List of Appendices

Appendix N

Health Canada – List of Substances

PLACENTIA BAY ATLANTIC SALMON AQUACULTURE PROJECT
GRIEG NL NURSERIES LTD. AND GRIEG NL SEAFARMS LTD.
List of Substances, Agents or Chemicals to be Used
Submitted to Health Canada
August 19, 2016 (2nd Revision: October 12, 2016)

Introduction and Background

Grieg NL Nurseries Ltd. and Grieg NL Seafarms Ltd. (Grieg) are planning to construct and operate a land-based Recirculation Aquaculture System (RAS) Hatchery for Atlantic Salmon in the Marystown Marine Industrial Park and 11 marine-based farms in Placentia Bay, NL. The land-based hatchery will produce up to seven million triploid smolt annually, which will be sold to salmonid aquaculture farms in the province and will be developed on approximately 10 hectares of serviced land. The 11 marine-based farms will be located in four Bay Management Areas: Rushoon, Merasheen, Red Island, and Long Harbour. Each marine-based farm will consist of multiple cages with cage collars at the surface and nets extending down to approximately 43 m. The Bay Management Areas will occupy 1,958 hectares of which 24 hectares will be occupied by the sea cages.

The Project was registered for Environmental Assessment (EA) review under the Newfoundland and Labrador *Environmental Protection Act (NL EPA*, Part 10) in February 2016. Following governmental and public review of the EA Registration, the Minister of Environment and Conservation announced on July 22, 2016 that the Project had been released from the EA review process, subject to a number of associated terms and conditions. These included the following:

> *Prior to the commencement of construction activities, the proponent must submit to Health Canada an inventory of all regulated substances that are intended to be used for the project…*

The preparation and submission of this document is intended to address the above noted condition of EA release for the Project.

The Table below provides a list of substances, agents or chemicals that will or may be used by Grieg as part of this Project. This includes information on the names and types of 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 particular circumstances, such as in the event of fish health issues). It also provides an estimate of the likely quantities / rates at which each product may be used.

It should be noted that this information reflects the current stage of Project planning and design, and may therefore be subject to further refinement as these aspects of the Project continue to progress. Should there be material changes to this information as Project design and implementation move forward, Grieg will provide an update to the relevant regulatory authorities, either directly or in the context of future Project-related permitting.

Project Stage / Purpose	Substance	Estimated Quantity / Rate of Use (Preliminary Estimates)
Cleaning and Disinfection	*Freshwater Systems*	
	a) Dawn™ -- soap	Used primarily for "cleaning" under CFIA quarantine for reportable diseases in freshwater applications. Emergency use only.
	b) Ovadine™	Used in small quantities for accepting eyed eggs from another facility. Used as a disinfectant under CFIA quarantine for freshwater systems. Usage rate is 100 ppm or 100 parts freshwater to 1 part Ovadine.
	c) Hypochlorite	Can be used as a freshwater only disinfectant. Not likely to be used.
	d) Virkon™	A disinfectant for freshwater applications and capable of managing viruses as well as bacteria. This is used daily in footbaths in freshwater facilities for biosecurity. Usage rate is 100 ppm or 1-liter freshwater to 10 grams of Virkon. Estimate 1000 grams per day.
	Saltwater Systems	
	a) Greenworks™ -- detergent	Used primarily for "cleaning" under CFIA quarantine for reportable diseases in saltwater applications. Emergency use only.
	b) Iodophor™ -- free iodine and detergent	Used in small quantities for accepting eyed eggs from another facility. Used as a disinfectant under CFIA quarantine for saltwater systems. An emergency use only. Iodophor is also used in day to day applications for foot baths and general equipment disinfection. Under day to day circumstances 1 liter per day per site would suffice. Usage rate is 100 ppm or 100 parts water to 1 part Iodophor. Contact time for a 100 ppm solution should not be less than 10 minutes and the solution should only be used once.
	All systems neutralizing agent	
	a) Sodium thiosulphate	Sodium thiosulphate chelates halide species as used in disinfection above. Neutralization is by colour titration from purple to clear. This is used in day and emergency use applications to neutralize free iodine compounds after

Project Stage / Purpose	Substance	Estimated Quantity / Rate of Use (Preliminary Estimates)
		they are spent. 100 grams per day per site would suffice.
Sterilization and surfactant (live fish water)	a) Ozone gas	Ozone is created onsite via electrical corona arc in pure dry oxygen. It can be used for disinfection or water sterilization, cleaving heavy organics at Sulphur bond, double bonds and triple bonds. The land facility use will be to cleave large organic compounds including any pheromones, hormones produced by the fish and residual geosmin produced by bacteria. The usage will be continuous but at a very low rate on the waste water return line and less than 1% of total facility water flow.
Vaccines Prescription Only	a) Forte™ (Novartis) oil emulsion with 4 antigens for various *Vibriosis (Ordalii, anguilarum, salmonicida)* and one *Furunculosis salmonicida* (held at the freshwater facility only and applied there via injection)	Each fish is given an injectable dose of 0.05 ml for 7,000,000 doses. Fish will be anaesthetized prior to administering the injection. Injections will occur intraperitoneally one fin length ahead of the pelvic fins along the midline. Food will be withheld from the fish 48 hours prior to vaccination.
	b) Renogen™ *Rheinobaterium salmonicida* (Bacterial Kidney Disease) vaccine (held at the freshwater facility only and applied there via injection)	Injectable at 0.1 ml per fish. No planned use. May be required should the system become infected with BKD. If used, fish will be anaesthetized prior to injection of the vaccine intraperitoneally along the ventral midline, one fin length cranial to the pelvic fins.
	c) Infectious Salmon Anemia (ISAv) vaccine *	Injectable at 0.1 ml per fish. No planned use. May be required should ISAv become prevalent in Placentia Bay.
	d) Sea lice vaccine *	This vaccine is still in the development stages but would be an important support to sea lice management.
	e) Noda virus vaccine (cleaner fish application)	No planned use. May be required for the cleaner fish *Cyclopterus lumpus* should Noda virus become prevalent in Placentia Bay.
Antibiotics (prescription only use in both freshwater and	a) Oxytetracycline (in feed and feed surface application)	Broad spectrum antibiotic (effective for both gram positive and gram negative infective bacteria). It can cross cell membrane for effective use with intracellular infective agents as well as

Project Stage / Purpose	Substance	Estimated Quantity / Rate of Use (Preliminary Estimates)
saltwater applications)		intercelluar. Emergency use only and by prescription by a licensed veterinarian. No planned usage.
	b) Romet / trimetrophin (in feed and feed surface)	Effective with intercellular gram negative bacteria. Emergency use only and by prescription by a licensed veterinarian. No planned usage.
	c) Aqua-flor (in feed and feed surface)	Broad spectrum antibiotic (effective for both gram positive and gram negative infective bacteria). It can cross cell membrane for effective use with intracellular infective agents as well as intercellular. Emergency use only and by prescription by a licensed veterinarian. No planned usage.
Antifoulant (saltwater applications / nets /vessels)	a) Flexguard™ (greater than 400 ppm copper base)	This compound is used as a paint on nets and other submerged marine equipment to inhibit fouling organisms. At concentrations > 400 ppm it is considered a pesticide. No planned usage.
	Saltwater Systems	
Anti-ectoparasitic (prescription only)	a) Slice™ (in Feed) – Emamectin benzoate	Recommended dose rate is 50 µg/kg of fish biomass per day for 7 consecutive days. Suggested feeding rate for medicated feed = 0.5% of total weight of fish per pen. If the feeding rate differs from 0.5% biomass/day, then the concentration of SLICE in feed must be adjusted proportionately. For 1,000 kg of fish administer: 5.0 kg of medicated feed per day / 35.0 kg per week. Emergency use only and in feed treatment of sea lice and by prescription by a licensed veterinarian. No planned usage.
	b) Calicide™ (in Feed) -- Teflubenzuron	Recommended dose rate is 2 grams per kg of fish feed for 7 days. Emergency use only and in feed treatment of sea lice and by prescription by a licensed veterinarian. No planned usage.
	c) Salmosan™ (Bath)	Fish affected by sea-lice should be bathed in 0.2 ppm the product (0.1 ppm azamethiphos) for a period of not less than 30 minutes and not more than 60 minutes. Emergency use only and in

