills on pelagic organisms need to be assessed through examination of effects of water-soluble fractions of oil or light hydrocarbon products.

Effects of diesel fuel spills on plankton are short-lived, with zooplankton being more sensitive than phytoplankton. Zooplankton accumulate hydrocarbons in their bodies. The hydrocarbons may be metabolized and depurated (Trudel 1985 *in* C-NLOPB 2010). Hydrocarbons accumulated in zooplankton during a spill would be depurated within a few days after a return to clean water and thus, there is limited potential for transfer of hydrocarbons up the food chain (Trudel 1985 *in* C-NLOPB 2010). Mortality of zooplankton can occur at diesel concentrations of 100–10,000 ppm (24–48 h LC50, where LC50 is the concentration of toxicant that kills 50 percent of the test animals (Trudel 1985 *in* C-NLOPB 2010).

Besides plankton, the FFH VEC includes fish and invertebrate eggs and larvae, juvenile fish and invertebrates, adult pelagic fish and invertebrates, and adult groundfish/demersal invertebrates. Planktonic fish eggs and larvae (ichthyoplankton) are less resistant to effects of contaminants than are adults because they are not physiologically equipped to either detoxify them or actively avoid them. In addition, many eggs and larvae develop at or near the surface where exposure to hydrocarbons may be the greatest (Rice 1985 *in* C-NLOPB 2010). It is estimated that sensitivities of fish larvae range from 0.1–1.0 ppm of

soluble aromatic hydrocarbons, ~10 times the sensitivities of adults (Moore and Dwyer 1974 *in* C-NLOPB 2010).

There is an extensive body of literature regarding the effects of exposure to hydrocarbons on juvenile and adult fish. Although some of the literature describes field observations, most refers to laboratory studies. If exposed to hydrocarbons in high enough concentrations, fish may suffer effects ranging from direct physical effects to more subtle physiological and behavioural effects. Actual effects depend on a variety of factors such as the amount and type of oil, environmental conditions, species and life stage, lifestyle, fish condition, degree of confinement of experimental subjects, and others.

An LC50 is based upon controlled laboratory experiments using confined fish, usually in a container of standing water. There are recognized problems in applying LC50 data to the "real world" but they are useful for "ball park" comparative information, especially in situations where it is very difficult to obtain good controlled field data.Based on laboratory toxicity studies, pelagic fish tend to be more sensitive (LC50s of 1–3 ppm) than either benthic (LC50s of 3–8 ppm) or intertidal fish species (LC50s of >8 ppm) (Rice et al. 1979 *in* C-NLOPB 2010).

Note that it has been shown through telemetry studies that Atlantic salmon typically use the upper 10 m of the water column during migration (Renkawitz et al. 2012; Thorstad et al. 2012; Godfrey et al. 2015). Therefore, Atlantic salmon may be more susceptible to the effects of exposure to the spilled diesel fuel than pelagic fishes that use the lower water column.

***Mitigation Measures***

In response to a spill of 100 L of diesel fuel, Grieg NL would immediately enact its spill response plan for fuel (Appendix M). Containment booms along with absorption pillows, pads and/or socks would be deployed to begin immediate recovery of the fuel. Skimmers would be used after the booms are in place. The pollution line as well as a contracted Emergency Response Organization would be contacted to assist with environmental cleanup.

Section 2.8.3 of the EIS provide more details related to these mitigation measures.

***Assessment***

*Wild Salmon VEC*

As indicated above, the diesel fuel spill is the component of the worst-case scenario of most concern to the environment, including wild salmon. Given the use of the upper water column by Atlantic salmon during marine migration, wild salmon in the area of the spill would be susceptible to exposure to the water-soluble hydrocarbons in that part of the water column. That being said, the likelihood of wild Atlantic salmon passing underneath the small contained slick is low. Given the relatively small volume of diesel fuel spilled, the size of the slick if containment is achieved quickly would likely be of minimal size. In addition, the persistence of toxic levels of hydrocarbons in the water-soluble portion below the slick should be relatively short.

After application of the mitigation measures, the emergency scenario of a 100 L diesel fuel spill at a single sea cage is predicted to have residual *negative* effects on the WS VEC that are *minor* in magnitude over a geographic area of *<1 km$^2$ to 1–10 km$^2$* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of a spill of 100 L of diesel fuel on the WS

VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium*.

*Fish and Fish Habitat VEC*

As with wild Atlantic salmon, the components of the FFH VEC that occur in the upper water column would most likely be exposed to hydrocarbons associated with the spill of 100 L of diesel fuel. These components include water, plankton, ichthyoplankton, eggs and larvae of invertebrates and pelagic fishes. While the plankton, eggs and larvae in the area of the spill could be directly affected by the spill, pelagic fishes would likely avoid the upper water column. If the slick is contained quickly, then the number of plankton, eggs and larvae exposed to the hydrocarbons should be minimal. After mitigative response measures are implemented, both slick size and the persistence of its toxicity should be minimal.

The emergency scenario of a 100 L diesel fuel spill at a single sea cage is predicted to have residual *negative* effects on the FFH VEC that are *minor* in magnitude over a geographic area of *<1 km$^2$* to *1–10 km$^2$* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of a spill of 100 L of diesel fuel on the FFH VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium*.

### 7.7.1.7 Formic Acid Spill – Emergency Scenario

This emergency scenario for a spill of 1,000 L of formic acid resulting from the loss of an entire IBC at a single sea cage in the Rushoon BMA during the summer may affect the WS and FFH VECs.

Food grade formic acid (85%) will be used to generate ensilage. The generation of ensilage is a standard practice in aquaculture for effectively handling and storing dead fish while preventing disease transmission, reducing odors and reducing pests. According to ECCC (2017), there is low risk of harm to organisms and the broader integrity of the environment from formic acid. This risk analysis was based on data on physical-chemical properties, fate (chemical half-lives in various media and biota, partition coefficients, and fish bioconcentration) and acute fish ecotoxicity derived from the scientific literature, available empirical databases, and/ or were based on bioaccumulation models. Formic acid biodegrades in water and has low potential to bioaccumulate (Univar 2016).

Despite the suggestion that Atlantic salmon typically use the upper 10 m of the water column during migration (Renkawitz et al. 2012; Thorstad et al. 2012; Godfrey et al. 2015), the relatively low volume of formic acid spilled and its biodegradation in water should minimize the susceptibility of Atlantic salmon to its effects.

***Mitigation Measures***

The key mitigation measures intended to minimize the potential effects of a spill of 1,000 L of formic acid at a sea cage include procedures described in Grieg NL's Spill Management Plan (Appendix M) and Emergency Response Plan (Appendix T).

***Assessment***

*Wild Salmon VEC*

After application of mitigation measures, the emergency scenario of a 1,000 L spill of formic acid at a single sea cage is predicted to have residual *negative* effects on the WS VEC that are *negligible* in

magnitude over a geographic area of *<1 km²* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of a 1,000 L spill of formic acid on the WS VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium* to *high*.

*Fish and Fish Habitat VEC*

After application of mitigation measures, the emergency scenario of a 1,000 L spill of formic acid at a single sea cage is predicted to have residual *negative* effects on the FFH VEC that are *negligible* in magnitude over a geographic area of *<1 km²* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of a 1,000 L spill of formic acid on the FFH VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium* to *high*.

### 7.7.1.8 Spill – Worst-case Scenario

This worst-case spill scenario is the hypothetical result of a vessel colliding with a feed/accommodation barge. This worst-case scenario includes the spill of 600 mt of feed (approximate volume of 925 $m^3$), 30,000 L of diesel fuel, 1,000 L of formic acid, 5 $m^3$ of sewage and 75 mt of ensilage (approximate volume of 5 $m^3$) in the Rushoon BMA during the summer. The potential effects on the WS and FFH VECs as a result of this worst-case spill scenario include:

- Extra deposition of organic material (i.e., feed) on the seabed;
- Attraction of wild fishes to the sea cages; and
- Sub-lethal and lethal contamination of wild biota in the vicinity of the spill.

Should the entire contents of the feed/accommodation barge be spilled, the following consequences may occur. Upon release to salt water, the feed would slowly dissolve and sink to the seabed, and likely be consumed by scavengers. The formic acid, sewage and ensilage spilled into the marine environment would be diluted and subsequently rendered relatively benign in terms of effects on the WS and FFH VECs. Formic acid biodegrades in water and has a low potential to bioaccumulate (Univar 2016). The ensilage does not pose any health risks since the acid is used to stabilize waste and deactivate pathogens (Dixon et al. 2012). Any potential of acute effects on either VEC from this worst-case spillage of formic acid, sewage and ensilage would be highest in the upper water column, which is where Atlantic salmon typically occur during migration (Renkawitz et al. 2012; Thorstad et al. 2012; Godfrey et al. 2015).

A loss of diesel fuel would pose the highest risk to the environment. See Section 7.7.1.6 for a discussion of diesel fuel fate and behaviour, and its potential effects on fish and fish habitat. Since hydrocarbon toxicity is highest in the upper water column after a spill, the risk of exposure would be higher for wild Atlantic salmon and other pelagic wild fishes than for demersal fishes.

***Mitigation Measures***

For this worst-case scenario spill, the Emergency Response Plan would be implemented. Grieg NL would immediately enact its spill response for fuel (Appendix M). Containment booms along with absorption pillows, pads and/or socks would be deployed to begin immediate recovery of the fuel. Skimmers would be used after the booms are in place. The pollution line as well as a contracted Emergency Response Organization would be contacted to assist with environmental cleanup. Section 2.8.3 provides more details related to these mitigation measures.

No mitigation measures would be implemented in relation to the release of feed, formic acid, sewage and ensilage into marine waters. An ROV would likely be used to inspect the deposition of the spilled feed on the seabed but it is unlikely that any further action would be taken.

***Assessment***

*Wild Salmon VEC*

As discussed in Section 2.8.3, it is highly unlikely that this worst-case scenario would occur because the feed/accommodation barges have heavy-duty safety bumpers surrounding them and extending from the water line to the top of the main deck hand rail. A vessel strike would most likely cause damage above the water line which would prevent the entire storage compartments from emptying. In addition, the strike would have to penetrate the safety bumpers, the outside wall of the barge and also the inside walls of the storage tanks.

However, should the full 30,000 L of diesel fuel be accidentally released to the marine environment, the resultant slick, even after containment, would be larger than the one described for the emergency spill scenario (Section 7.7.1.6) involving 1,000 L of diesel fuel (i.e., <1 $km^2$). As with the emergency scenario, the persistence of toxic levels of hydrocarbons in the water-soluble portion below the slick should be relatively short.

The worst-case spill scenario involving the release of feed, diesel fuel, formic acid, sewage and ensilage into the marine environment is very unlikely to occur. However, should it occur, this accidental event is predicted to have residual *negative* effects on the WS VEC that are *minor* to *moderate* in magnitude over a geographic extent of *11–100 $km^2$* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of a worst-case spill scenario on the WS VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium*.

*Fish and Fish Habitat VEC*

As with the WS VEC, the components of the FFH VEC that occur in the upper water column would most likely be exposed to hydrocarbons associated with the spill of 30,000 L of diesel fuel. These components include water, plankton, ichthyoplankton, eggs and larvae of invertebrates and pelagic fishes. While the plankton, eggs and larvae in the area of the spill could be directly affected by the spill, pelagic fishes would likely avoid the upper water column. If the slick is contained quickly, then the number of plankton, eggs and larvae exposed to the hydrocarbons should be minimal relative to the total number of plankton, eggs and larvae in Placentia Bay.

After application of mitigation measures, the worst-case spill scenario is predicted to have residual *negative* effects on the FFH VEC that are *minor* to *moderate* in magnitude over a geographic area of *11–100 $km^2$* for a duration of *<1 month* (see Table 7.21). Based on these criteria ratings, the *reversible* residual *negative* effects of a worst-case spill scenario on the FFH VEC are predicted to be *not significant* (see Table 7.22). The level of confidence associated with this prediction is *medium*.

## 7.7.2 Species at Risk VEC

This section provides an assessment of the potential effects of accidental events and malfunctions on the Species at Risk (SAR) VEC. The assessment focuses on the scenarios developed for the sea cage sites.

The accident scenarios developed for the RAS Hatchery involved spills of diesel, formic acid, and ensilage. These spills will be treated in accordance with Grieg NL's Spill Management Plan (Appendix M) and Emergency Response Plan (Appendix T). Emergency and worst-case scenarios were also developed for fish mortalities in the RAS Hatchery. As described in Section 2.8.2, fish mortalities would be handled in accordance with established procedures in Grieg NL's Waste Management Plan (Appendix J) and Emergency Response Plan (Appendix T). There is very limited potential for land bird SAR to interact with spill events and no potential for interaction with fish mortality accident scenarios. If any bird species or other wildlife happens to occur at the RAS Hatchery site during a potential spill event, measures will be taken prevent the animal(s) from contacting the spill area; this will be detailed in Grieg NL's EPP.

Species at risk which may occur in the Study Area are provided in Table 4.14, and profiles of species at risk receiving legal protection and/or are considered under environmental assessment provisions (i.e., those listed as *endangered, threatened, special concern* or *vulnerable* under Schedule 1 of *SARA* and/or the *ESA*) are provided in Section 4.2.5.2.

The Rushoon BMA was selected as the location for marine accidental event scenarios, given its proximity to some of the most productive salmon rivers in Placentia Bay and higher exposure to weather and sea conditions as compared to the other BMAs (see Section 7.7.1). Table 7.23 indicates the potential interactions between accidental event/malfunction scenarios and the SAR VEC. Interactions between the taxonomic groups of species at risk within the Study Area and Project activities are shown.

### 7.7.2.1 Fish Escape – Emergency Scenario

The emergency sea cage fish escape scenario of 160,000 salmon and 16,000 lumpfish escaping from a sea cage in the Rushoon BMA during spring/early-summer could potentially affect the fish SAR, which include Atlantic wolfish, spotted wolfish, northern wolfish, white shark, American eel and banded killifish (Table 7.23).

The primary potential effect on the fish SAR is the transfer of diseases and parasites from the sea cage fish. While possible, there is not any documentation to support the transfer of diseases and parasites from Atlantic salmon and lumpfish to the six fish SAR. See Section 7.7.1.1 for more detail regarding transfers of disease and parasites.