Project Stage / Purpose	Substance	Estimated Quantity / Rate of Use (Preliminary Estimates)
		feed treatment of sea lice and by prescription by a licensed veterinarian. No planned usage.
	d) Hydrogen Peroxide (Bath)	Fish affected by sea-lice or amoebic gill disease (AGD) should be bathed in (1500 mg/L) for 20 minutes. Treatments are administered daily or on consecutive alternate days for three treatments. Emergency use only and in feed treatment of sea lice and by prescription by a licensed veterinarian. No planned usage.
	Freshwater Systems	
	a) Parasite-S™ (Formalin)	Formalin is a 37% solution of formaldehyde gas in water stabilized with 10% methanol. Formalin is used at 250 ppm for 30 to 60 minutes in a static bath with vigorus aeration for control of Saprolignia (fungus). Emergency use only and in treatment of BGD and by prescription by a licensed veterinarian. No planned usage.
Anti-endoparasitic (prescription only)	*Freshwater and Saltwater (in Feed)*	
Anesthetic (prescription only)	a) TMS (MS – 222) {3-aminobenzoic acidethyl ester methanesulfonate}	General anaesthesia use for fish handling during vaccination and other examinations. The recommended dosage is 100 ppm for 90 seconds in water that does not exceed 10°C (50°F). Saltwater is not buffered but freshwater is buffered with sodium bicarbonate to a pH of 7. Available only by prescription from a licensed veterinarian. 10 kilograms per year should suffice.
Preservative (containment)	a) Formic Acid (Organic food grade acid)	Formic acid is used to maintain a pH of 3.0 with fine ground mortalities to neutralize microbial activities and permit internal digestive enzymes liquefy the mass. This is termed silage and the stabilized material is then fit for transport with control to be used as material for composting or fertilizer.
Probiotics (in feed imunostimulants)	a) Betaglucans	Yeast cell extracts included in functional feeds to aid immune response in salmon during periods of

Project Stage / Purpose	Substance	Estimated Quantity / Rate of Use (Preliminary Estimates)
		stress. Typical inclusion rates can be 1% of the diet.
Fish feed complete salmonid diets	a) Health Canada Scheduled ingredients for animal feeds cross referenced to salmonids	These are extensive ingredient Schedules and animal cross referencing Schedules for permitted ingredients in animal diets in Canada. *http://laws-lois.justice.gc.ca/eng/regulations/SOR-83-593/page-11.html*
* Substance under development		

Appendix O
Aqualine Certifications

DNV·GL

CERTIFICATION DOCUMENT

Product certification no:
PRONO 073

Certificate issued: 28.01.2015
Revised: 28.11.2016

Aqualine AS

Dyre Halses gate 1A, Portalen, 7042 Trondheim

This certification document applies to serial production of floating collars according to NYTEK regulation and NS 9415. Conditions for the quality system are described in NS-EN 1990, ISO/IEC 17065 and ISO/IEC 17067, scheme type 5.

Floating collars with the same serial number/product name, shall be manufactured in accordance with specifications in the specific product certificate (produktsertifiserings-bevis) for each design, reliability class 2. Approved production procedures shall be followed.

The validity of this certification document requires annual follow-up of the supplier and shall follow the proposed audit plan. The supplier is responsible for delivered collars in the period up to the next audit.

The certification document will be withdrawn if the supplier fails to comply with the provisions on which the validity is based.

DNV GL - Business Assurance is accredited by Norsk Akkreditering as certification body PROD 013 for products regarding the NS 9415, the NYTEK regulation and guidelines for product certification according to requirements in NS-EN ISO/IEC 17065 and NS-EN ISO/IEC 17067.

Place and date:
Bergen 09.12.16

Lead auditor

For accredited body:
DNV GL - Business Assurance

Controller

Violations of the conditions set out in the certification agreement may render this certificate invalid.
ACCREDITED BODY: DNV GL - Business Assurance Norway AS, Veritasveien 1, P.O. Box 300, 1322 Høvik, Norway. Tel: +47 67 57 99 00. assurance.dnvgl.com

Certificate:	PRONO 073 Aqualine AS				
2	09.12.2016	New certificate template	Liv Solveig Olafsson	Johnny Gravvold	09.12.2016
1	28.01.2015	Certification document issued	Liv Solveig Olafsson	Johnny Gravvold	28.01.2015
Version	**Date**	**Description**	**Performed by**	**Internal control by**	**Date internal control**

DNV·GL

2018-02-12

Confirmation

We hereby confirm that DNV GL Business Assurance Norway AS performs certification of Aqualine AS's floating collars. The DNV GL unit *Technical Aqua Services* is accredited by Norwegian Accreditation for certification of main components used in fish farms. The floating collars are certified according to requirements stated in the Norwegian regulation NYTEK (FOR-2011-08-16-849) and the Norwegian standard NS 9415.

We have certified Aqualine's floating collars since September 2014.

Liv Solveig Olafsson
Head of Section
Technical Aqua Services

SINTEF Ocean AS

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Enterprise /VAT No: NO 937 357 370 MVA

Aqualine AS
Dyre Halsesgate 1A
NO-7412 TRONDHEIM
NORWAY

Your ref.	**Our ref.**	**Project No. / File code**	**Date**
Martin Søreide	Henning Braaten	302001288	2018-01-30

Dear Mr Martin Søreide,

Model Tests of the Midgard System performed at SINTEF

1 Background

SINTEF Ocean, https://www.sintef.no/ocean/, performs research and development within maritime, offshore oil and gas, renewable energy, aquaculture, biomarine and marine environmental technology for domestic and international trade and industry.

MARINTEK is from 2017 a part of the new unit SINTEF Ocean through an internal merger in the SINTEF Group. This is a merger of MARINTEK, SINTEF Fisheries and Aquaculture and the Department for Environmental Technology at SINTEF Materials and Chemistry.

The Marine Technology Centre in Trondheim, Norway, consists of two partners: SINTEF Ocean and NTNU (Norway's Technical and Scientific University in Trondheim). The Marine Technology Centre is one of the strongest research and educational institutions within Marine Hydrodynamics and Marine Structures worldwide. Its laboratories built in 1939 (Towing Tank) and 1980 (Ocean Basin) were by the outset considered as national laboratories. The laboratories are central suppliers of technology to the three largest export industries of Norway: offshore oil and gas, fisheries and aquaculture and shipping.

Throughout the years, SINTEF/NTNU has contributed in the development of better ships, and numerous technology challenges within the oil and gas production on the Norwegian continental shelf have been solved through studies in the Ocean Basin and the Towing Tank. This has contributed to an extremely strong and effective specialist community within this field in Norway.

Use of the Towing Tank with carriage for the study of ships' propulsion and seakeeping properties for commercial, educational and research purposes have been a basic part of the activity at SINTEF and NTNU Department of Marine Technology, continuously since 1945.

Offshore oil and gas field developments including floaters and /or subsea production systems have been tested in the Ocean Basin and investigated in parallel with the use of numerical simulation tools. New experiments and analyses of existing offshore installations and of removal operations, complete this picture. SINTEF and NTNU have also during the last 10 – 20 years run a number of research programs to improve the knowledge of the behaviour of long sea pipelines, vertical flexible risers and similar structures exposed to ocean currents. Novel measuring principles and tools are developed for this purpose.

The Ocean Basin is used for basic as well as applied research on marine structures and operations. A total environmental simulation including wind, waves and current offers a unique possibility for testing of models in realistic conditions. With a depth of 10 meters and a free water surface of 50 x 80 m, the Ocean Basin is an excellent tool for investigation existing and future structures within the marine technology field.

2 Model testing

Hydrodynamic model testing will basically have three different aims:

- To obtain relevant design data to verify performance of actual concepts for ships and other marine structures
- To verify and calibrate theoretical methods and numerical codes
- To obtain a better understanding of physical problems.

Physical models are intended to represent the full-scale system as close as possible at a smaller scale. To be able to determine the proper properties of the model, modelling according to scaling laws that ensure similar behaviour in model as in full scale is applied. When waves are dominating, the Froude's law of scaling is normally used.

3 The Midgard Model Tests

Since 2012 SINTEF Ocean has performed several model test campaigns with the Midgard System.

The first model test campaign was conducted in November 2012. The model tests were performed in a linear scale of 1:16. The objective of the model tests were to study the behaviour of the Midgard System in various wave and current conditions.

The present model test set-up consisted of a cage model with net and mooring system. The diameter of the cage model was equal to 50 m in full scale. The net was purposely built for these model tests, and it had cylindrical shape with vertical side walls and a conical bottom. Different configurations of floater tubes and bottom rings were tested together with different weights in the conical end of the net. The mooring system consisted of a quadratic, horizontal frame mooring system spread out with 4 buoys and 8 mooring lines attached to the seabed. Another 8 horizontal mooring lines facilitated the connection between the frame mooring system and the fish farm.

Forces and accelerations were measured at different connection points between the net, the cage and the mooring lines. For this set-up 6 linear accelerometers were used together with 14 tension rings. Further, the wave elevations and current velocities were measured. Video recordings were taken from both above - and below water cameras.

The model was installed in the middle of the Ocean Basin and the water depth was set equal to 52 m. The mooring lines were attached to the bottom at predefined locations.

A total of 6 different environmental conditions were used for these tests. They consisted of 3 different wave conditions and 2 current speeds, 0.5 m/s and 0.7 m/s. The following wave conditions were calibrated prior to the testing with the wave spectrum formulation according to the JONSWAP formulation as specified by client:

No.	Hs (m)	Tp (s)	Vc (m/s)
1	4.5	8.0	0.0
2	4.5	8.0	0.5
3	4.5	8.0	0.7
4	3.8	13.2	0.7
5	2.5	6.0	0.7
6	2.5	6.0	0.5

The waves were calibrated for a test duration corresponding to 3 hours full scale time.

The full test program consisted of:

- 28 irregular wave tests with current
- 1 irregular wave test without current
- 2 current only tests,

and included parameter variations of rigging of the fish farm, weight changes and elasticity variations.

4 Closing remarks

SINTEF Ocean has developed applied and theoretical expertise in structures and systems for sea-based aquaculture. SINTEF Ocean is a world leader in technological research in the field of exposed aquaculture structures, with structural engineering and hydrodynamics as important subjects.

SINTEF Ocean has several ongoing research programmes on aquaculture. The test methodology used for this project has been developed through decades and is state-of the art.

Yours sincerely,
for SINTEF Ocean AS

Henning Braaten
Research Manager

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NORWEGIAN ACCREDITATION
INSP 036

Accreditation scope for INSP 036

Aqualine AS

Postboks 2200
7412 Trondheim

Telephone: 73809931/73809940
E-mail: jens.aasmul@aqualine.no
Internet: http://www.aqualine.no

The inspection body meets the requirement in
NS-EN ISO/IEC 17020

Accreditation was first granted: 22/08/2012

Accreditation requires regular follow-up, and is valid to: 18/05/2022

Accreditation includes:

The administrative / geographical unit:

Aqualine AS

Dyre halses gt. 1A
7042 Trondheim

Is accredited as Inspection body type C covering following areas:

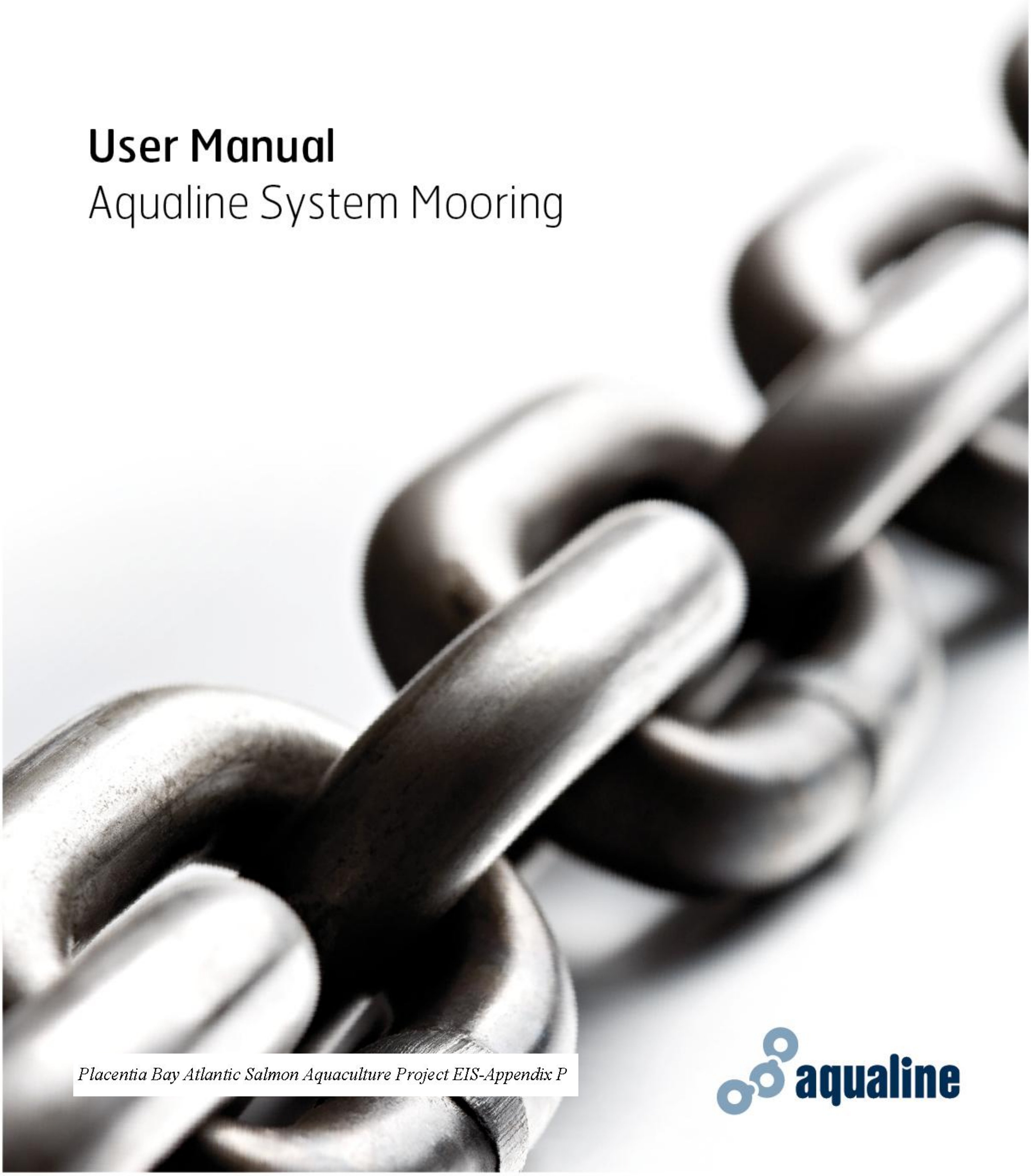
Field of inspection	Type and Range of Inspection	Normative document/scope	Ramarks/method
Mooring Analysis	new, used, in use, rebuildt, moved	Nytek and NS 9415:2009: Marine fish farms - Requirements for site survey, risk analyses, design, dimensioning, production, installation and operation	

Appendix P

Aqualine System Mooring User Manual

Aqualine Certified

User Manual
Aqualine System Mooring



Placentia Bay Atlantic Salmon Aquaculture Project EIS-Appendix P

aqualine

Contents:

1 Aqualine System Mooring

Aqualine AS have been supplying system moorings for the fishfarming industry for the last 25 years. We design complete systems and provide certified components to mooring systems.

Aqualine systems moorings are designed and produced according to the Norwegian standard NS9415. The systems mooring is tailor-made for the floating structure and helps it surviving even the most severe conditions.

This user manual contains important information regarding the system mooring and all its components. It described all handling related to transport, installation, inspection and maintenance.

Enclosed are forms for inspection and maintenance forms.

2 Components

2.1 General

Aqualine system moorings consists of a grid mooring with anchor lines and bridles. These are connected by using connection plates.