***Mitigation Measures***

Despite the lack of evidence for disease and parasite transfer from farm fish to the six fish SAR, mitigation measures for this possible effect include:

- Implementation of biosecurity measures;
- Routine husbandry practices;
- Health checks and procedures;
- Use of specialized feed and feeding procedures;
- Sea lice control procedures;
- Water quality monitoring;
- No reuse of cleaner fish;
- Vaccinations; and
- Regular removal and treatment of dead fish from sea cages.

The Fish Health Management Plan (Appendix K) and Sections 2.5.1.2 and 2.5.2.2 of the EIS provide more details related to these mitigation measures.

**Table 7.23. Potential interactions between accidental events and the Species at Risk VEC.**

| Accidental Event Scenarios | Valued Environmental Component: Species at Risk | | | |
|---|---|---|---|---|
| | Fishes | Birds | Marine Mammals | Sea Turtles |
| Sea Cage Fish Escape – Emergency Scenario–160,000 salmon and 16,000 lumpfish | X | | | |
| Sea Cage Fish Escape – Worst-case Scenario – 2 million salmon and 200,000 lumpfish | X | | | |
| Mass Mortality of Sea Cage Fish – Emergency Scenario – 1,000 salmon | X | | | |
| Mass Mortality of Sea Cage Fish – Worst-case Scenario – 6 million salmon and 600,000 lumpfish | X | | | |
| Spill – Emergency Scenario – 1 kg feed | X | | | |
| Spill – Emergency Scenario – 100 L diesel fuel | X | X | X | X |
| Spill – Emergency Scenario – 1,000 L formic acid | X | | X | X |
| Spill – Worst-case Scenario – 600 mt feed, 30,000 L diesel fuel, 1,000 L formic acid, 5 $m^3$ sewage, 75 mt ensilage | X | X | X | X |

***Assessment***

Background information related to the sea cage fish escape emergency scenario, particularly with respect to disease and parasite transfer, is provided in Section 7.7.1.1. With mitigation measures in place, the emergency scenario of a sea cage fish escape is predicted to have residual *negative* effects on the fishes of the SAR VEC that are *minor* in magnitude over a geographic extent of *1,001–10,000 $km^2$* for a duration of *1–12 months* (Table 7.24). Based on these criteria ratings, the *reversible* residual *negative* effects of the escape of 160,000 farmed salmon and 16,000 lumpfish on the fish SAR are predicted to be *not significant* (Table 7.25). The level of confidence associated with this prediction is *medium*.

### 7.7.2.2 Fish Escape – Worst-case Scenario

The worst-case fish escape scenario of 2 million salmon and 200,000 lumpfish from all sea cages in the Rushoon BMA during spring/early-summer could potentially result in effects on the fish SAR. As is the case for the emergency escape scenario, the primary potential effect on the fish SAR is the transfer of diseases and parasites from the sea cage fish. While possible, there is not any documentation to support the transfer of diseases and parasites from Atlantic salmon and lumpfish to the six fish SAR. See Section 7.7.1.1 for more detail regarding transfers of disease and parasites.

***Mitigation Measures***

The mitigations described in 7.7.2.1 are also applicable to this scenario for fish SAR. The Fish Health Management Plan (Appendix K) and Sections 2.5.1.2 and 2.5.2.2 of the EIS provide more details related to these mitigation measures.

**Table 7.24. Assessment of potential residual environmental effects of accidental events and the Species at Risk VEC.**

| Valued Environmental Component: Species at Risk | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Accidental Event Scenario** | **Principal Potential Positive (P) or Negative (N) Environmental Effect** | **Key Mitigation Measure(s)** | **Evaluation Criteria for Assessing Environmental Effects** | | | | | |
| | | | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| Sea Cage Fish Escape – Emergency Scenario- 160,000 salmon and 16,000 lumpfish | Spread of disease and/or parasites from sea cage fish to SAR fishes (N) | • Recapture efforts, on the advice of DFO;<br>• Emergency Response Plan;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices;<br>• Health checks and procedures;<br>• No reuse of cleaner fish;<br>• Use of specialized feed and feeding procedures;<br>• Sea lice control procedures;<br>• Water quality monitoring;<br>• Vaccinations;<br>• Regular removal and treatment of dead fish. | 1 | 5 | 1 | 2 | R | 2 |
| Sea Cage Fish Escape – Worst-case Scenario – 2 million salmon and 200,000 lumpfish | Ecological interaction between sea cage fish and wild fish (N);<br><br>Genetic introgression between sea cage fish and wild fish (N);<br><br>Spread of disease and/or parasites from sea cage fish to wild fish (N) | • Use of triploid all-female Atlantic salmon in sea cages;<br>• Use of Newfoundland broodstock lumpfish as cleaner fish in the sea cages;<br>• Locating sea cage sites at some distance from the mouths of salmon rivers;<br>• Recapture efforts, on the advice of DFO;<br>• Emergency Response Plan;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices;<br>• Health checks and procedures;<br>• Use of specialized feed and feeding procedures;<br>• Sea lice control procedures;<br>• Water quality monitoring;<br>• Vaccinations;<br>• Regular removal and treatment of dead fish. | 1 | 5 | 1 | 2 | R | 2 |
| Mass Mortality of Sea Cage Fish – Emergency Scenario – 1,000 salmon – due to low DO and elevated water temperatures | Attraction of wild marine fauna to the sea cages (N);<br><br>Extra deposition of organic material to the seabed (N) | • Emergency Response Plan;<br>• Rapid removal of dead fish from the sea cage. | 1 | 2 | 1 | 1 | R | 2 |
| Mass Mortality of Sea Cage Fish - Worst-case Scenario – 6 million salmon and 600,000 lumpfish – due to ISA | Spread of disease and/or parasites from sea cage fish to wild fauna (N) | • Emergency Response Plan;<br>• Rapid removal of dead fish from the sea cages;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices;<br>• Health checks and procedures; | 1 | 3 | 1 | 1 | R | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Attraction of wild fauna to the sea cages (N);<br><br>Extra deposition of organic material to the seabed (N) | • Use of specialized feed and feeding procedures;<br>• Sea lice control procedures;<br>• Water quality monitoring;<br>• Vaccinations;<br>• Regular removal and treatment of dead fish. | | | | | | |
| Spill – Emergency Scenario – 1 kg feed | Additional organic material being deposited to the seabed in the vicinity of the sea cage (N);<br><br>Attraction of wild fauna (N) | • Spill Management Plan;<br>• Emergency Response Plan. | 0 | 1 | 1 | 1 | R | 2 |
| Spill – Emergency Scenario – 100 L Diesel Fuel | Contamination of upper water column (N);<br><br>Sub-lethal and lethal effects marine fauna (N) | • Spill Management Plan;<br>• Emergency Response Plan. | 1 | 1-2 | 1 | 1 | R | 2 |
| Spill – Emergency Scenario – 1,000 L Formic Acid | Contamination of upper water column (N);<br><br>Sub-lethal and lethal effects on marine fauna (N) | • Spill Management Plan;<br>• Emergency Response Plan. | 0 | 1 | 1 | 1 | R | 2 |
| Spill – Worst-case Scenario – 600 mt feed, 30,000 L diesel fuel, 1,000 L formic acid, 5 $m^3$ sewage, 75 mt ensilage | Additional organic material being deposited to the seabed in the vicinity of the sea cage (N);<br><br>Contamination of upper water column and biota within it (N);<br><br>Sub-lethal and lethal effects on marine fauna (N) | • Spill Management Plan;<br>• Emergency Response Plan. | 1-2 | 3 | 1 | 1 | R | 2 |

Key:

Magnitude:
0 = Negligible
1 = Minor
2 = Moderate
3 = Major

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = Continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1-$km^2$
2 = 1-10-$km^2$
3 = 11-100-$km^2$
4 = 101-1,000-$km^2$
5 = 1,001-10,000-$km^2$
6 = > 10,000-$km^2$

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not affected by human activity
2 = Evidence of existing effects

**Table 7.25. Significance of potential residual environmental effects of accidental events on the Species at Risk VEC.**

| Valued Environmental Component: Species at Risk | | | | |
|---|---|---|---|---|
| **Accidental Event Scenario** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[a]** | |
| | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| Sea Cage Fish Escape – Emergency Scenario-160,000 salmon and 16,000 lumpfish | NS | 2 | | |
| Sea Cage Fish Escape – Worst-case Scenario – 2 million salmon and 200,000 lumpfish | NS | 2 | | |
| Mass Mortality of Sea Cage Fish – Emergency Scenario – 1,000 salmon | NS | 2-3 | | |
| Mass Mortality of Sea Cage Fish – Worst-case Scenario – 6 million salmon and 600,000 lumpfish | NS | 2 | | |
| Spill – Emergency Scenario – 1 kg feed | NS | 3 | | |
| Spill – Emergency Scenario – 100 L Diesel Fuel | NS | 2 | | |
| Spill – Emergency Scenario – 1,000 L Formic Acid | NS | 2-3 | | |
| Spill – Worst-case Scenario – 600 mt feed, 30,000 L diesel fuel, 1,000 L formic acid, 5 $m^3$ sewage. 75 mt ensilage | NS | 2 | | |

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 $km^2$.

Residual environmental Effect Rating:
S = Significant Negative Environmental Effect
NS = Not-significant Negative Environmental Effect
P = Positive Environmental Effect

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Level of Confidence: based on professional judgment:
1 = Low
2 = Medium
3 = High

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low
2 = Medium
3 = High

[a] Considered only in the case where 'significant negative effect' is predicted.

### *Assessment*

The simultaneous escape of all fish from all 36 sea cages in the Rushoon BMA has a very low probability of occurrence. With mitigation measures in place, the worst-case scenario of a sea cage fish escape is predicted to have residual *negative* effects on the fish SAR that are *minor* in magnitude over a geographic extent of *1,001–10,000 km²* for a duration of *1–12 months* (see Table 7.24). Based on these criteria ratings, the *reversible* residual *negative* effects of the escape of 2 million farmed salmon and 200,000 lumpfish on the fish SAR are predicted to be *not significant* (see Table 7.25). The level of confidence associated with this prediction is *medium*.

### 7.7.2.3 Mass Mortality – Emergency Scenario

This emergency scenario for mass mortality of 1,000 salmon in a sea cage in the Rushoon BMA during August may affect the fish SAR. This emergency scenario considers low oxygen levels and higher water temperatures as the primary causes of the mass mortality. The key potential effects include:

- Attraction of fish SAR to the sea cage, with focus on the white shark; and
- Deposition of additional organic matter from the sea cage to the seabed in the immediate vicinity.

***Attraction of Fish SAR to the Sea Cage***

A potential effect of a mass mortality of 1,000 salmon in the sea cage would be attraction of large predators, like the white shark, which could result in breaches of sea cage nets. Small numbers of escapes from sea cages on the south coast of Newfoundland were reported in 2012 as a result of damage to the netting caused by sharks and tuna. In August 2015, an unknown number of salmon escaped sea cages in southern Newfoundland that had holes in the netting due to damage caused by predator strikes (DFO 2017a). During consultations for the Project, fishers indicated that they have seen a marked increase in the number of sharks in Placentia Bay during the past four to five years (Grattan et al. 2018 *in* Volume 3).

***Deposition of Additional Organic Material***

If the 1,000 dead fish occurring as a result of the mass mortality emergency scenario were not removed quickly, the decaying fish may increase deposition of organic material from the sea cage to the seabed. Accumulation of organic material in the marine system can negatively impact the ecosystem by contributing to organic enrichment of the benthic systems (i.e., BOD matter) (Strain and Hargrave 2005 *in* Taranger et al. 2015; Hamoutene et al. 2015b; Verhoeven et al. 2016; Salvo et al. 2017). The deposition of organic material to the seabed could potentially attract demersal fishes, such as the three wolfish species, to the sea cage areas, making them more prone to interaction with potential predators.

***Mitigation Measures***

The primary mitigation measures intended to minimize the potential effects of the mass mortality of 1,000 salmon in a single sea cage on the fishes of the SAR VEC include:

- A Predator Control Plan, required as part of Grieg NL's aquaculture license application, will include methods to monitor, deter and exclude marine predators from the sea cages sites; and
- Use of an automatic pumping system to remove as quickly as possible dead fish from the sea cages and transfer them to an ensilage tank.

Section 2.5.2.2 of the EIS provides more details related to these mitigation measures associated with a smaller mass mortality.

***Assessment***

After application of mitigation measures, the emergency scenario of mass mortality in a sea cage is predicted to have residual *negative* effects on fish SAR that are *minor* in magnitude over a geographic extent of *1–10 km$^2$* for a duration of *<1 month* (see Table 7.24). Based on these criteria ratings, the

*reversible* residual *negative* effects of the mass mortality of 1,000 farmed salmon on the fish SAR are predicted to be *not significant* (see Table 7.25). The level of confidence associated with this prediction is *medium* to *high*.

### 7.7.2.4 Mass Mortality – Worst-case Scenario

The mass mortality worst-case scenario that involves 6 million salmon and 600,000 lumpfish in all 36 sea cages in the Rushoon BMA during July could affect the fish SAR. The presumed cause of this worst-case scenario is ISA and an associated depopulation order. Note that there are not any salmonids in the fish SAR being considered. As is the case for the emergency scenario of a mass mortality, the key potential effects include:

- Attraction of wild fauna to the sea cages (see Section 7.7.2.3); and
- Deposition of additional organic matter from the sea cages to the surrounding seabed (see Section 7.7.2.3).

***Mitigation Measures***

The primary mitigation measures intended to minimize the potential effects of the mass mortality of 6 million salmon and 600,000 lumpfish on the fish SAR include:

- Implementation of the Emergency Response Plan (Appendix T); and
- Immediate response to a mass mortality will include the use of backup vessels provided by OCI in combination with the well boat to collect all mortalities from the sea cage.

The Emergency Response Plan (Appendix T) and Section 2.8.2 of the EIS provide more details related to these mitigation measures.

***Assessment***

Given the unlikelihood of occurrence of the worst-case mass mortality scenario, and after application of mitigation measures, the worst-case scenario of mass mortality in multiple sea cages is predicted to have residual *negative* effects on the fish SAR that are *minor* in magnitude over a geographic extent of *11–100 km*$^2$ for a duration of *<1 month* (see Table 7.24). Based on these criteria ratings, the *reversible* residual *negative* effects of the mass mortality of six million farmed salmon and 600,000 lumpfish on the fish SAR are predicted to be *not significant* (see Table 7.25). The level of confidence associated with this prediction is *medium*.

### 7.7.2.5 Feed Spill – Emergency Scenario

The feed spill emergency scenario of 1 kg of spilled feed in the Rushoon BMA during the summer is likely to have limited, if any, effects on fish SAR.

After application of mitigation measures, the feed spill emergency scenario is predicted to have residual *negative* effects on the fish SAR that are *negligible* in magnitude over a geographic area of *<1 km*$^2$ for a duration of *<1 month* (see Table 7.24). The *reversible* residual *negative* effects of the feed spill of 1 kg in the Rushoon BMA during the summer on the SAR VEC are predicted to be *not significant* (see Table 7.25). The level of confidence associated with this prediction is *high*.

### 7.7.2.6 Diesel Fuel Spill – Emergency Scenario

The diesel fuel spill emergency scenario of 100 L of diesel fuel spilled during refueling at a single cage in the Rushoon BMA during the summer could potentially result in sub-lethal and/or lethal effects on the SAR VEC, with effects localized owing to the size of the spill. All animal groups considered for the SAR VEC could potentially interact with spilled diesel fuel (Table 7.23). As described in Section 2.8.3.2, this emergency scenario is thought to be a result of a break in a refueling hose leading to a feed/accommodation barge. The possible effects of an emergency scenario diesel fuel spill are described below for fish and plankton, marine mammals and sea turtles, and birds.

***Fishes***

Fish eggs and larvae as well as pelagic juvenile and adult fish have the highest probability of exposure to spilled diesel fuel. Section 7.7.1.6 describes the potential effects of marine diesel on different life stages of marine fishes and the marine habitat. Ichthyoplankton (fish eggs and larvae) fauna are more susceptible to exposure than adult stages (see Section 7.7.1.6). See Section 7.7.1.6 for sensitivity concentrations for soluble aromatic hydrocarbons for fish larvae. Pelagic species, such as the American eel, which may occupy the upper water column during migration may be more susceptible to the effects of exposure to spilled diesel fuel than those inhabiting the lower water column or that are demersal/benthic (i.e., the wolffishes). Since the banded killifish occurrence in the marine system is typically restricted to estuaries, it is unlikely that they would be exposed to the spill of 100 L of diesel fuel.

***Marine Mammals and Sea Turtles***

Hydrocarbons can be inhaled or ingested by marine mammals and may cause behavioural changes, inflammation of mucous membranes, pneumonia and neurological damage (see Geraci and St. Aubin 1990). In the Study Area, whales and seals rely on a layer of blubber for insulation, so oil has little effect on thermoregulation when compared to other marine mammals that rely on fur for insulation. The exception is seal pups that have not yet developed insulating blubber (Kooyman et al. 1976 *in* Helm et al. 2015). Oil could have numerous effects on the health or behaviour of marine mammals (MMC 2011). However, very little research has been conducted on the effects of oil spills on seals (Helm et al. 2015). Lightly oiled ringed seals (*Pusa hispida*) show changes in liver enzyme levels, but no organ lesions (Geraci and Smith 1976; Engelhardt 1982). However, crude oil causes pathologies of the respiratory system, eye, oral cavity, and anal and urogenital surfaces in ringed seal that are characteristic of oil fume inhalation (St. Aubin 1990).

The effects of oil on whales had also received little study until the *Deepwater Horizon* blowout in 2010. Although initial avoidance of slicks by cetaceans has been observed (except in the case of sheens) (Sidorovskaia et al. 2016), several species have been seen swimming through, and feeding in, large slicks (see Helm et al. 2015; Wilkin et al. 2017). Although oil could coat the baleen of mysticete whales and reduce filtration efficiency, this effect is considered reversible (Geraci 1990). *Deepwater Horizon* oil has been observed adhering to the skin of 11 species of cetaceans (Aichinger Dias 2017), persisting for at least two years after blowout for some species. Oil from such spills can have negative impacts on cetacean health. For example, renal (kidney) cells of spotted dolphins (*Stenella* spp.) exposed to No. 1 fuel oil show reductions in survivability that appear to be dose-dependent (Pfeiffer et al. 2000). Atlantic bottlenose dolphins (*Tursiops truncatus)* oiled during the *Deepwater Horizon* incident revealed respiratory abnormalities, impaired stress response (hormonal), and elevated adrenal hormone levels (Schwacke et al. 2014; Balmer et al. 2015; Lane et al. 2015; Venn-Watson et al. 2015; Smith et al. 2017). These effects persisted for at least four years after the blowout (Smith et al. 2017). In addition, immune

function in these individuals was consistent with bacterial infection (De Guise et al. 2017). Annual survival in these populations was significantly lower than that in an unoiled area (McDonald et al. 2017; Mullin et al 2017), and dead-stranding rates were up to four times greater in the areas with heaviest oiling (Kellar et al. 2017). The reproductive success rates in dolphins in oiled areas were reduced by more than two-thirds (Kellar et al. 2017), while the percentage of pregnant females giving birth to viable calves was reduced by 75% (Lane et al. 2015). Most of the pregnant females that failed to give birth to viable calves had previously been diagnosed with lung disease coinciding with the blowout.

Oil spills can also have negative effects on cetaceans at the population level. Bottlenose dolphin populations impacted by the *Deepwater Horizon* blowout were significantly reduced in size (McDonald et al. 2017). These populations were very susceptible to the effects of this blowout because the small size of pod home ranges resulted in continuous exposure to the oil (Wells et al. 2017). Killer whale pods in Prince William Sound that were photo-identified before the *Exxon Valdez* oil spill lost 33% to 41% of their members in the first year (Matkin et al. 2008). The loss of adult females suppressed reproduction so that pod size failed to recover to pre-spill levels or declined during 16 years of follow-up monitoring (Loughlin 1994; Peterson et al. 2003; Matkin et al. 2008).

Sea turtles may be more susceptible to the effects of exposure to hydrocarbons than marine mammals because they do not respond with avoidance behaviour, exhibit indiscriminate feeding, and take large pre-dive inhalations (see Milton et al. 2010; Vander Zanden et al. 2016). Ingestion of oil is particularly deleterious to sea turtle health (Camacho et al. 2013). Many of the surface-pelagic juvenile sea turtles oiled during the *Deepwater Horizon* blowout showed physiological derangements (Stacy et al. 2017), and visibly oiled sea turtles found dead or dying had elevated levels of polycyclic aromatic hydrocarbons (Ylitalo et al. 2017). However, few, if any sea turtles, are expected to be exposed to the small amount of fuel (100 L) assessed here given the low numbers of sea turtles that may occur at the sea cage sites and small size and expected short persistence of the fuel release, as well as mitigation measures in place.

***Birds***

The reported effects of hydrocarbons on marine birds vary with species, type of hydrocarbon, weather conditions, time of year, and duration of the spill (Gorsline et al. 1981). These factors also affect the number of birds coming into contact with a hydrocarbon spill, with the result that the volume of hydrocarbons released is only weakly correlated with the number of birds affected (Burger 1993). Natural inter-annual variation in other factors that affect populations (e.g., prey availability and weather) reduces the ability of scientists to assess the full effect of hydrocarbon spills on bird populations (Eppley 1992; White et al. 1995; Votier et al. 2005).

Individual marine birds that come into contact with hydrocarbons could suffer a variety of effects, ranging from sub-lethal to lethal (e.g., Hartung 1995; Wiese and Ryan 2003; Beyer et al. 2016; Dean and Bursian 2017; Fallon et al. 2018). An exposure to a surface release of hydrocarbons under calm conditions may harm or kill individual birds. Exposure to oil causes thermal and buoyancy deficiencies that typically lead to the deaths of affected marine birds. External exposure to hydrocarbons occurs when flying birds land in oil slicks, diving birds surface from beneath oil slicks, and swimming birds swim into slicks. The external exposure results in matting of the feathers, which effectively destroys the thermal insulation and buoyancy provided by the air trapped by the feathers. Morandin and O'Hara (2016) demonstrated that only a small amount of oil (e.g., 10 ml) is required to affect the feather structure of Common Murre and Dovekie with potential to lethally reduce thermoregulation. Consequently, oiled birds may suffer from hypothermia and/or drown (Clark 1984; Hartung 1995). Birds living in cold-water environments, such as Placentia Bay, are most likely to succumb to hypothermia (Hartung 1995;

Wiese and Ryan 2003). Most mortalities occur during the initial phase of oil spills, when large numbers of birds are exposed to floating oil (Hartung 1995).

Oiled birds that escape death from hypothermia and/or drowning often seek refuge ashore, where they engage in abnormally excessive preening in an attempt to remove the oil (Hunt 1957 *in* Hartung 1995). The preening leads to the ingestion of substantial quantities of oil that, although apparently only partially absorbed, can still cause lethal effects (e.g., McEwan and Whitehead 1980; Hughes et al. 1990; Khan and Ryan 1991). Individuals that survive may suffer sub-lethal effects that affect reproductive success and thus population size (e.g., Esler et al. 2011; Dean and Bursian 2017; Fallon et al. 2018). For some individual birds, oiling has not had lethal or marked sub-lethal effects. Among oiled, colour-banded Herring Gulls and Lesser Black-backed Gulls (*Larus fuscus*), most survived and cleaned themselves within a few weeks of oiling, with some breeding successfully and surviving up to 20 years after oiling (Camphuysen 2011).

It is difficult to estimate how many marine birds are oiled during any particular oil spill, because some birds may not reach shore (dead or alive), and beached carcasses may be scavenged or washed out to sea before being counted (Ford et al. 1987). Even small spills can cause cumulative mass mortality of marine birds (Joensen 1972; Carter et al. 2003; Hampton et al. 2003). In contrast, relatively low mortalities have been recorded from some huge spills (e.g., Clark 1984). Tan et al. (2010) found no correlation between seabird mortality and spill size, except for spills less than 7 tonnes in size.

There are possible changes in habitat use of oiled areas by both oiled and un-oiled birds. The greatest decrease in use of contaminated habitats immediately following a spill occurs in species that feed on or close to shore and either breed along the coast or are full-year residents (Wiens et al. 1996). Day et al. (1997) showed that species lacking clear evidence of recovery tended to be intertidal feeders and residents. However, they also found that other ecologically-similar species did not show signs of initial effects or showed rapid recovery.

If effects on individuals were extensive enough to cause large numbers of mortalities and/or severe sub-lethal effects on growth and reproduction, then effects could be measured at the level of populations. The duration of sub-lethal effects would likely vary by species, life stage, type and degree of exposure, among other factors. It is impossible to predict with any level of realistic precision how a range of sub-lethal effects might affect a particular population (e.g., Irons et al. 2000; Wiens et al. 2001; Esler et al. 2002).

A hydrocarbon spill would have its greatest effect on marine bird populations if the spill reached an important area used by species at risk or by concentrations of birds. Diving species such as auks, loons and ducks are considered to be the most susceptible to the immediate effects of surface slicks (Leighton et al. 1985; Chardine 1995; Wiese and Ryan 1999; Irons et al. 2000).

During winter, a spill that reached Cape St. Mary's could put Harlequin Ducks and possibly Barrow's Goldeneye (both *SARA* Schedule 1 *special concern*) at risk of exposure to hydrocarbons. However, the 100 L diesel fuel spill in the Rushoon BMA is not expected to interact with bird SAR.

***Mitigation Measures***

In the event of a fuel spill of 100 L of diesel fuel, Grieg NL would immediately initiate its spill response plan for fuel (Appendix M), including the following primary measures:

- Deployment of containment booms and absorption pillows/socks;
- Immediately contacting the Pollution Line and/or contracted Emergency Response Organization for assistance with environmental cleanup as required;
- Use of skimmers after the booms are in place; and
- Personnel on board the barges will be trained in the use of the on board spill kit.

***Assessment***

The marine species at risk fauna of the SAR VEC that utilize the upper water column would be the most likely animals exposed to hydrocarbons associated with the emergency scenario of 100 L of spilled diesel fuel. It is possible that some pelagic species may avoid the upper water column in the event of such a spill. Providing the spill was quickly contained, the number of exposed marine fauna should be minimal. The spill size and persistence of toxicity should be minimal with the implementation of mitigation measures.

After application of mitigation measures, the spill emergency scenario of 100 L of diesel fuel at a single cage in the Rushoon BMA during the summer is predicted to have residual *negative* effects on the SAR VEC that are *minor* in magnitude over a geographic area of *<1 km$^2$* to *1–10 km$^2$* for a duration of *<1 month* (see Table 7.24). Based on these criteria ratings, the *reversible* residual *negative* effects of an emergency scenario spill of 100 L of diesel fuel on the SAR VEC are predicted to be *not significant* (see Table 7.25). The level of confidence associated with this prediction is *medium*.

### 7.7.2.7 Formic Acid Spill – Emergency Scenario

The formic acid spill emergency scenario of 1,000 L of formic acid spilled due to the loss of an entire IBC at a single cage in the Rushoon BMA during the summer could potentially affect the SAR VEC. Grieg NL will use food-grade formic acid (85%). There is low risk of harm to organisms and the environment from formic acid (see Section 7.7.1.7).

***Mitigation Measures***

Mitigation measures to minimize the potential effects of a formic acid emergency scenario spill of 1,000 L of formic acid are provided in Spill Management Plan (Appendix M) and Emergency Response Plan (Appendix T). Formic acid containers are designed to have neutral buoyancy, but in the event the container should be damaged and sinks, it could be retrieved onto the attendant barge via ROV. Formic acid biodegrades in water, would be diluted by the surrounding seawater, and has a low potential to bioaccumulate (see Section 2.8.3.2).

***Assessment***

After application of mitigation measures, the emergency scenario of a formic acid spill of 1,000 L at a single cage in the Rushoon BMA during the summer is predicted to have residual *negative* effects on the fish SAR that are *negligible* in magnitude over a geographic area of *<1 km$^2$* for a duration of *<1 month* (see Table 7.24). The *reversible* residual *negative* effects of a 1,000 L formic acid emergency scenario spill on the SAR VEC are predicted to be *not significant*, with a *medium* to *high* level of confidence associated with this prediction (see Table 7.25).