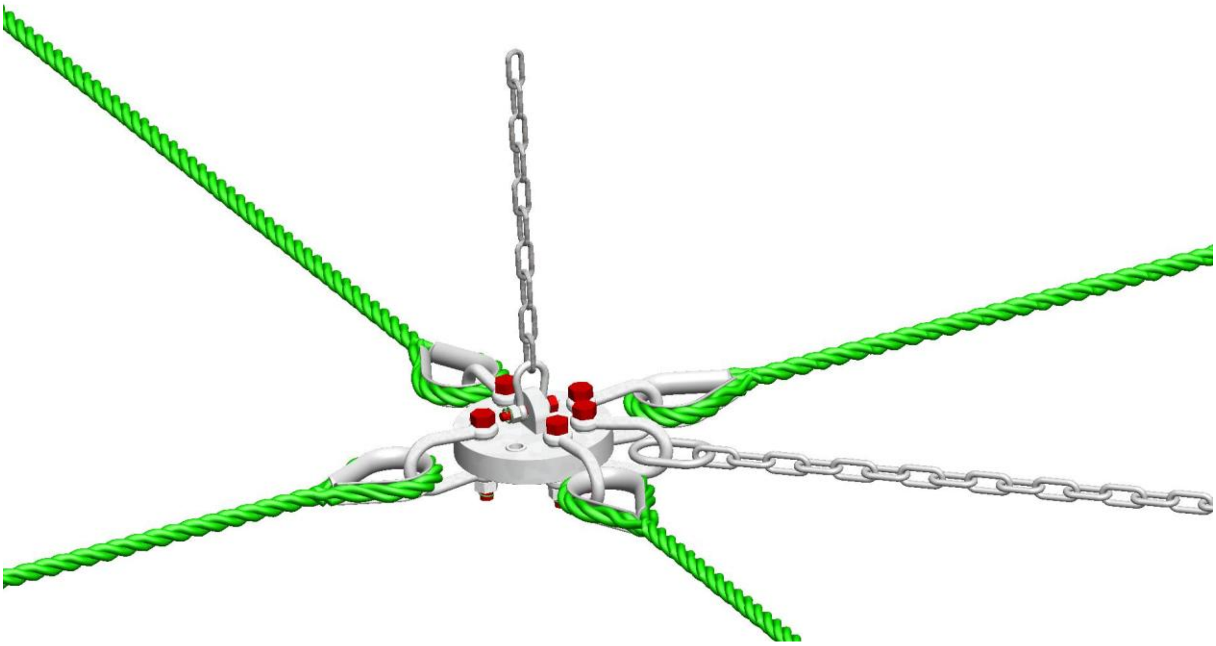


Figure 1: Aqualine connection plates

To avoid shock loads the system mooring is pretensioned. Buoys are used to obtain the pretension without affecting the cages.

2.2 Traceability

All components are provided with information for traceability and a corresponding certificate.

2.3 Anchor lines

A general description of anchor lines is shown in figure 2. The numeration relates to the numbering of the following chapters where each component is described more closely.

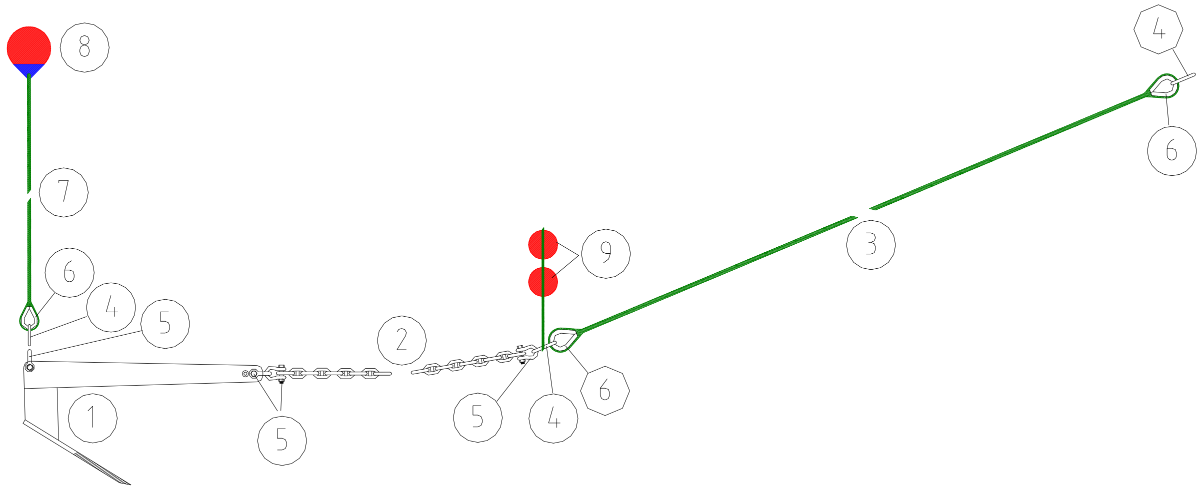


Figure 2: Anchor line configuration

1) Anchoring point
2) Anchor chain
3) Rope
4) Galvanized link
5) Shackle
6) Thimble
7) Crown line
8) Float
9) Trawl floats (optional)

2.3.1 Anchoring points

2.3.1.1 Anchors

When dimensioning anchors the demand is that the holding capacity is higher than the largest calculated load. Aqualine AS recommend testing the holding capacity during installation.

- Aqualine Fluke anchors
  - Design holding capacity: 20 times the weight

Figure 3: Aqualine fluke anchor

2.3.1.2 Rock pins

Rock pins made of galvanized steel are used when the seabed consist of solid rock.

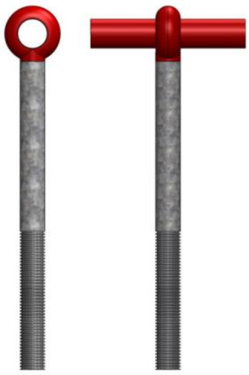


Figure 4: Rock pin designs

2.3.2 Anchor chain

Aqualine AS provides anchor chain grade 2. Both stud-less chain and stud-link chain are used.

Figure 5: Stud-less and stud-link anchor chain

2.3.3 Rope

Both 3-strand and 8-braided fiber rope are used in Aqualine system moorings. The rope complies with NS9415. Rope characteristics:

- high resistance to abrasion
- High UV-protection
- Floats
- Resistant to rotting
- Easy handling
- Adapted to be used in system moorings

2.3.4 Galvanized link

To obtain a safety distance between the rope and other components in the system mooring, galvanized links are used to terminate rope lengths.

2.3.5 Shackle

Mooring shackles are used to join components in the system mooring, These shackles are specially made to be used in systems moorings for fishfarming.

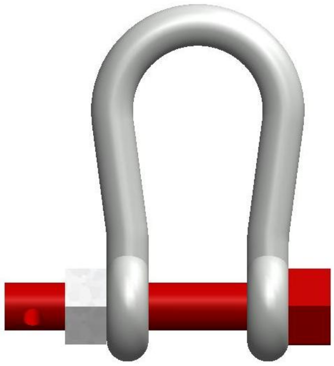


Figure 6: Mooring shackle

2.3.6 Thimbles

To protect the rope ends against chafing and damages extra soli thimbles are used. Aqualine AS use galvanized BS464 in system moorings.

2.3.7 Crown line

Crown lines are used to handle anchors during installation. These are composed of fiber rope and thimbles.

2.3.8 Float

To mark the position of an anchoring point the crown line may be placed permanent connected to the anchor. The upper crown line end is kept floating by using a float.

2.3.9 Trawl floats

It is important to protect the anchor line against touching the seabed. Trawl floats are used to keep the connection between the anchor chain and the rope maintains a distance over the seabed.

2.4 Connection plates

Aqualine AS uses custom made connection plates in system moorings. The galvanized plate is tailor made to be combined with mooring shackles, maintaining optimum performance for both components.

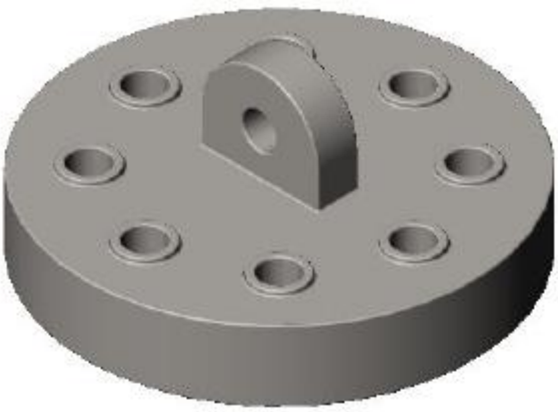


Figure 7: Aqualine connection plate

2.5 Mooring buoys

All mooring buoys used in Aqualine systems moorings are certified according to NS9415 and are made to withstand submergence.

2.6 Grid lines

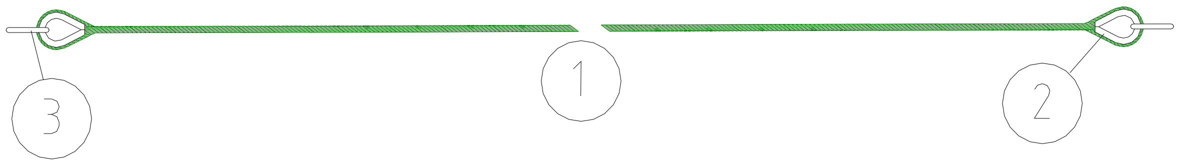


Figure 8: Grid line

The grid liens are composed by using:

1) Rope
2) Thimble
3) Galvanized link (optional)

2.7 Bridle

The cage is connected to the system mooring by using bridles.

2.7.1 Configuration

Bridles are made of rope with thimble and optionally galvanized links.

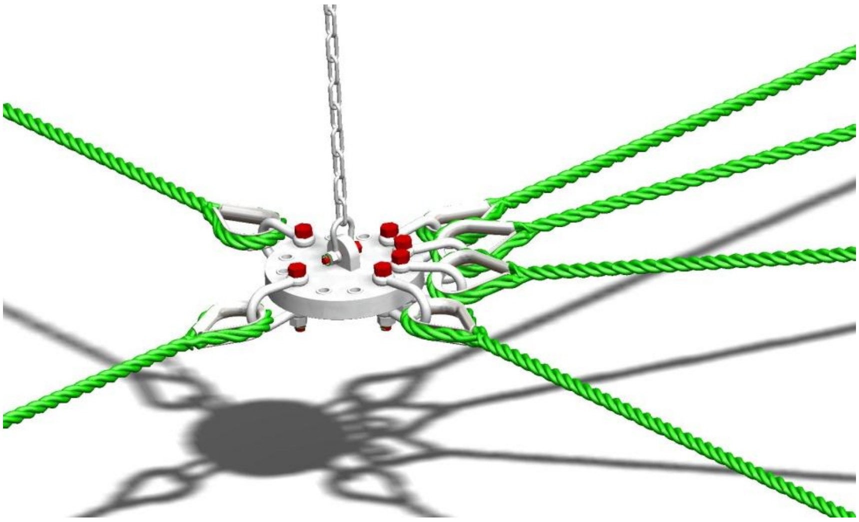


Figure 9: Bridle

3 Delivery

All parts of the system mooring are marked with traceability information.

When the system is delivered check everything to make sure the delivery is complete and as planned.

4 Assembly, installation and inspection

4.1 Personnel requirements

Assembly and installation shall be done by personnel with minimum 2 years experience in installation and operation of system moorings.

4.2 Client responsibility regarding assembly and installation

Depending on what is agreed the client is responsible for making sure that a suitable area for assembly is available.

Parts and components for which the client is responsible will arrive prior to the assembly and installation. It is important that these are unloaded and preliminary stored safe and undamaged.

In case the goods is received at a distance from the assembly site, the client is responsible for transporting the goods to the assembly site.

The client is responsible for having competent personnel, suitable vessels and gear in order to ensure a correct assembly and installation of the system mooring.

4.3 Planning and preparations for assembly and installation

Weather conditions needs to be appropriate so any risk related to the work is minimized. Limitations during installation is dependent on the vessel operational capabilities.

Identify requirements for vessels and gear needed and any limitations in operation of these. To install anchor chain and anchors a crane and a winch is needed. When tensioning the system a capstan is mandatory.

4.4 Installation procedure

The installation procedure depends on the layout at the specific site. A general guideline is presented to assist in planning the installation.

4.4.1 Overview components

The system mooring is delivered with an overview in form of a sketch and an order confirmation

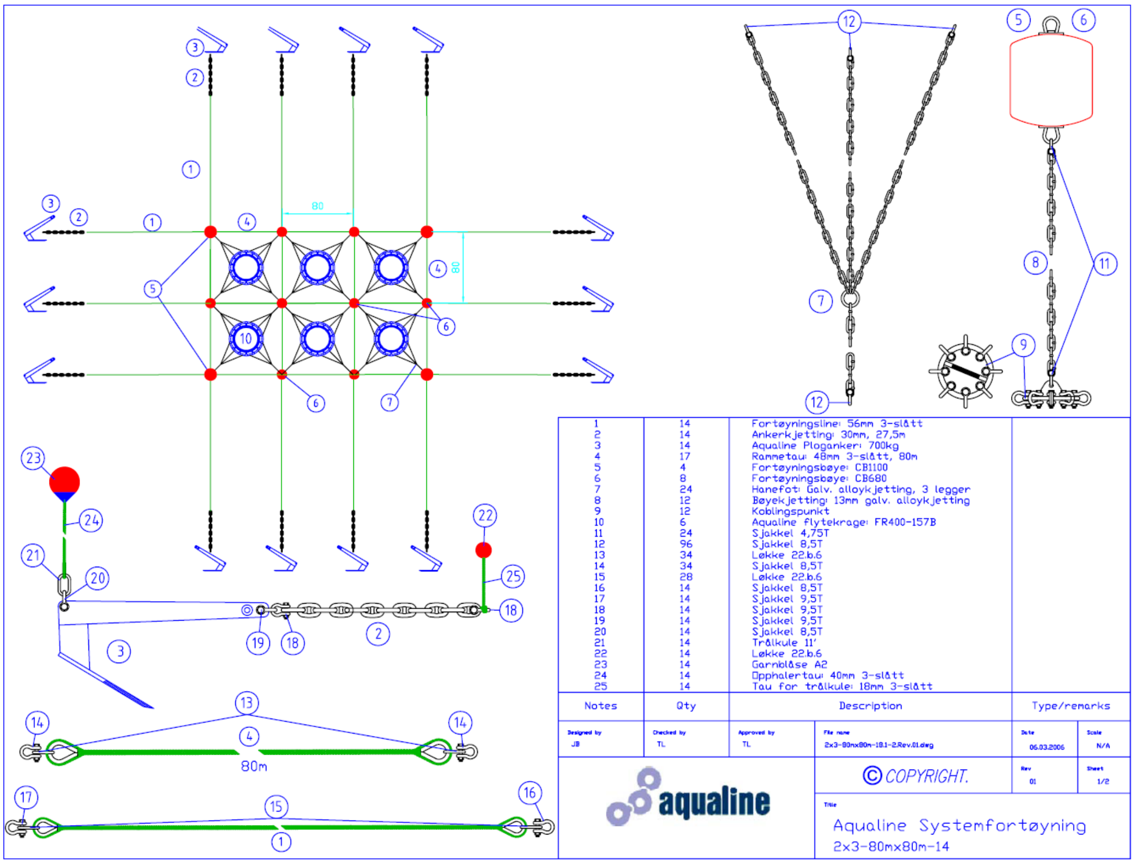
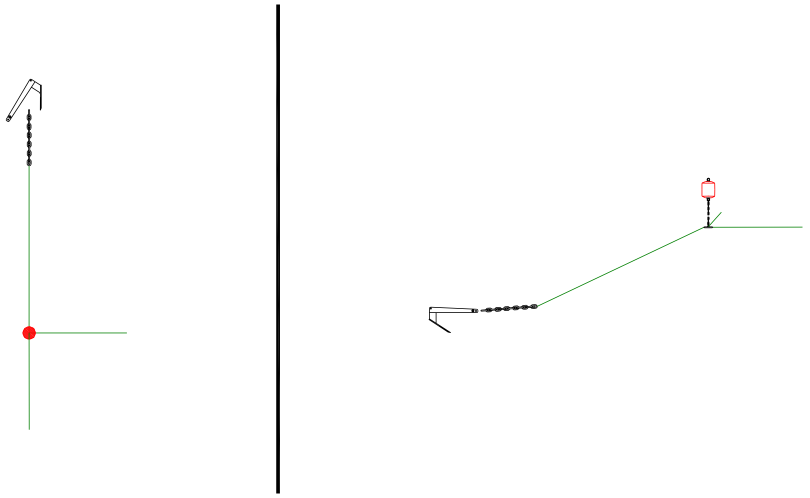


Figure 10: General sketch with component overview

4.4.2 Step-by-step installation guide

Step 1



Assemble corner anchor line by connecting the anchor to one end of the anchor chain. The other end is connected to the rope segment. Use the assigned shackles for the connections. Shackle pins shall be secured by using the received plastic covered galvanized steel string. Lower the anchor y using the crown line. It is recommended to test the holding capacity at this point. Tension the line to ensure secure penetration of the anchor.