### 7.7.2.8 Spill – Worst-case Scenario

The worst-case spill scenario could result from the collision of a vessel with a feed or accommodation barge in the Rushoon BMA during the summer. This scenario includes the spill of 600 mt of feed (~925 $m^3$), 30,000 L of diesel fuel, 1,000 L of formic acid, 5 $m^3$ of sewage and 75 mt of ensilage (~5 $m^3$). All animal groups considered for the SAR VEC could potentially be affected by the worst-case spill scenario (see Table 7.23). The potential effects on the SAR VEC include:

- Extra deposition of organic material on the sea bed (i.e., feed);
- Attraction of wild marine fauna to the sea cages; and
- Sub-lethal and/or lethal contamination of wild biota in the vicinity of the spill.

The consequences of spillage of the entire contents of the feed/accommodation barge are described in Sections 2.8.3.2 and 7.7.1.8. A loss of diesel fuel would pose the highest risk to the SAR VEC, principally the biota utilizing the upper water column (see Sections 7.7.1.6, 7.7.1.8 and 7.7.2.6). See Sections 7.4, Sensitive Areas VEC and 7.7.2.3 for details on the deposition of organic matter and attraction of wild fauna.

***Mitigation Measures***

Mitigation measures may not be required for the spillage of feed, formic acid, sewage or ensilage. If required, measures would be in accordance with Grieg NL's Spill Management Plan (Appendix M), Emergency Response Plan (Appendix T), and as described in Sections 7.7.2.5 and 7.7.2.7. An ROV could be used to inspect the deposition of spilled feed on the seabed and retrieve containers of formic acid that may have been lost overboard.

The primary mitigation measures intended to minimize the effects of a worst-case scenario spill are described in Grieg NL's Spill Management Plan (Appendix M) and Emergency Response Plan (Appendix T), including:

- Deployment of containment booms;
- Deployment of hydrophobic absorbent booms;
- Use of skimmers after booms in place; and
- Contacting the Pollution Line and contracted Emergency Response Organization to assist with environmental cleanup.

***Assessment***

This worst-case scenario is highly unlikely to occur, as the barges are equipped with surrounding heavy-duty bumpers, including from the water line to the top of their main deck hand rails (see Sections 2.8.3 and 7.7.1.8). In order to completely drain storage departments, a vessel strike would have to penetrate the barge's safety bumpers and outside walls and the inside walls of the storage tanks. Most of the damage from a vessel strike would most likely be above the water line, further reducing the probability of complete loss of storage tank contents.

Even post-containment, the slick caused by the accidental release of all 30,000 L of diesel fuel would be larger than that for the emergency diesel fuel spill scenario (see Sections 7.7.1.8 and 7.7.2.6). As per the emergency diesel spill scenario, the persistence of toxic levels of hydrocarbons in the water-soluble portion below the slick should have a relatively short duration, potentially impacting marine species at

risk utilizing the upper water column (see Section 7.7.2.6). It is possible that some pelagic species would avoid the slick.

After application of mitigation measures, the worst-case spill scenario involving the release of feed, diesel fuel, formic acid, sewage and ensilage into the marine environment is predicted to have residual *negative* effects on the SAR VEC that are *minor* to *moderate* in magnitude over a geographic extent of *11–100 km*$^2$ for a duration of *<1 month* (see Table 7.24). Based on these criteria ratings, the *reversible* residual *negative* effects of a worst-case spill scenario in the Rushoon BMA during the summer on the SAR VEC are predicted to be *not significant* (see Table 7.25). The level of confidence associated with this prediction is *medium*.

### 7.7.3 Sensitive Areas VEC

The potential effects of accidental events and malfunctions in the marine environment on the Sensitive Areas (SA) VEC are assessed here. No sensitive areas were identified for the RAS Hatchery site in the Marystown Marine Industrial Park, which has already been cleared of vegetation. As such, RAS Hatchery accident and malfunction scenarios are not considered.

The principal features which led to Placentia Bay being declared an EBSA are detailed in Section 4.2.6 and summarized here. Placentia Bay hosts a high aggregation of ichthyoplankton, particularly those of Atlantic cod, cunner, American plaice and capelin, in the western and northern portions of the Bay. Identified ichthyoplankton high-aggregation areas overlap all 11 proposed sea cage sites. It also has the largest Atlantic cod spawning stock within the Northwest Atlantic. Placentia Bay is also an important area for feeding and/or migration for large aggregations of marine mammals and sea turtles, particularly during the spring and summer months. Harbour seals occur there year-round and Placentia Bay hosts the highest densities of river otters in the province. The western and northern portions of Placentia Bay are among the most important for marine mammals, including the Rushoon, Merasheen and Red Island BMAs. Placentia Bay supports high numbers of birds, and has four IBAs for nesting, feeding and overwintering. The largest, the Placentia Bay IBA, is closest to the proposed sea cage sites in the Red Island and Long Harbour BMAs.

Critical habitat for leatherback sea turtles was recently proposed for the southern portion of Placentia Bay, the northern extent of which is near the Rushoon BMA (see Section 4.2.6). The principal features which led to the proposed designation include the quantity and quality of gelatinous prey items, acoustic environment and water quality. Leatherbacks typically occur within Atlantic Canadian waters during late-spring through fall, with peak use of proposed critical habitat areas during the summer and fall.

The Rushoon BMA was selected as the location for marine accidental event scenarios. Table 7.26 indicates the potential interactions between accidental event/malfunction scenarios and the SA VEC. Note that interactions between the SA VEC and fish escape scenarios are not assessed here as these scenarios primarily relate to potential effects on fish and fish habitat, which was assessed in Section 7.7.1.

**Table 7.26. Potential interactions between accidental events and the Sensitive Areas VEC.**

| Accidental Event Scenario | Valued Environmental Component: Sensitive Areas | |
|---|---|---|
| | Placentia Bay Extension EBSA | Proposed Leatherback Critical Habitat |
| Sea Cage Fish Escape – Emergency Scenario-160,000 salmon and 16,000 lumpfish | | |
| Sea Cage Fish Escape – Worst-case Scenario – 2 million salmon and 200,000 lumpfish | | |
| Mass Mortality of Sea Cage Fish - Emergency Scenario – 1,000 salmon | X | X |
| Mass Mortality of Sea Cage Fish - Worst-case Scenario – 6 million salmon and 600,000 lumpfish | X | X |
| Spill – Emergency Scenario – 1 kg feed | X | X |
| Spill – Emergency Scenario – 100 L diesel fuel | X | X |
| Spill – Emergency Scenario – 1,000 L formic acid | X | X |
| Spill – Worst-case Scenario – 600 mt feed, 30,000 L diesel fuel, 1,000 L formic acid, 5 $m^3$ sewage, 75 mt ensilage | X | X |

### 7.7.3.1 Mass Mortality – Emergency Scenario

The mass mortality emergency scenario (i.e., 1,000 salmon in a sea cage in the Rushoon BMA during August) may affect the SA VEC. The key potential effects of this emergency scenario, which assumes low oxygen levels and higher water temperatures are the cause of mortality, include:

- Attraction of wild fauna to the sea cages (see Section 7.7.3.2); and
- Deposition of additional organic matter from the sea cages to the surrounding seabed (see Section 7.7.3.2).

***Mitigation Measures***

The primary mitigation measures to minimize the potential effects of the mass mortality emergency scenario of 1,000 salmon in a single sea cage on the SA VEC include:

- Abiding by a Predator Control Plan, which is required as part of Grieg NL's aquaculture licence application and will include methods to monitor, deter and exclude marine predators from the sea cage sites; and
- Use of an automatic pumping system to remove as quickly as possible dead fish from the sea cages and transfer them to an ensilage tank.

Section 2.5.2.2 of the EIS further details the mitigation measures associated with such levels of mass mortality.

***Assessment***

After the application of mitigation measures, the mass mortality emergency scenario is predicted to have residual *negative* effects on the SA VEC that are *minor* in magnitude over a geographic extent of *1–10 $km^2$* for a duration of *<1 month* (Table 7.27). Based on these criteria ratings, the *reversible* residual *negative* effects of the mass mortality emergency scenario on the SA VEC are predicted to be *not significant* (Table 7.28). The level of confidence associated with this prediction is *medium* to *high*.

### 7.7.3.2 Mass Mortality – Worst-case Scenario

The mass mortality worst-case scenario of the death of 6 million salmon and 600,000 lumpfish in all 36 sea cages in the Rushoon BMA during July could affect the SA VEC. This worst-case scenario considers ISA and a depopulation order as the cause for mass mortality. The key potential effects include:

- Transfer of ISA to wild salmonids;
- Attraction of wild fauna to the sea cages (see Section 7.7.3.2); and
- Deposition of additional organic matter from the sea cages to the surrounding seabed (see Section 7.7.3.2).

See Section 7.7.1.4 for background information on ISA, and Sections 7.4 and 7.7.3.2 for details on the attraction of wild fauna and deposition of organic matter.

***Mitigation Measures***

In the event of a worst-case scenario mass mortality in an entire BMA, Grieg NL would be obligated to act as quickly and efficiently as possible to reduce any further effect on sea cage sites within other BMAs and abide by all regulatory requirements. Grieg NL would implement the mass mortality procedures of the Emergency Response Plan, including the notification of regulatory agencies and activation of depopulation, if required. Backup vessels supplied by OCI and the well boats would be used to expediently collect all mass mortalities from the sea cages, using equipment and procedures similar to those used during harvesting. The Predator Control Plan would also be implemented.

Grieg NL's Emergency Response Plan (Appendix T) and Section 2.8.2 further describe these mitigation measures.

***Assessment***

In the event of a worst-case scenario mass mortality of 6 million farmed salmon and 600,000 lumpfish in the Rushoon BMA during July, the primary concerns related to the SA VEC are minimizing the spread of the ISA virus and attraction of wild marine fauna (including large predators) to the sea cages. Given the size of such a mass mortality, prompt removal of all of the mortalities from the 36 sea cages would likely take up to several days for completion. It is important to note that such a massive scale of mortality is highly unlikely to occur, owing to the separation distance between sea cage sites within the Rushoon BMA.

After application of mitigation measures, the mass mortality worst-case scenario is predicted to have residual *negative* effects on the SA VEC that are *minor* to *moderate* in magnitude over a geographic area of *11–100 km$^2$* for a duration of *<1 month* (Table 7.27). The *reversible* residual *negative* effects of the mass mortality of 6 million farmed salmon and 600,000 lumpfish at all 36 sea cages in the Rushoon BMA during July are predicted to be *not significant* (Table 7.28). The level of confidence associated with this prediction is *medium*.

**Table 7.27. Assessment of potential residual environmental effects of accidental events and the Sensitive Areas VEC.**

| Valued Environmental Component: Sensitive Areas | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Evaluation Criteria for Assessing Environmental Effects | | | | | |
| **Accidental Event Scenario** | **Principal Potential Positive (P) or Negative (N) Environmental Effect** | **Key Mitigation Measure(s)** | **Magnitude** | **Geographic Extent** | **Frequency** | **Duration** | **Reversibility** | **Ecological/ Socio-Cultural and Economic Context** |
| Mass Mortality of Sea Cage Fish – Emergency Scenario – 1,000 salmon – due to low DO and elevated water temperatures | Attraction of wild marine fauna to the sea cages (N);<br><br>Extra deposition of organic material to the seabed (N) | • Rapid removal of dead fish from the sea cage. | 1 | 2 | 1 | 1 | R | 2 |
| Mass Mortality of Sea Cage Fish - Worst-case Scenario – 6 million salmon and 600,000 lumpfish – due to ISA | Spread of disease and/or parasites from sea cage fish to wild fauna (N)<br><br>Attraction of wild fauna to the sea cages (N);<br><br>Extra deposition of organic material to the seabed (N) | • Emergency Response Plan;<br>• Rapid removal of dead fish from the sea cages;<br>• Implementation of biosecurity measures;<br>• Routine husbandry practices;<br>• Health checks and procedures;<br>• Use of specialized feed and feeding procedures;<br>• Sea lice control procedures;<br>• Water quality monitoring;<br>• Vaccinations;<br>• Regular removal and treatment of dead fish. | 1-2 | 3 | 1 | 1 | R | 2 |
| Spill – Emergency Scenario – 1 kg feed | Additional organic material being deposited to the seabed in the vicinity of the sea cage (N);<br><br>Attraction of wild fauna (N) | • Spill Management Plan;<br>• Emergency Response Plan. | 0 | 1 | 1 | 1 | R | 2 |
| Spill – Emergency Scenario – 100 L Diesel Fuel | Contamination of upper water column (N);<br><br>Sub-lethal and lethal effects marine fauna (N) | • Spill Management Plan;<br>• Emergency Response Plan. | 1 | 1-2 | 1 | 1 | R | 2 |
| Spill – Emergency Scenario – 1,000 L Formic Acid | Contamination of upper water column (N);<br><br>Sub-lethal and lethal effects on marine fauna (N) | • Spill Management Plan;<br>• Emergency Response Plan. | 0 | 1 | 1 | 1 | R | 2 |
| Spill – Worst-case Scenario – 600 mt | Additional organic material being deposited to the seabed in the | • Spill Management Plan; | 1-2 | 3 | 1 | 1 | R | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| feed, 30,000 L diesel fuel, 1,000 L formic acid, 5 $m^3$ sewage, 75 mt ensilage | vicinity of the sea cage (N);<br><br>Contamination of upper water column and biota within it (N);<br><br>Sub-lethal and lethal effects on marine fauna (N) | • Emergency Response Plan. | | | | | | |

Key:

Magnitude:
0 = Negligible
1 = Minor
2 = Moderate
3 = Major

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = Continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1-$km^2$
2 = 1-10-$km^2$
3 = 11-100-$km^2$
4 = 101-1,000-$km^2$
5 = 1,001-10,000-$km^2$
6 = > 10,000-$km^2$

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not affected by human activity
2 = Evidence of existing effects

**Table 7.28. Significance of potential residual environmental effects of accidental events on the Sensitive Areas VEC.**

| Valued Environmental Component: Sensitive Areas | | | | |
|---|---|---|---|---|
| **Accidental Event Scenario** | **Significance of Predicted Residual Environmental Effects** | | **Likelihood[a]** | |
| | **Significance Rating** | **Level of Confidence** | **Probability of Occurrence** | **Scientific Certainty** |
| Mass Mortality of Sea Cage Fish – Emergency Scenario – 1,000 salmon | NS | 2-3 | | |
| Mass Mortality of Sea Cage Fish – Worst-case Scenario – 6 million salmon and 600,000 lumpfish | NS | 2 | | |
| Spill – Emergency Scenario – 1 kg feed | NS | 3 | | |
| Spill – Emergency Scenario – 100 L Diesel Fuel | NS | 2 | | |
| Spill – Emergency Scenario – 1,000 L Formic Acid | NS | 2-3 | | |
| Spill – Worst-case Scenario – 600 mt feed, 30,000 L diesel fuel, 1,000 L formic acid, 5 $m^3$ sewage. 75 mt ensilage | NS | 2 | | |

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 $km^2$.