Figure 11: Detials anchoring point using fluke anchor

Mount the upper end of the anchor line to a connection plate. Connect the buoy chain and corresponding buoy to the plate. Also connect the correct grid lines to the plate.

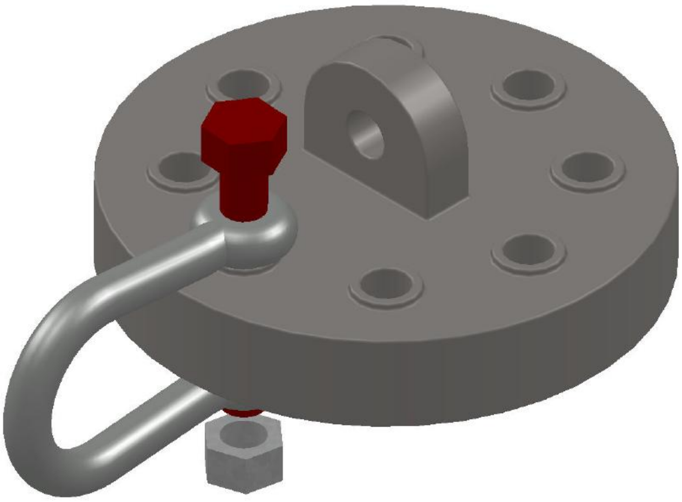
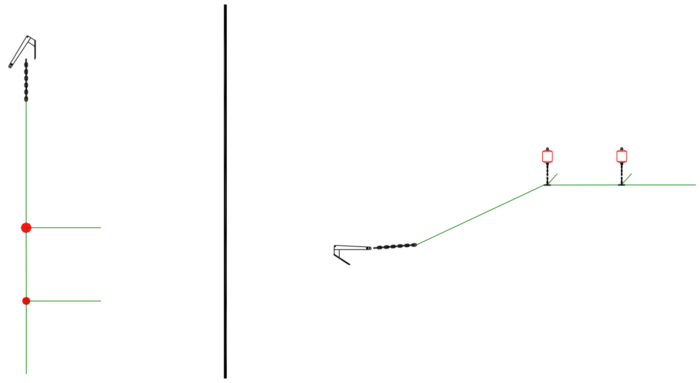


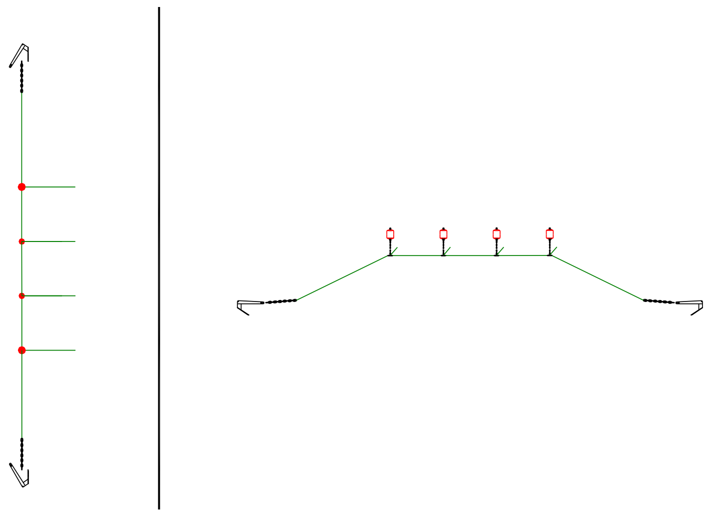
Figure 12: Connecting a shackle to the connection plate

Step 2



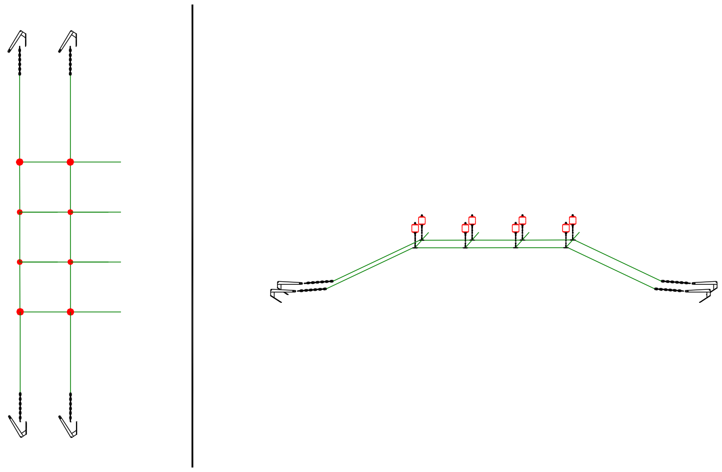
The other end of the first longitudinal grid line is connected to the next connection plate with buoy chain and buoy. The next grid ropes longitudinal and transversal are connected as the previous plate. The same procedure is followed to the other corner is reached.

Step 3



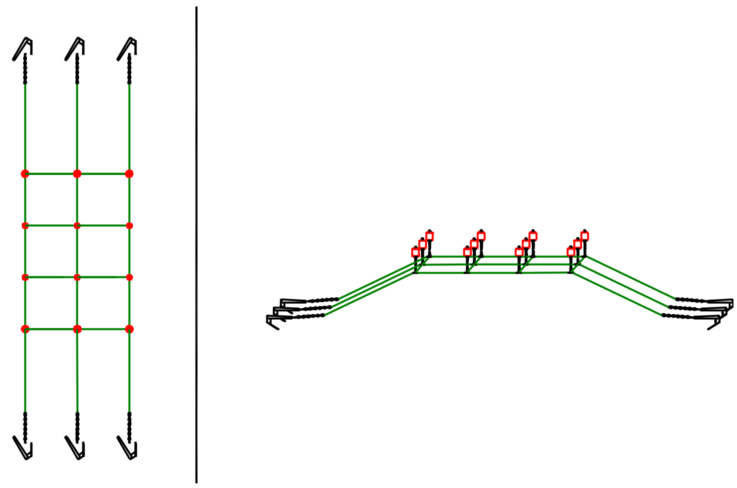
In the end of the transversal gridline, the anchor line is assembled and connected as shown in step 1.

Step 4



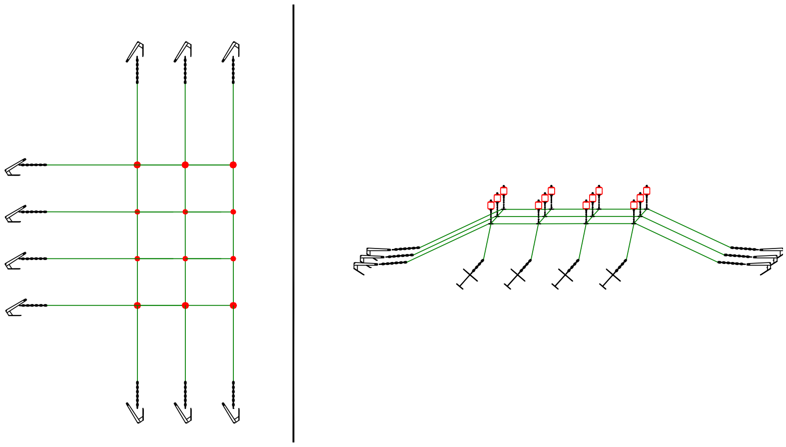
Continue as shown in step 2 and 3 with the addition of connecting the transversal grid lines from step 2 and 3 as well.