Residual environmental Effect Rating:
S = Significant Negative Environmental Effect
NS = Not-significant Negative Environmental Effect
P = Positive Environmental Effect

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Level of Confidence: based on professional judgment:
1 = Low
2 = Medium
3 = High

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low
2 = Medium
3 = High

[a] Considered only in the case where 'significant negative effect' is predicted.

### 7.7.3.3 Feed Spill – Emergency Scenario

In the event of an emergency scenario of a feed spill of 1 kg of feed in the Rushoon BMA during the summer, the primary effects related to the SA VEC are deposition of organic matter and attraction of wild marine fauna (possibly including large predators) to the sea cages, albeit interactions would be minimal given the relatively small amount of feed spilled. Given the current speed in the sea cage locations, it is unlikely that this amount of spilled feed would result in the smothering of sessile benthic marine fauna.

After application of mitigation measures, the feed spill emergency scenario is predicted to have residual *negative* effects on the SA VEC that are *negligible* in magnitude over a geographic area of *<1 $km^2$* for a duration of *<1 month* (see Table 7.27). The *reversible* residual *negative* effects of the feed spill of 1 kg of feed in the Rushoon BMA during the summer are predicted to be *not significant* (see Table 7.28). The level of confidence associated with this prediction is *high*.

### 7.7.3.4 Diesel Fuel Spill – Emergency Scenario

The emergency scenario of a diesel fuel spill of 100 L of diesel fuel during refueling at a single cage in the Rushoon BMA during the summer could potentially result in sub-lethal and/or lethal effects on the SA VEC, although effects would be localized due to the size of the spill. Marine diesel and its effects on different life stages of marine invertebrates and fishes and the marine habitat are described in Section

7.7.1.6. As detailed in Section 7.7.1.6, ichthyoplankton and other larval stages of marine fauna are more sensitive to exposure to the WAF than adult stages, and zooplankton are more sensitive to the effects of diesel fuel spills than phytoplankton. Lethal diesel concentrations for zooplankton and the sensitivity concentrations of soluble aromatic hydrocarbons for fish larvae are provided in Section 7.7.1.6.

Pelagic species which utilize the upper water column may be more susceptible to the effects of exposure to the spilled diesel fuel than those that inhabit the lower water column or are demersal/benthic.

***Mitigation Measures***

In response to a spill of 100 L of diesel fuel, Grieg NL would immediately enact its spill response plan (Appendix M), including the deployment of containment booms and absorption pillows/socks, and immediately contacting the Pollution Line and/or contracted Emergency Response Organization for assistance with environmental cleanup as needed. Skimmers would be used after the booms are in place. Personnel on board the barges will be trained in the use of the on board spill response kit.

***Assessment***

The components of the SA VEC that occur in the upper water column would most likely be exposed to hydrocarbons associated with the emergency scenario spill of 100 L of diesel fuel, including plankton, ichthyoplankton and pelagic species. While the plankton and ichthyoplankton in the area of the spill could be directly affected by the spill, pelagic species would likely avoid the upper water column in such a scenario. Providing the slick is contained quickly, the number of plankton and ichthyoplankton exposed to the hydrocarbons should be minimal, along with the potential for toxins to be transmitted up the food chain. Similarly, there is limited potential for marine mammals, birds, and sea turtles to occur in the area of a spill—particularly since the activities associated with clean-up would deter close approach by these animals. The persistence of the slick's toxicity and slick size should be minimal upon implementation of mitigation measures.

After application of mitigation measures, the diesel fuel spill emergency scenario of 100 L at a single cage in the Rushoon BMA during the summer is predicted to have residual *negative* effects on the SA VEC that are *minor* in magnitude over a geographic area of *<1 km$^2$* to *1–10 km$^2$* for a duration of *<1 month* (see Table 7.27). Based on these criteria ratings, the *reversible* residual *negative* effects of an emergency scenario spill of 100 L of diesel fuel on the SA VEC are predicted to be *not significant* (see Table 7.28). The level of confidence associated with this prediction is *medium*.

### 7.7.3.5 Formic Acid Spill – Emergency Scenario

The emergency scenario of a formic acid spill of 1,000 L of formic acid caused by the loss of an entire IBC at a single cage in the Rushoon BMA during the summer may affect the SA VEC. Food grade formic acid (85%) will be used by Grieg NL to generate ensilage. As described in Section 7.7.1.7, there is low risk of harm to organisms and environmental integrity from formic acid.

***Mitigation Measures***

The mitigation measures intended to minimize the potential effects of an emergency scenario spill of 1,000 L of formic acid are described in Grieg NL's Spill Management Plan (Appendix M) and Emergency Response Plan (Appendix T). The formic acid containers are designed to have neutral buoyancy, but if it were to sink it could be retrieved with the assistance of an ROV and placed on the

attendant barge. Spilled formic acid would be diluted by the surrounding sea water. Formic acid biodegrades in water and has a low potential to bioaccumulate (see Section 2.8.3.2).

***Assessment***

After application of mitigation measures, the emergency scenario of a 1,000 L spill of formic acid at a single sea cage in the Rushoon BMA during the summer is predicted to have residual *negative* effects on the SA VEC that are *negligible* in magnitude over a geographic extent of *<1 km²* for a duration of *<1 month* (see Table 7.27). The *reversible* residual *negative* effects of a 1,000 L emergency scenario formic acid spill on the SA VEC are predicted to be *not significant* (see Table 7.28). The level of confidence associated with this prediction is *medium* to *high*.

### 7.7.3.6 Spill – Worst-case Scenario

As described previously, the worst-case spill scenario includes the spill of 600 mt of feed (~925 $m^3$), 30,000 L of diesel fuel, 1,000 L of formic acid, 5 $m^3$ of sewage and 75 mt of ensilage (~5 $m^3$) in the Rushoon BMA. The potential effects on the SA VEC include:

- Extra deposition of organic material (i.e., feed) on the seabed;
- Attraction of wild marine fauna to the sea cages; and
- Sub-lethal and/or lethal contamination of wild biota in the vicinity of the spill.

The consequences of spillage of the entire contents of the feed/accommodation barge are described in Sections 2.8.3.2 and 7.7.1.8. A loss of diesel fuel would pose the highest risk to the environment, namely biota that occur within the upper water column (see Sections 7.7.1.6, 7.7.1.8 and 7.7.3.4). See Sections 7.4, 7.7.3.1 and 7.7.3.2 for details on the deposition of organic matter and attraction of wild fauna.

***Mitigation Measures***

It is possible that no mitigation measures would be implemented in relation to the spillage of feed, formic acid, sewage and ensilage, but if required, measures would be as described in Sections 7.7.3.3, 7.7.3.5 and Grieg NL's Spill Management Plan (Appendix M) and Emergency Response Plan (Appendix T). An ROV could be used to inspect the deposition of spilled feed on the seabed, or to retrieve lost containers of formic acid.

With respect to the diesel fuel, Grieg NL would immediately enact its spill response plan for fuel as per its Spill Management Plan (Appendix M), and described in Section 7.7.3.4. The primary mitigation measures intended to minimize the potential effects of this worst-case spill scenario are provided in Grieg NL's Spill Management Plan (Appendix M) and Emergency Response Plan (Appendix T), including:

- Deployment of containment booms;
- Deployment of hydrophobic absorbent booms;
- Use of skimmers after booms in place; and
- Contacting the Pollution Line and contracted Emergency Response Organization to assist with environmental cleanup.

More details to these mitigation measures are provided in Section 2.8.3.

***Assessment***

As discussed in Sections 2.8.3 and 7.7.1.8, the likelihood of this worst-case spill scenario is highly remote, owing to the heavy-duty bumpers surrounding the barges, and extending from the water line to the top of their main deck hand rails. Entire storage compartments are unlikely to empty completely, as a vessel strike would most likely cause damage above the water line and would need to be able to penetrate the outside wall of the barge and inside walls of the storage tanks, assuming the strike was even capable of penetrating the safety bumpers.

If the full 30,000 L of diesel fuel should be accidentally released into the marine environment, the resultant slick, even after containment, would be larger than that described for the emergency diesel fuel spill scenario (Sections 7.7.1.8 and 7.7.3.4). Similar to the emergency diesel fuel spill scenario, the persistence of toxic levels of hydrocarbons in the water-soluble portion below the slick should be relatively short, with potential impacts for important ichthyoplankton areas within the Placentia Bay EBSA, gelatinous zooplankton, leatherback sea turtles and their proposed critical habitat (see Section 7.7.3.4). While the plankton and ichthyoplankton in the area of the spill could be directly affected by the spill, pelagic species would likely avoid the upper water column. If the slick is contained quickly, the number of plankton and ichthyoplankton exposed to the hydrocarbons would be minimal relative to the total number of plankton and ichthyoplankton within Placentia Bay.

After application of mitigation measures, the worst-case spill scenario involving the release of feed, diesel fuel, formic acid, sewage and ensilage into the marine environment is predicted to have residual *negative* effects on the SA VEC that are *minor* to *moderate* in magnitude over a geographic extent of *11–100 km*$^2$ for a duration of *<1 month* (see Table 7.27). Based on these criteria ratings, the *reversible* residual *negative* effects of a worst-case spill scenario in the Rushoon BMA during the summer on the SA VEC are predicted to be *not significant* (see Table 7.28). The level of confidence associated with this prediction is *medium*.

## 7.8 Follow-up Monitoring

Grieg NL will prepare and submit an Environmental Effects Monitoring and Follow-up Program (EEMP) subsequent to the completion of the EIS but prior to initiation of Project construction. The EEMP will provide the details of the proposed follow-up monitoring that will be conducted to verify certain residual effects predictions on the Fish and Fish Habitat VEC and the Wild Salmon VEC. If the follow-up monitoring identifies unforeseen negative effects, Grieg NL commits to an adaptive management approach to address issues. More specifically, mitigation measures will be adjusted or new mitigation measures will be implemented and additional follow-up monitoring will be implemented as warranted.

The EEMP will clearly outline the objectives of monitoring, methodology, criteria for adaptive management, identification of procedures to test the efficacy of mitigation measures and follow-up monitoring, and a communication plan for disseminating findings of the EEMP to interested parties.

The concepts of the follow-up monitoring are presented below and are divided between predictions for the effects of planned Project activities on the Fish and Fish Habitat VEC and effects predictions for an accidental escape of farmed salmon on the Wild Salmon VEC. Follow-up monitoring for the socio-economic VECs is also provided.

### 7.8.1 Planned Project Activities

Follow-up monitoring will be implemented to validate predictions regarding the residual effects of planned Project activities on the Fish and Fish Habitat VEC at the sea cage sites. The focus will be on monitoring benthic habitat and water quality at the sea cage sites.

Underwater camera surveys (i.e., drop camera, ROV) of benthic habitat will be conducted under and adjacent to the sea cages to assess the deposition of organics from the sea cages during routine operations. They will assess both the amount of deposition and the visual bioindicators of organic enrichment, including the presence and off-gassing of flocculent matter (dark layer of decomposing fish feces and pellets which covers the seabed), the formation of white *Beggiatoa* (bacterium) mats that indicate hypoxic/anoxic conditions and the production of sulphur, the occurrence of opportunistic polychaete complexes (OPC), and/or the occurrence of barren sites (i.e., no presence of organisms) (Hamoutene et al. 2016; Salvo et al. 2017). These surveys will constitute a benthic monitoring program as prescribed by the AAR and associated Aquaculture Monitoring Standard. Surveys will be conducted at both active and fallowed sea cage sites to allow for assessment of benthic habitat recovery time. If conditions allow, samples of the deposited organic material at the sea cage sites will be collected and analyzed for various parameters (e.g., sulfide levels, infauna).

Recognizing the uncertainty around effects predictions related to the potential use of therapeutants and antibiotics on the Fish and Fish Habitat VEC, Grieg NL will collect, where possible, samples of the deposited organic material in the vicinity of the sea cages and analyze the samples for presence of chemicals found in these substances, if therapeutants and antibiotics have to be used. Fauna may also be collected and analyzed to determine a sense of bioavailability of the substances. This will provide information about the quantity and persistence of these chemicals on the seabed.

A multi-year environmental monitoring project will be undertaken and will involve the deployment of an ADCP and multiple probes at the Rushoon, Merasheen and Red Island BMAs. Each of the three ADCPs will be deployed at a 40-m depth to collect current profile data in 2-m depth cells in the upper 40 m of the water column. In addition, multiple probes will be installed on the ADCP mooring lines at selected depths above the current profiler to collect data on water temperature, wave profiles, conductivity, salinity, pH, total dissolved solids, and dissolved oxygen. These data will provide information on water quality at the sea cage sites, information relevant to both the quality of fish and fish habitat, and the health of fish in the sea cages.

### 7.8.2 Accidental Events

As per the Code of Containment (see Section 2.5.2.2), in the event of an accidental escape of fish from sea cages, Grieg NL must contact DFO and DFLR before initiating any response effort. Any attempt to recapture escaped fish requires DFO approval. The follow-up monitoring in the event of an accidental escape of farm fish would involve sampling Atlantic salmon in scheduled salmon rivers located nearest the location of the escape in order to determine whether escaped farm salmon have entered the freshwater systems. Sampling would involve collecting and analyzing blood samples, which will provide information such as source of the fish (i.e., wild or farm), the broodstock of the fish, and whether or not the fish is triploid and/or female. Given DFO's expertise in genetic analysis of Atlantic salmon, Grieg NL proposes to design and conduct the follow-up monitoring for farm salmon in the rivers in collaboration with DFO scientists. Details will be provided in the EEMP.

### 7.8.3 Socio-economic VECs

Grieg NL has identified follow-up monitoring related to training, employment, and business as summarized below.

It will continue to work with public and private training institutions to ensure that necessary training is available for actual and potential employees and contractors, particularly at locations on the Burin Peninsula. Grieg NL will monitor and facilitate the efforts and success of training of local employees/contractors, including hands-on training by the major suppliers.