Step 5



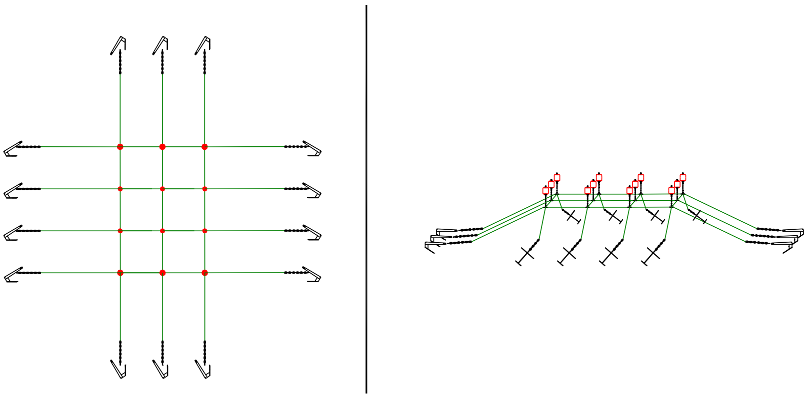
Finalize all longitudinal anchor lines.

Step 6



Connect the transversal anchor lines on one side.

Step 7



Connect anchor lines to connection plates on the opposite side from the lines in step 6.

Step 8

If applicable, connect secondary anchor lines to their corresponding positions.

Step 9

The system mooring must now be tensioned. Maintain an even tension in the anchor lines either by measurements or observe the buoys to get a good distribution in all the anchor lines. Make sure that the system mooring is aligned both longitudinal and transversal before continuing the installation.

Step 10

Bridles are connected when the cage is installed. In order to connect the bridles to the connection plate the plates have to be lifted. Make sure that the length of the bridle is correct so that the pretension is distributed within the system mooring and not in the cage.

Step 11

Place the cage within the system mooring. Make sure not to be in contact with the grid lines.

When the cage is positioned correctly, connect the bridles to the mooring brackets on the cage. The cage should be centered within its assigned grid space.

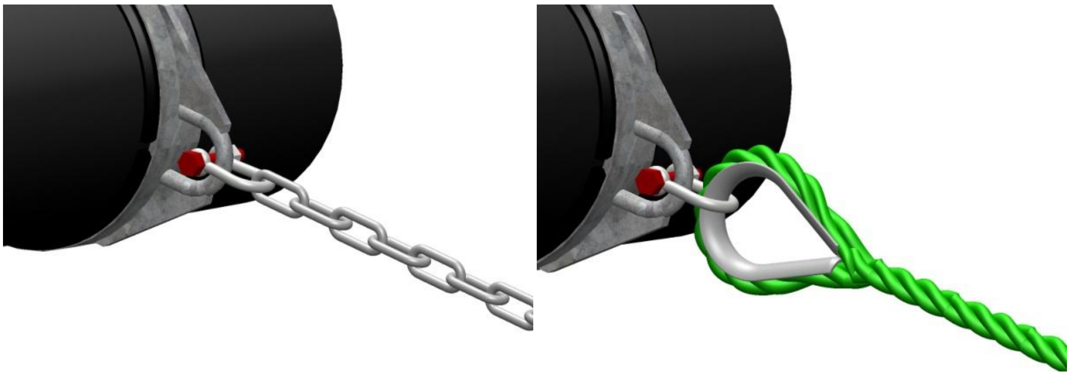


Figure 13: Bridle connection on cage

5 Operation and maintenance

During operation it is important to avoid loading that might severe the system mooring. If extreme situations occur, an inspection shall be performed to observe any damages. In the appendices you will find forms to use for inspection and maintenance.

Aqualine recommend that the person responsible for operation and maintenance has minimum 2 years experience with system moorings and handling ropes.

5.1 Modifications

Aqualine is to be notified if any modifications are done to the system mooring.

5.2 Logbook

A logbook describing all maintenance, modifications, expansions etc. should be kept.

6 Inspection and replacements

In operation inspection and maintenance shall be performed. In the appendices a set of forms are given as a program for this. The intervals for each part is based on a risk analysis.

Aqualine recommend that the person responsible for inspection has minimum 2 years experience with system moorings and handling ropes.

- To inspect submerged parts of the system mooring it we recommend using an ROV or underwater camera.
- Inspections shall be done before and after rough weather conditions. Appendix 6 gives an overview of the scope for this inspection.
- After any unforeseen incidents an inspection as described in appendix 7 shall be done.
- Replacements and repairs should be logged in the form in Appendix 9.

6.1 Unforeseen incidents

Examples:

- Vessel or large floating objects colliding with the fishfarm
- Unusual weather condition
- Extreme tidal differences
- Vandalism

6.2 Replacements

All replacements should be reported to Aqualine. Inspections after modifications should be performed as described in appendix 11.

6.3 Logbook

A log describing all inspections and replacements should be kept.

6.4 Spare parts

We recommend the following guideline when planning the amount of spare parts:

- Shackles – 5 % of the total number of the given dimension
- Thimbles – 5 % of the total number of the given dimension
- Rope – Sufficient to replace 3 grid lines.
- Rope – Sufficient to replace a complete set of bridles.
- Rope - Sufficient to replace the longest anchor line in the given dimension.
- Galvanized link – 5 % of the total number of the given dimension.
- Connection plate – 3 Pcs.
- Buoys – 3 of the largest size.

7 Replacement procedures

7.1 Grid line

1) Hoist the connection plate
2) Fasten the connection plate to the vessel to be able to release tehsnion from the grid lines
3) Unhook grid line from connection plate
4) Connect new grid line to the onnection plate
5) Repeat procedure at other end of line
6) Lower the connection plate
7) Control the pretension after the change

7.2 Anchor line

1) Hoist the anchor by using the crown line
2) Pull in the mooring line as the vessel moves towards the connection plate
3) Unhook the line at the connection plate
4) Connect new anchor line
5) Re-set the anchor as described in chapter 4.4.3
6) Check the distribution of pretension

7.3 Bridle

1) Loosen the bridle from tha cage
2) Hoist the connection plate and unhook the bridle
3) Connect the new bridle
4) Lower the connection plate
5) Fasten the bridle to the cage
6) Control the pretension in the system after the change

7.4 Connection plate

1) Hoist the connection plate to be changed
2) Fasten grid lines, bridles and anchor lines to the vessel so take tension off the connection plate
3) Loosen all lines from the connection plate
4) Change the plate an fasten all lines
5) Lower the connection plate
6) Control the pretension in the system after the change

7.5 Buoy

1) Hoist the connection plate
2) Unfasten the buoy chain from the plate
3) Unfasten the buoy from the chain and replace buoy
4) Lower the connection plate

7.6 Anchor

1) Hoist the anchor using the crown line
2) Lift the anchor on the vessel deck using a crane
3) Unhook anchor chain and replace anchor
4) Install and re-set new anchor as describe in 4.4.3

7.7 Criteria for repair and replacement of components

Criteria for repair and replacement of components		
Component	**Repair**	**Replacement**
Grid line	• Loosened knots and splices • Fouling	• Damage surface, chafing/abrasion • Rupture
Anchor line	• Loosened knots and splices • Fouling	• Damage surface, chafing/abrasion • Rupture
Bridle rope	• Loosened knots and splices • Fouling	• Damage surface, chafing/abrasion • Rupture
Bridle chain	• Fouling	• Deformation • Rupture • Corrosion/ abrasion more than 10%
Connection plate	• Shackle pin not secured • Fouling	• Deformation • Rupture • Corrosion/ abrasion more than 10%
Buoy	• Shackle pin not secured • Fouling	• Corrosion/ abrasion more than 10% • Rupture armature • Cracks/ damages shell
Anchor	• Anchor stock bent • Shackel pin unsecured	• Deformation shank or fluke • Welding cracks • Rupture • Corrosion/ abrasion more than 10%
Anchor chain		• Deformasjon • Corrosion/ abrasion more than 10%
Galv. chain comp.: • **Links** • **Connection plate**	• Fouling	• Deformasjon • Brudd • Corrosion/ abrasion more than 10%
Shackle	• Shackle pin unsecured • Security measure damaged	• Deformation • Rupture • Corrosion/ abrasion more than 10%
Thimble		• Deformation • Rupture • Corrosion/ abrasion more than 10%

7.8 Maintenance- and inspection

Maintenance- and inspection plan					
Maintenance and inspecion to be performed		Daily	Every 3 months	Every 6 months	Yearly
What	**How**				
Buoys	Check that all buoys are visible and floating normally.	■			
Rope	Check fibre rope for: • Damages surface • Damages du to friction • Slack splices • Loose thimbles • Loose ends • Fouling		■		
Chain comp. surface	Check chain components for: • Rupture • Corosion • Damaged galvanization • Fouling • Deformations			■	
Shackles	Check shackles for: • Ruptures • Corrosion • Damaged galvanization • Deformation • Security missing			■	
Connection plate	Check connection plate for: • Rupture • Corrosion • Damaged galvanization • Deformation			■	
Complete system	Complete system mooring shall be checked after 3 months after installation. After that a yearly check shall be performed.		**3 months after inst.**	■	

8 Appendix 1: Logbook - daily inspection and maintenance

What	How	Year	Sign.
Buoys	Check if all buoys are visible and floating normally.		