Grieg NL has indicated their expectation of best efforts regarding local employment, training and procurement to their major contractors, and will monitor efforts and success for continuous improvement. Grieg NL has prepared a Women's Employment Plan (Appendix Y) that will provide guidance to Grieg NL and its major contractors. Grieg NL will monitor efforts and success regarding diversity in hiring and retention by their major contractors.

It will monitor its major suppliers regarding their efforts and success with local procurement and use this information to advise relevant industry associations. Grieg NL will continue its proactive program of communication with communities, local commercial fishers, stakeholder groups, and development groups to ensure that the Project benefits are realized and concerns addressed.

## 7.9 Assessment Summary and Conclusions

The EIS has assessed the residual effects of both planned Project activities and accidental events and malfunction scenarios on biophysical VECs: Fish and Fish Habitat, Wild Salmon, Species at Risk, and Sensitive Areas. The assessment focused on activities in the marine environment given that the terrestrial components of the Project are limited to the RAS Hatchery, which is located in the established Marystown Marine Industrial Park. The site for the RAS Hatchery was cleared in 2016 and 2017 and there is limited potential for biophysical VECs to interact with activities at the site, particularly since the hatchery will have negligible air emissions.

The assessment of biophysical effects considered planned Project activity–VEC interactions that had some potential to affect VECs. The planned Project activities were categorized by Project phase: (1) construction; (2) operations and maintenance; and (3) decommissioning and rehabilitation. For the assessment of the potential effects of accidental events and malfunctions, two fish escape scenarios (emergency and worst-case), two mass mortality scenarios (emergency and worst-case), and four spill scenarios (three emergency and one worst-case) were considered. Substances considered in the spill scenarios included fish feed, diesel fuel, formic acid, sewage and ensilage. Section 3.0 describes the methodology used to conduct the assessment of the residual effects of planned Project activities and accidental events and malfunctions on the VECs. Input received during consultations was considered in the assessment (summarized in Table 5.1). Mitigation measures considered when predicting residual effects are described in Section 2.5 and summarized in Table 8.1.

An assessment of Project effects on socio-economic VECs has also been undertaken. Effects of the RAS Hatchery and sea cage sites were considered on demographics and the economy, more specifically on training, employment, and business.

The cumulative effects associated with each biophysical and socio-economic VEC were assessed in Section 7.6. Other projects and activities in Placentia Bay considered in the cumulative effects

assessment included vessel traffic, existing aquaculture, sewage outfalls, industrial outfalls and developments currently proposed for Placentia Bay.

Assessment summaries and conclusions are presented by VEC. Detailed assessments are provided in Sections 7.1–7.7.

### 7.9.1 Planned Activities

#### 7.9.1.1 Fish and Fish Habitat VEC

The assessment of the Fish and Fish Habitat (FFH) VEC included consideration of various biophysical components of fish and fish habitat including seawater, sediment, plankton, invertebrate and fish eggs and larvae, and juvenile/adult invertebrates and fishes.

The primary negative effect on fish and fish habitat associated with finfish aquaculture operations is the potential for accumulation of organic waste (i.e., excess fish feed, fish feces, and biofoulants cleaned from the cages) on the seabed below and adjacent to the sea cages which could potentially cause chemical, physical and biological changes to the surficial sediment. There is also potential for the transfer of disease and/or parasites from farm fish to wild fishes but there is little evidence to support this for non-salmonid fishes. With mitigation measures in place (e.g., cessation of feeding at ~80% satiation, siting of sea cages at locations with suitable currents and depth to distribute organic waste, fallowing of sea cage sites, routine husbandry practices, procedures for fish health maintenance), effects on fish and fish habitat from planned Project activities were predicted to be minor, localized, and short-term, with the exception of benthic habitat change attributable to the footprint of mooring anchors, which would be continuous but reversible.

Overall, the residual effects of planned Project activities on the FFH VEC were predicted to be *not significant*. The level of confidence with this prediction ranged from *medium* to *high*.

#### 7.9.1.2 Wild Salmon VEC

The assessment of the Wild Salmon (WS) VEC included consideration of both immature and mature salmon. The wild salmon comprising the Placentia Bay stocks are part of the South Newfoundland population designated as *Threatened* by COSEWIC. The current DFO maximum abundance estimate for the Placentia Bay stocks is 5,099 mature salmon. Little is known about the migratory corridors used by both immature and mature salmon within Placentia Bay during movements between the rivers and the feeding areas in offshore marine waters.

The primary potential negative effect on wild salmon associated with finfish aquaculture operations is the potential for transfer of disease and parasites from farm salmon to wild salmon. Wild salmon would likely have to occur very close to the sea cages to be infected so minimization of their attraction to sea cages is required. With mitigation measures in place (e.g., maintenance of sea cage fish health, cessation of feeding at ~80% satiation, siting of sea cages at locations with suitable currents and depth to distribute organic waste), effects on wild salmon from planned Project activities were predicted to be minor, localized, and relatively short-term.

Overall, planned Project activities on the WS VEC were predicted to be *not significant*. The level of confidence with this prediction ranged from *medium* to *high*.

### 7.9.1.3 Species at Risk VEC

Of the six fish Species at Risk (SAR) considered, the three wolffish species are demersal, the white shark and American eel are pelagic, and the banded killifish, if it occurs in the marine environment, remains in shallow estuarine waters. Effects on fish SAR were predicted to be minor, localized, primarily limited to the sea cage sites, and short-term, with the exception of benthic habitat change attributable to the footprint of mooring anchors, which would be continuous but reversible.

Few interactions between bird SAR and the Project are expected because, with the exception of small numbers of Harlequin Ducks and perhaps Barrow's Goldeneye in winter, other species (i.e., Ivory Gull, Piping Plover, and Red Knot) are not expected to occur at the proposed sea cage sites or along the transit routes to the sea cage sites. The primary negative effects on birds associated with finfish aquaculture operations is the potential for entanglement in the sea cages and anti-predator nets and attraction to artificial lighting at night which may lead to birds colliding with vessels. With mitigation measures in place (e.g., appropriate bird netting, reduction in light use where practicable, monitoring vessels and release protocols), effects on bird SAR from planned Project activities were predicted to be minor, localized, and short-term.

Of the three baleen whale SAR that are known to occur in the Study Area, only fin whales are expected to regularly occur there. There have been several studies of marine mammal interactions with aquaculture operations around the world and limited study of sea turtles. The primary types of effects identified for marine mammals and sea turtles include entanglement, loss of habitat, vessel strikes, and disturbance from noise. Potential entanglement and loss of habitat for marine mammals are related to the physical presence of sea cages and associated mooring systems. Marine mammal and sea turtle SAR could experience disturbance related to noise and possibly the physical presence of vessels and equipment during most Project activities. With mitigation measures in place (e.g., mooring and buoy lines will be kept tensioned, video monitoring, slow vessel speeds), effects on marine mammal and sea turtle SAR from planned Project activities were predicted to be minor, localized and short-term with the exception of a minor loss in habitat from the sea cage footprints.

Overall, the residual effects of planned Project activities on the SAR VEC were predicted to be *not significant*. The level of confidence with this prediction ranged from *medium* to *high*. In the highly unlikely event that a blue whale or North Atlantic right whale experiences mortality as a result of entanglement in a sea cage this effect is considered *significant*.

### 7.9.1.4 Sensitive Areas VEC

Several sensitive areas have been identified in the Study Area. The assessment of sensitive areas focused on the principal features which led to Placentia Bay being declared an EBSA as well as the proposed leatherback sea turtle critical habitat. The deposition of organic material from fish in the sea cages and potential transfer of disease and parasites to wild fishes were identified as the key concern for the SAR VEC. With mitigation measures in place (e.g., cessation of feeding at ~80% satiation, siting of sea cages at locations with suitable currents and depth to distribute organic waste, fallowing of sea cage sites, routine husbandry practices, procedures for fish health maintenance), effects on the Sensitive Areas VEC from planned Project activities were predicted to be minor, localized and short- to medium-term.

Overall, the residual effects of planned Project activities on the Sensitive Areas VEC were predicted to be *not significant*. The level of confidence with this prediction ranged from *medium* to *high*.

#### 7.9.1.5 Socio-economic VECs

Grieg NL's proposed Project is seen as having potential socio-economic implications that are important to the residents of the Burin Peninsula, particularly those within the Study Area. Over the past few years, the Burin Peninsula has seen a high level of out-migration, economic decline and need of long-distance commute for work.

Grieg NL anticipates that the construction phase, which will involve the building of the RAS Hatchery and fabrication of the sea cages, will require more than 200 skilled workers for technical and engineering positions, and skilled trades. With the current downturn in the construction industry in the province, it is expected that a sufficient labour pool will be available on the Burin Peninsula itself or within the Placentia Bay area. During the operations phase, Grieg NL expects to directly hire 170 workers, with additional hires by contractors and suppliers. While some positions relate to administration and maintenance, most are technical and specific to the industry. The Project will also require a wide range of services that will be purchased by Grieg NL and its suppliers and contractors.

Based on the assessment of the potential effects of planned Project activities on the Demographics VEC and the Economy: Training, Employment, and Business VEC, the effects of the proposed Project are considered *positive* and *significant*.

#### 7.9.1.6 Cumulative Effects

The assessments of cumulative effects on the biophysical and socio-economic VECs included consideration of vessel traffic, existing aquaculture, sewage outfalls, industrial outfalls and proposed developments for Placentia Bay. Overall, it was predicted that there would be *no significant* negative cumulative effects of other projects in combination with Grieg NL's proposed Project on VECs. The mitigation measures which will be implemented by Grieg NL and the general lack of spatial overlap amongst projects limits potential cumulative effects. The level of confidence with this prediction ranged from *medium* to *high*.

### 7.9.2 Accidents and Malfunctions

The effects of eight marine accidental event scenarios were assessed for each VEC and details are provided in Section 7.7. A key concern as identified during consultations is that escaped farmed salmon may affect the genetic integrity and biological fitness of wild Atlantic salmon in Placentia Bay. This concern is exacerbated because the wild salmon comprising the Placentia Bay stock are part of the South Newfoundland population considered *Threatened* by the federal government. The worst-case fish escape scenario assumed that 2,000,000 salmon escaped from the Rushoon BMA sea cages during spring/early summer as a result of a hurricane-like storm that was not forecasted. It was also assumed that the sea cage mooring system was not properly secured.

The residual effects of this worst-case fish escape scenario on wild Atlantic salmon were predicted to be *not significant*. The level of confidence with this prediction is *medium*. Triploid female salmon are sterile and studies suggest that they do not enter freshwater systems where they could potentially compete ecologically with wild salmon. Resource competition between escaped farm salmon and wild salmon in Placentia Bay would likely be minimal given that both immature and mature wild salmon are likely most focused on migration in marine environment. Currently, little is known about the behaviour of both immature and mature wild Atlantic salmon in Placentia Bay during migration. To address this data gap, DFO plans to conduct a study of Atlantic salmon migration corridors in Placentia Bay in 2018.

Potential residual effects of accident and malfunction scenarios on Fish and Fish Habitat, Species at Risk, and Sensitive Areas VECs were predicted to be *not significant*.

### 7.9.3 Conclusions

The EIS provided a comprehensive review and analysis of the potential effects of the proposed Project on biophysical and socio-economic VECs. Effects on demographics and the economy are considered a significant positive contribution to the Study Area and the Province. With the implementation of mitigation measures, the residual effects of planned Project activities and accidental events are predicted as *not significant* on fish and fish habitat, wild Atlantic salmon, species at risk, and sensitive areas within Placentia Bay. Data gaps, particularly those related to wild Atlantic salmon migration routes and the degree of ecological interaction between wild salmon and escaped farmed salmon, limit the confidence in some effects predictions. Follow-up monitoring will be conducted in the event of an accidental escape of salmon and to validate effects predictions of planned Project activities on the Fish and Fish Habitat VEC at the sea cage sites.

# 8.0 Environmental Protection

Grieg NL has identified mitigation measures to minimize potential negative effects and enhance potential positive effects of the Project. These measures are detailed in Section 2.5 and summarized in Table 8.1. Mitigation measures and enhancements relevant to the socio-economic VECs and other users of Placentia Bay are included in Section 7.5 and Section 2.5.2.2, respectively. Grieg NL is ultimately responsible for ensuring these measures are implemented and a system of accountability will be in place for activities conducted by contractors and subcontractors. Follow-up monitoring will also be conducted to verify effects predictions as detailed in Section 7.8. If the follow-up monitoring identifies unforeseen negative effects, Grieg NL commits to an adaptive management approach to address issues. More specifically, mitigation measures will be adjusted or new mitigation measures will be implemented and additional follow-up monitoring will be implemented as warranted.

Grieg NL has also developed a series of plans which detail procedures and personnel responsibilities for dealing with routine Project activities like waste management and fish health as well as plans for dealing with accidents, malfunctions, and emergencies. More specifically, these plans include:

- Waste Management Plan (Appendix J);
- Fish Health Management Plan (Appendix K);
- Emergency Response Plan (Appendix T); and
- Spill Management Plan (Appendix M).

These plans are considered living documents and will be updated prior to Project commencement and throughout the Project.

Prior to Project commencement, Grieg NL will also develop an Environmental Protection Plan (EPP) as outlined in Section 8.2. The EPP will be a standalone document intended for Grieg NL personnel, contractors, subcontractors, and government personnel responsible for surveillance. The EPP will clearly layout all environmental protection procedures for each phase of the Project.

## 8.1 Summary of Mitigation Measures

As noted above, mitigation measures have been described in detail in Section 2.5 and in the case of the socio-economic VECs Section 7.5. Table 8.1 provides a summary of key mitigation measures by VEC (biophysical) and type of potential effect.

**Table 8.1. Summary of mitigation measures and monitoring for the Project relevant to the biophysical VECs.**

| Potential Effect (Activity) | Applicable VEC | Key Mitigation Measures |
|---|---|---|
| Disruption of breeding bird or breeding bird habitat (hatchery construction; sea cage operation – Project related vessel transit) | Sensitive Areas<br>Species at Risk | • Visual monitoring for nesting activity within land-based construction area(s) during breeding bird season<br>• Delay of land-based clearing activities if nesting is detected<br>• Transiting vessels to abide by safe distance regulations in accordance with specific breeding seabird colony area(s), & avoid disturbing birds to extent possible (especially during breeding seasons) |
| Uncontrolled release of hazardous materials (i.e., leak or spill) (hatchery construction) | Species at Risk | • Hard copy of procedures for handling hazardous materials & spill contingency plans at receiving, storage, transfer & disposal areas<br>• Compliance with all relevant laws & regulations for hazardous material transportation, storage & use<br>• Inventory of hazardous materials<br>• WHMIS & *Transportation of Dangerous Goods Act* compliance<br>• Contractors adhere to EPP |
| Greenhouse gas emissions (hatchery operation/maintenance; sea cage operation – attendant vessels) | Sensitive Areas<br>Species at Risk | • RAS Hatchery designed to minimize greenhouse gas emissions<br>• Atmospheric emissions from Project vessels will be within normal range of typical marine vessels in eastern NL<br>• Feed/accommodation barges will be anchored & only operate generators<br>• Newly constructed service vessels will have engines designed to minimize emissions & comply with new Tier Three Regulations of Transport Canada & Annex VI of MARPOL 73/78 |
| Pollution from solid/liquid wastes (hatchery construction, operation/maintenance; sea cage operation) | Wild Atlantic Salmon<br>Fish & Fish Habitat<br>Sensitive Areas<br>Species at Risk | • Minimize waste where possible (recycle & reuse)<br>• Wastes handled in accordance with Grieg NL's Waste Management Plan<br>• Pollution prevention training, orientation & ongoing environmental awareness program<br>• Project vessels in good working order<br>• Avoid discharge of oils, fuels or other such compounds into environment<br>• Bilge dumping prohibited<br>• No waste of any kind permitted to be thrown overboard<br>• Waste management consistent with industry best practices, MARPOL 73/78 Annexes IV & V<br>• Barge refueling conducted in accordance with *Canada Shipping Act* & Transport Canada procedures<br>• Spill kits & procedures on board barges (Grieg NL Emergency Response Plan) |
| Nutrification/deposits in sea cage vicinity (e.g., fish feces, uneaten feed, & naturally occurring biofouling material) (sea cage operation) | Wild Atlantic Salmon<br>Fish & Fish Habitat<br>Sensitive Areas<br>Species at Risk | • Sea cage site with sufficient current velocity & direction to minimize depositional build-up<br>• Adequate water depth for sea cages<br>• Suitable bottom type (>50% hard bottom)<br>• Adequate distance from other human activities in Placentia Bay, including sewage outfalls, & sensitive habitat/areas<br>• Fallowing of the sea cage sites (and BMAs) for periods that meet or exceed provincial requirements to decrease accumulation of organic materials/attraction of wild fauna<br>• Biodegradable detergents used during routine cleaning of net collar, after harvesting, & during fallowing<br>• Routine sea cage cleaning via ROV to minimize biofouling<br>• Cessation of feeding upon ~80% salmon satiation<br>• Monitoring for aquatic invasive species & reporting to DFO |
| Spread of diseases/parasites (hatchery operation/maintenance – smolt transfer [hatchery to well boat]; sea cage operation) | Wild Atlantic Salmon<br>Fish & Fish Habitat<br>Species at Risk | • Routine health checks and procedures & at each stage of development to minimize health risks/infectious diseases, including ≤45 days before transfer (Grieg NL Fish Health Management Plan)<br>• Smolt & lumpfish vaccinated prior to transfer as per provincial vet recommendations<br>• No transfer if any health concerns<br>• No transfer until receipt of transfer permit approved by DFO, DFLR & CFIA<br>• Minimize fish stress during transfer |

| Potential Effect (Activity) | Applicable VEC | Key Mitigation Measures |
|---|---|---|
| | | • Post-handling fish monitoring<br>• Biosecurity measures (e.g., use of BMAs)<br>• Husbandry practices (e.g., cleaning/disinfecting of equipment, vessels & ROVs, designated personnel work clothing for each cage site, & designated/separate crew embarkation/disembarkation sites & waste/supply vessel sites)<br>• Sea lice control procedures (e.g., routine parasite screening & active surveillance, & lumpfish as cleaner fish)<br>• Water quality monitoring<br>• Use of centralized and automatic fish mortality collection system to remove dead fish daily from sea cages<br>• Removal & treatment of dead/moribund fish<br>• Only one winter at sea<br>• No reuse of cleaner fish; lumpfish harvested from sea cage the same time as salmon<br>• Veterinarian guidance (provincial and private) as needed<br>• Functional feed (increased mucous production on salmon skin, inhibits sea lice attachment), possibly via subfeeder<br>• "Thermolicer", therapeutant or unscheduled fish harvesting if all other methods unable to reduce sea lice, in balance with maintaining fish health and based on advice of veterinarians.<br>• Minimized feed wastage/organic accumulation to reduce attraction of wild fish |
| Farmed salmon escape (hatchery operation/maintenance – smolt transfer [hatchery to well boat]; sea cage operation) | Wild Atlantic Salmon<br><br>Fish & Fish Habitat<br><br>Species at Risk | • Full equipment check & preparation one day prior to fish transfer<br>• Counting devices (inflow & outflow) & video monitoring<br>• Double-walled pipes (~150-m length)<br>• Reinforced, continuous hose (floats on water surface)<br>• Continuous monitoring of transfer hose<br>• Fish transfer to sea cages only during calm conditions<br>• Management strategy in accordance with DFLR *Code of Containment for the Cage Culture of Salmonids in Newfoundland and Labrador*<br>• Use of Aqualine Midgard sea cage system including moorings (best available technology)<br>• Compliance with the Norwegian Standards (NS9415:2009) for sea cage systems<br>• Annual on-site escape response drills<br>• Grieg NL Emergency Response Plan procedures in event of mass fish mortality, escape of fish during transfer, serious fish health incident, or major ice incursion<br>• Ice management plan<br>• Routine monitoring of sea cages for ice accretion & removal as appropriate<br>• Daily monitoring of weather and ice (when appropriate)<br>• Monitoring, deterring, exclusion and/or release methods for predators near sea cages, as per Predator Protection Plan (e.g., bird nets, reinforced netting, daily removal of dead fish, underwater cameras, immediate net repairs, fish behaviour monitoring, anti-predator net if needed, & fencing inside gangway)<br>• Sea cages in sheltered, predominantly ice-free locations, & cages oriented to minimize wind/wave exposure |
| Alter genetic integrity or biological fitness of wild salmon (sea cage operation – accidental salmon escape) | Wild Atlantic Salmon<br><br>Species at Risk | • Triploid (sterile; 100%) & all-female eggs<br>• Two-tier testing procedure for triploidy & all-female verification testing (Stofnfiskur)<br>• Use of improved technology and smaller (2 L) hydrostatic chambers to ensure all eggs subjected to same & necessary pressure for triploidy induction (Stofnfiskur)<br>• Discard of entire egg batch if triploidy verification tests <100% (Stofnfiskur)<br>• DFO proposed sea cage distance of ≥20 km from salmon river mouths (only sea cages in Rushoon BMA are <20 km from scheduled salmon rivers) |

| Potential Effect (Activity) | Applicable VEC | Key Mitigation Measures |
|---|---|---|
| | | • Avoid use of antibiotics, where possible<br>• No pesticides or disinfectants at cage sites |
| Alter genetic integrity or biological fitness of wild lumpfish (sea cage operation – accidental lumpfish escape) | Fish & Fish Habitat<br>Species at Risk | • Broodstock originated from lumpfish collected in Newfoundland<br>• Harvesting before lumpfish reach sexual maturity |
| Interaction/interference with marine fauna or habitat (sea cage towing; sea cage operation – Project-related vessel transit) | Wild Atlantic Salmon<br>Fish & Fish Habitat<br>Sensitive Areas<br>Species at Risk | • Tow speed <3 knots (5.6 km/h)<br>• Transit route vessel speed ≤10 knots (18.5 km/h)<br>• Vessels to maintain constant course & speed when possible<br>• Vessels to exercise caution with respect to whales & sea turtles, & if sighted, slow then maintain speed & direction<br>• Minimize lighting and use downward-pointing and shaded lights on the barges<br>• Monitoring vessels for stranded birds & implement bird handling/release protocols<br>• Recording of species at risk observed at sea cage sites & during transit to sea cage sites, & submission to DFO/ECCC-CWS as appropriate<br>• Personnel will receive fauna ID/recording training from experienced biologist(s)<br>• Avoidance of sensitive areas (e.g., sea cage sites located away from Important Bird Areas [IBAs] & outside of proposed leatherback sea turtle critical habitat) |
| Marine fauna entanglement with sea cage nets or associated mooring & buoy lines (sea cage operation) | Wild Atlantic Salmon<br>Fish & Fish Habitat<br>Species at Risk | • Release & reporting of entangled birds as per ECCC-CWS procedures<br>• Migratory Bird Handling Permit in place<br>• Use of submersible video camera(s) for monitoring<br>• Sea cage mooring & buoy lines will be kept tensioned & no loose ropes in water<br>• Reporting of entangled marine mammals, wild fish or sea turtles to DFO, & response to free/remove animal as per DFO & Whale Release and Strandings Group guidance<br>• Lethal measures may be considered in consultation with DFO as a last resort in extreme circumstances |
| No or inadequate restoration of aquatic habitat (sea cage decommissioning) | Wild Atlantic Salmon<br>Fish & Fish Habitat<br>Sensitive Areas<br>Species at Risk | • Decommissioning Plan will be developed, with input from regulatory agencies, outlining procedures for Grieg NL to shut down sea cage site operations<br>• Plan will detail approach, mitigation & monitoring measures for removal of all fish & fish products, waste, chemicals, equipment, infrastructure, & restoration of aquatic environment |

## 8.2 Environmental Protection Plan Outline

Grieg NL will submit a completed EPP for approval by the Minister of Municipal Affairs and Environment subsequent to the completion of the EIS and prior to the initiation of Project construction activities. An annotated Table of Contents of the EPP is provided here.

**Preface**

Distribution List — *Recipients of the approved EPP.*
Maintenance of the EPP — *Provides a record of document changes made by date and source.*
Revision Request Initiation Form — *Any user is encouraged to submit suggestions for changes and improvements to the EPP. A form is provided to assist those providing suggestions.*
Revision Control Record — *Identifies and records changes by date, source, and indicates approval of changed text.*

1.0 Introduction

- 1.1 Environmental Health and Safety Management System – *describes the Grieg NL policy on EH&S.*
  - 1.1.1 Roles and Responsibilities— *Describes the management responsibility and accountability for implementation of EH&S policy.*
- 1.2 Purpose of the EPP— *Describes the EPP as a stand-alone document that targets the responsible company staff including front line workers, occupational health and safety staff, and environmental staff. The role of the document with respect to government environmental surveillance staff is also referenced. The scope of the EPP is designated as addressing specific project phases:- construction and operation and maintenance.*
- 1.3 Owners Policy— *Establishes a link between the EPP and the corporate policy on sustainability.*
- 1.4 Organization of the EPP— *Provides an overview of the sections of the document, and instructions for users.*
  *Describes the contents of the EPP, including:*
  - *proponent's environmental policies;*
  - *environmental compliance monitoring;*
  - *environmental protection measures;*
  - *mitigation measures;*
  - *permit application and approval planning;*
  - *contingency planning for accidental and unplanned events;*
  - *statutory requirements; and*
  - *revision procedures and contact lists.*
- 1.5 Development and Implementation of the EPP— *Provides advice on the use of the EPP as a guide to taking appropriate environmental protection actions, and points out the series of task-specific Protection Measures.*
  - 1.5.1 Site-specific Approach to EPP Development— *Describes the geographic-specific information that is utilized to direct EPP actions at each specified site. Includes items like Daily Environmental Meetings, Tool-box Meetings, and Employee Orientation.*
- 1.6 Environmental Orientation— *Describes the environmental orientation that is to be provided to all new employees as part of their job orientation.*

1.7 Project Description— *Provides a brief overview summary of the scope of the project, with a focus on the activities carried out to produce and market a quality product.*

2.0 Environmental Concerns
- 2.1 Construction Activity Environmental Concerns— *Lists the environmental interactions associated with this Project Phase, and the potential for unplanned events that could produce negative environmental effects.*
- 2.2 Operation and Maintenance Environmental Concerns— *Lists the environmental interactions associated with this Project Phase, and the potential for unplanned events that could produce negative environmental effects. Decommissioning and Rehabilitation will be added to a revised EPP prior to initiation of this project Phase.*

3.0 Environmental Protection Procedures
- 3.1 Introduction— *Describes the template to be applied in describing the required measures to be employed with respect to identifiable Project activities.*
- 3.2 Storage, Transportation, Transfer, Handling and Disposal of Fuel and Other Hazardous Substances
- 3.3 Storage, Transportation, Handling and Dispensing of Fish Feed
- 3.4 Sewage Disposal
- 3.5 Storage, Transportation, Handling and Disposal of Solid Waste
- 3.6 Equipment Use and Maintenance
- 3.7 Noise Control
- 3.8 Dust Control
- 3.9 Protection of the Marine Environment
- 3.10 Water Quality Monitoring
- 3.11 Groundwater Development and Use
- 3.12 Pumps and Generators
- 3.13 Marine Traffic
- 3.14 Vehicular Traffic
- 3.15 Concrete Handling and Placing
- 3.16 Storage, Handling and Dispensing of Therapeutants
- 3.17 Storage, Transport, Handling and Disposal of Ensilage
- 3.18 Storage, Handling and Disposal of Fish Mortalities

4.0 Contingency Plans
- 4.1 Introduction— *Identifies the plans applicable to unplanned events, their inter-relationship, and where each is located and accessible to employees.*
- 4.2 Fuel or Hazardous Material Spills— *Refers to Spill Response Plan and Emergency Response Plan*
- 4.3 Marine Mammal/ Wildlife Encounters— *Provides guidance on measures to take, resources available, regulatory issues, and mitigation measures.*
- 4.4 Vessel Accidents— *Refers to Emergency Response Plan*
- 4.5 Fires and Explosions— *Refers to Emergency Response Plan*
- 4.6 Extreme Weather Events— R*efers to Emergency Response Plan*
  - Flooding
  - Ice
  - Wind/Waves
  - Storms

5.0 Legislation, Permits and Authorizations— *Lists all relevant rules and regulations, as well as required permits and authorizations.*
- 5.1 Legislation

5.2 Permits and Authorizations— *Refers to an Appendix which holds copies of all permits and authorizations, as well as terms and conditions and compliance records.*

6.0 Contact List— *Provides a listing of corporate personnel, contractors, external resources, regulators, emergency contacts, and other advisory resources*.
- 6.1 Emergency Numbers
- 6.2 Advisory and Other Contact Numbers

7.0 Resource Material
- 7.1 Key Reference Material— *Identifies and, as appropriate includes as appendices, various guidelines and resource material relevant to environmental protection measures, mitigation and monitoring.*

8.0 Site Specific Environmental Protection Plan— *Describes site-specific conditions, available resources, and relevant site activities to which EPP measures can apply.*
- 8.1 RAS Hatchery
  - 8.1.1 Environmental Issues
  - 8.1.2 Environmental Protection Procedures
  - 8.1.3 Relevant Documents
  - 8.1.4 Permits, Approvals and Authorizations
  - 8.1.5 Compliance Monitoring Requirements
- 8.2 Marine Sites (Sea Cage Sites, Crew Change Sites, Resupply Sites, Transit Routes)
  - 8.2.1 Environmental Issues
  - 8.2.2 Environmental Protection Procedures
  - 8.2.3 Relevant Documents
  - 8.2.4 Permits, Approvals and Authorizations
  - 8.2.5 Compliance Monitoring Requirements

Appendices— *Includes a variety of resource material as identified during development of the EPP including – permits and conditions, contact lists, advisory resources, emergency contacts, and relevant literature.*

# 9.0 References

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E. Johnson, resident of North Harbour and Haystack. 29 April 2018.
P. Keiley, OCI. 24 April 2018.
L. King, SAM, Conservation Biologist. 26 February 2018.
J. Lawson, Research Scientist, DFO. 5 May 2018.
L. Lewis, Career Counselor, Keyin College. 13 April 2018.
K. Lundrigan, Mayor, Town of Burin. 21 February 2018.
B. Mactavish, Technician, LGL Limited. 19 March 2018.
Mayor and Councillors, Town of Marystown. 14 March 2018.
G. Melvin, Research Scientist, DFO. 2015.
D. Miller, Past President, Kayak NL. 25 February 2018.
E. Murphy, Chair, Placentia West Tourism Committee. 20 February 2018.
H. Murphy, Mayor, Parkers Cove, Chair, BPWMC, and Member, Burin Peninsula Joint Council. 20 February 2018.
N. Paddy, Contract Manager, PGS. 11 February 2017.
P. Pike, Mayor, St. Lawrence, Placentia Bay. 19/21 February 2018.
L. Pomeroy, Woody Island Resort Owner/Operator, Placentia Bay. 24 February 2018.
P. Power, Human Resources Manager, Grieg NL. 4/20 February/27 March/13 April 2018.
J. Sharpe, Department of Fisheries and Land Resources, Wildlife Division. 26 February 2018.
M. Slade, Harbor Authority, Arnold's Cove. 22/23 February 2018.
Synard, Mayor, Town of Marystown. 14 March 2018.
G. Veinott, DFO Research Scientist. 19 Feb/5 March/4 May 2018.
R. Wareham, Resident, Arnold's Cove and Harbour Buffet. 31 January 2018.

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## Section 7 – Personal Communication

D. Boyce, OSC. March 2018

J. Bradley, Business Development Officer, Canada Business Network. 9 March 2018.

M. Butland, Owner, Butland Communications. 25 April 2018.

C. Collier, Chair, Grand Bank Development Corporation. 16 Mach 2018.

B. Dempson, DFO Research Scientist, 12 April 2018.

S. Hunt, LHPP Operations. 11 April 2018.

W. Ledwell, Whale Release and Strandings Group. 26 March 2018.

Mayor and Councillors, Town of Marystown. 14 March 2018.

H. Murphy, Resident, Parker's Cove. 20 February 2018.

P. Power, Human Resources Manager, Grieg NL. 20 February 2018 and March 2018.

S. Synard, Mayor, Town of Marystown. 14 March 2018.

G. Veinott, DFO Research Scientist, 4 May 2018.

# Glossary

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| Acoustic Survey | Aquatic survey that use emitted sound waves to estimate the abundance of targeted fish species. |
| Adjuvant | A compound added to a vaccine to increase the immune response. |
| Adult salmon | Stage attained by post-smolts at sea. |
| Advection | Transfer of fish eggs and larvae by water currents. |
| Alevin | A newly hatched salmon still carrying the yolk sac. |
| Amphipods | A crustacean of the primarily marine order *Amphipoda* (e.g., *Gammarus oceanicus*). |
| Anadromous | Fish that feeds in the marine environment and migrates to the freshwater environment to spawn. |
| Anti-predator net | A net that provides a defence against predation or predators. |
| Aquaculture | Controlled culture and propagation of aquatic animals, crustaceans, shellfish, and/or plants. |
| ATPase | A class of enzymes that catalyze the decomposition of ATP. |
| Batch | Fish grown from a group of eggs |
| Benthos | Flora and fauna living either in or on the seabed. |
| Biosecurity | Procedures intended to protect humans or animals against disease or harmful biological agents. |
| Blood-water | Water containing blood from harvested fish. |
| BMA | Bay Management Area – A designated area to enhance biosecurity and maintain a single species and year-class stock within defined areas. |
| BOD | Biochemical Oxygen Demand – a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. |
| Bridle | A span of chain, wire, or rope that can be secured at both ends to an object to spread the force of a pull. |
| Broodstock | Adult fish retained for spawning. |
| Bycatch | Non-targeted species unintentionally caught while catching a specifically targeted species. |
| Byssus | A mass of strong, silky filaments by which certain bivalve molluscs, such as mussels, attach themselves to rocks and other fixed surfaces. |
| Caprellid | An amphipod characterized by slender elongated bodies. |
| Cephalopod | Active predatory molluscs of the class *Cephalopoda* that include squids, octopuses and cuttlefish. |
| Cleaner fish | A fish used to manage and remove parasites from the skin, mouth, and gills of larger fish. |
| Cnidarian | Predominantly marine invertebrate animals of the phylum *Cnidaria* (e.g., jellyfish). |
| Copepod | Small aquatic crustacean of the class *Copepoda* (e.g., sea louse). |
| Crows feet | An arrangement of ropes in which one main rope exerts pull at several points simultaneously through a group of smaller ropes, resembling a bird's footprint. |
| Ctneophore | Marine invertebrate animal of the phylum *Ctenophora* that superficially resemble jellyfishes. (e.g., comb jelly). |
| Decapod | Ten-legged crustacean of the order *Decapoda* (e.g., shrimp, crab, lobster). |
| Degree days | A value used, especially during egg incubation, to estimate and predict the various stages of development. Calculated by multiplying the average temperature by the number of days.<br>(e.g., 300 degree days may be 30 days at 10$^{o}$C, or 100 days at 3 $^{o}$C) |
| Demersal Egg | Egg that remains on the bottom during development, existing either freely or attached to the substrate. |
| Dewaterer | The process of removing water. |
| Diploid | Containing two complete sets of chromosomes. |
| Dip-vaccine | In dip vaccination, fish are immersed for a very short duration, usually 30 seconds, in a highly concentrated vaccine solution, usually 1 part vaccine product to 9 parts water. |

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| DNS | Denitrification System – The process where bacteria are used to convert nitrite into nitrogen gas. |
| Drop net | A net used to catch/contain fish during aquaculture practices (i.e., fish health monitoring). |
| Echinoderm | Marine invertebrate of the phylum *Echinodermata* (e.g., starfish, sea urchin, sea cucumber) |
| Egg | The mature female germ cell, ovum. |
| Ensilager | The process of making ensilage. |
| Epibiota | Plants or animals living on the surfaces of other living plants and animals, usually parasitically. |
| Epidermis | The outer layer of cells of the fish (the surface of the skin). |
| Fallowing | Leaving a site unused to allow for the environment to return to a natural state. |
| Feed barge | A barge used to distribute and store feed for sea sites. |
| Feed Selection Valve | Distributes feed to the correct tank/cage and ensures gentle feed handling. |
| Fingerling | The last stage of a juvenile salmon when they have developed scales and working fins. . |
| First-Feeding Facility | Where fry go to begin feeding once they have consumed most of their yolk sac. |
| Floating collar | Consists of a double floater tube and railing tubes in polyethylene plastic. |
| Fouling | The accumulation of unwanted material on pipes and underwater surfaces by organisms such as barnacles and algae. |
| Fry | A juvenile salmon that absorbed the yolk sac and is capable of feeding themselves. |
| Full Production | See steady state. |
| Gametogenesis | The process in which cells undergo meiosis to form gametes. |
| Gammarid | Small shrimp-like amphipod crustacean found in both fresh and sea water. |
| Gillnet | Type of fishing gear comprised of vertical panels of netting typically set in a straight line intended to catch fish by their gills. |
| Groundfish | Fish that live on, in, or near the seabed (e.g., cod and halibut) |
| Grubbing | Denotes the removal of trees, shrubs, stumps, and rubbish from a site. |
| Hatchery | A facility where fish eggs are hatched under artificial conditions. |
| Hopper loader | This transfers the feed into the air flow with optimum pellet quality. |
| Husbandry | The care and cultivationof fish. |
| Hypoxia | A depletion of oxygen to a level that no longer supports living organisms requiring oxygen. |
| Incubator | An apparatus used to hatch eggs under controlled conditions. |
| Infauna | Benthic animals which live in the substrate of a body of water (e.g., clams and tubeworms). |
| Lease Area | Area where the sea cages will be located. |
| Lice skirt | The use of a tarpaulin skirt for shielding the fish from the lice in the upper water column. |
| Maternal chromosome | The chromosomes that come from the mother. |
| Meiosis | A specialized form of cell division that produces reproductive cells, such as sperm and egg cells. |
| Mollusc | Invertebrate with soft, unsegmented body often protected by an external calcareous shell that live in either aquatic or damp habitats (e.g., mussels, snails) |
| Mooring | Any permanent structure to which a sea cage and vessel may be secured. |
| Moribund | In terminal decline; lacking vitality or vigor. |
| Muster Station | A location where people should gather in the event of an emergency. |
| Nursery | More commonly known as the First-Feeding Facility. |
| Ontogenesis | Development of an individual organism or anatomical/behavioral feature from the earliest stage to maturity. |
| Ouananiche | Landlocked Atlantic salmon that spend their entire lives in freshwater. |
| Ova | The egg/gamete of a female fish. |
| Ovoviviparous | Reproductive strategy characterized by young hatching from the egg within the body of the parent. |
| Parr | A freshwater stage of a salmon distinguished by dark rounded patches |

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| | evenly spaced along its sides. |
| Paternal Chromosome | the chromosomes that come from the father. |
| Pathogens | A bacterium, virus, or other microorganism that can cause disease. |
| Pelagic | Refers to the water column of the open ocean |
| pH | Potential Hydrogen – a measure of acidity or alkalinity of water soluble substances. |
| Phenotypic Selection | Selection of certain phenotypes (the set of observable characteristics of an individual resulting from the interaction of its genotype with the environment). |
| Photic | Refers to the areas of an aquatic system that are accessible to sufficient sunlight to allow plant growth. |
| Pin eye | An egg that does not develop. |
| PIT Tag | Passive Integrated Transponder tag is a microchip with a permanent code used identify fish. |
| Polar Body | Each of the small cells that bud off from an oocyte at the two meiotic divisions and do not develop into ova. |
| Polychaetes | Typically infaunal marine worm of the class *Polychaeta* (e.g., bristle worm). |
| Post-smolt | Stage of salmon that first enters the marine environment. |
| Post-smolt Facility | A salt water/brackish water facility used to hold salmon until they are ready to go to sea. |
| Programmable Logic Controller | A special computer device used for industrial control systems. |
| Proteome | The entire complement of proteins that is or can be expressed by a cell, tissue, or organism. |
| Rock berm | An embankment built of rock which is used to prevent inflow or outflow of material from an area. |
| Sac fry | A salmon that has not fully absorbed its yolk sac. |
| Sea lice | Marine ectoparasites (external parasites) that feed on the mucus, epidermal tissue, and blood of host marine fish. |
| SeaWiFS | Sea-viewing, Wide-Field-of-View Sensor Spacecraft – Satellite-borne sensor designed to collect global ocean biological data, particularly those related to chlorophyll produced by marine phytoplankton. |
| Sensitive Area | Area either afforded some level of protection under federal or provincial legislation or under consideration for such legislative protection due to its particular ecological or cultural importance. |
| Silt fencing | A temporary sediment control device used on construction sites to protect water quality in nearby streams, rivers, lakes and seas from sediment in storm water runoff. |
| SLICE | A feed pre-mix used for the control of sea lice. |
| Sludge | Uneaten feed and faeces from fish in RAS system filtered from process water. Procedure creates a material that is 80% solid and 20% mixture. |
| Slurry | A semi-liquid mix. |
| Smolt | Last freshwater stage of developing salmon. |
| Smoltification Facility | The facility where salmon are held throughout the smoltification process. |
| Stage I Eggs | Newly spawned eggs with only a few embryonic cells. |
| Stage II Eggs | More developed eggs with a greater number of cells and more DNA. |
| Steady State | When production is at capacity. |
| Stocking density | The weight or number of fish held per unit area or volume. |
| Sump | A pit or hollow in which liquid collects. |
| Superchill | When the water temperatures fall below freezing and ice nuclei form and then develop across the epidermis of the fish. This typically occurs in the colder surface waters. |
| Telemetry | An automated communications process by which measurements and other data are collected at remote or inaccessible points and transmitted to receiving equipment for monitoring (e.g., monitoring movements of fish tagged with sonic transmitters).a |
| Triploid | Containing three sets of chromosomes. |
| Triploidy | The process of creating a triploid fish which results in a sterile fish. |
| Ubiquitous | Present, appearing or found everywhere. |
| Ultra SG netting | A newly-developed netting material, with excellent properties regarding |

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| | breaking strength longevity and anti-abrasion properties. |
| UV disinfected | When water is disinfected via UV radiation. |
| Well boat | A boat that have a large holding tank for fish. |
| Year Class | The individual fish of a particular species that were born in any one year. |
| Yolk sac larvae | A newly hatched salmon that is still absorbing the yolk in the ventrally attached sac and has not started feeding yet and (also called Alevin, and Sac fry) |
| 2n | Diploid |
| 3n | Triploid |

# List of Appendices
**(See Volume 2)**

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B. EIS Key Personnel

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D. Public Consultation Report

E. Grieg Seafood Sustainability Report 2017

F. Conditional Approval - Marystown Hatchery

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L. Aquifer Testing Report (Amec Foster Wheeler)

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