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT.DAY	SUNDAY

Guideline:
Sign OK and the date. Any repairs should be logged.

9 Appendix 2: Logbook - inspection and maintenance 3 months after installation

What	How	Year	Sign.
Complete system mooring	Check the complete system mooring.		

WEEK	SIGN	WEEK	SIGN	WEEK	SIGN	WEEK	SIGN	WEEK	SIGN
1		12		23		34		45	
2		13		24		35		46	
3		14		25		36		47	
4		15		26		37		48	
5		16		27		38		49	
6		17		28		39		50	
7		18		29		40		51	
8		19		30		41		52	
9		20		31		42		53	
10		21		32		43			
11		22		33		44			

Guideline:
Sign OK and the date. Any repairs should be logged.

10 Vedlegg 3: Logbook - inspection and maintenance every 3 months

What	How	Year	Sign.
Rope	Check fibre rope for: • Damages surface • Damages due to friction • Slack splices • Loose thimbles • Loose ends • Fouling		

WEEK	SIGN	WEEK	SIGN	WEEK	SIGN	WEEK	SIGN	WEEK	SIGN
1		12		23		34		45	
2		13		24		35		46	
3		14		25		36		47	
4		15		26		37		48	
5		16		27		38		49	
6		17		28		39		50	
7		18		29		40		51	
8		19		30		41		52	
9		20		31		42		53	
10		21		32		43			
11		22		33		44			

Guideline:

Sign OK and the date. Any repairs should be logged.

11 Appendix 4: Logbook - inspection and maintenance every 6 months

What	**How**	**Year**	**Sign.**
Chain comp. surface	Check chain components for: • Rupture • Corosion • Damaged galvanization • Fouling • Deformations		
Shackles	Check shackles for: • Ruptures • Corrosion • Damaged galvanization • Deformation • Security missing		
Connection plate	Check connection plate for: • Rupture • Corrosion • Damaged galvanization • Deformation		

SIGN. YEAR					
JANUARY		FEBRUARY		MARCH	
APRIL		MAY		JUNE	
JULY		AUGUST		SEPTEMBER	
OCTOBER		NOVEMBER		DECEMBER	

Guideline:
Sign OK and the date. Any repairs should be logged.

12 Appendix 5: Logbook - inspection and maintenance yearly

What	How	Year	Sign.
Complete system mooring	Check the complete system mooring.		

Guideline:
Sign OK and the date. Any repairs should be logged.

13 Appendix 6: Logbook - inspection and maintenance after severe weather

What	How	Date	Sign.
Buoys	• Check that shackle pins are secured • Check for wearing on the buoy connections		
Bridle connections cages	• Check ropes • Check for deformations in the cage structure		
Anchor lines and grid lines	• Check ropes • Check for slack splices and knots		
Pretension in the system mooring	• Check the distribution of the pretension		

Guideline:
Sign OK and the date. Any repairs should be logged.

14 Appendix 7: Logbook - inspection and maintenance unforeseen incidents

What	How	Date	Sign.
Permanent change in position	• Check if anchoring points have moved		
Changes in the pretensioning	• Check the distribution of the pretension		
Bridle connections cages	• Check ropes • Check for deformations in the cage structure		
Buoys	• Check that shackle pins are secured • Check for wearing on the buoy connection points		
Anchor lines and grid lines	• Check ropes • Check for slack splices and knots		

Guideline:
Sign OK and the date. Any repairs should be logged.

15 Appendix 8: Logbook - Repair and discrepancies

Description repair or modification:
To-do suggestion:

Date Sign.

Repair **Describe what is done and estimate cost related, incl. work time:**
Was the repair successful:

Date Sign.

16 Appendix 9: Logbook system mooring

Date	Descripition event/ discrepancies	Sign.

Appendix Q

Aerial Maps

Appendix Q

Aerial Maps

Figure 1. Overview of Mortier Bay and land-based RAS Hatchery located in Marystown, NL.

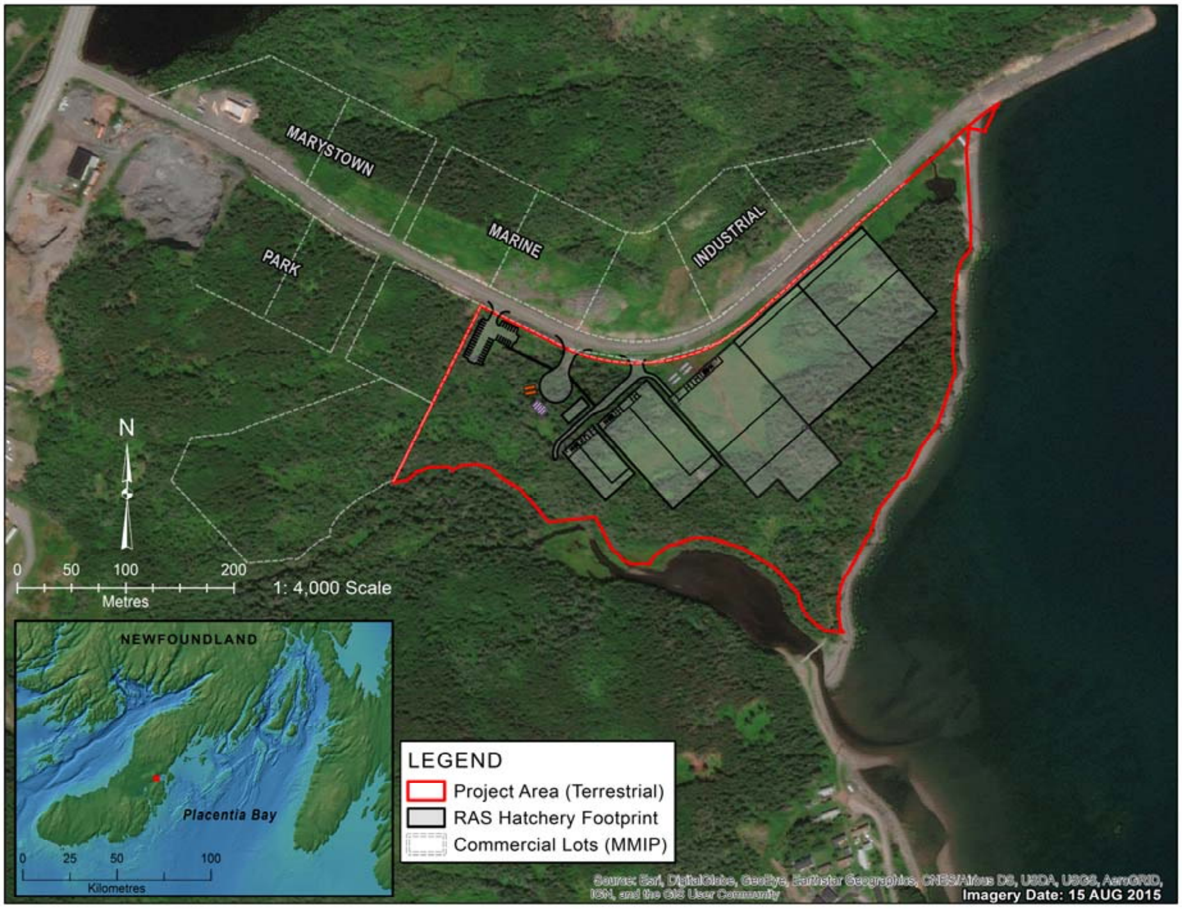


Figure 2. Aerial image of proposed land-based RAS Hatchery located in Marystown, NL at Marystown Marine Industrial Park.

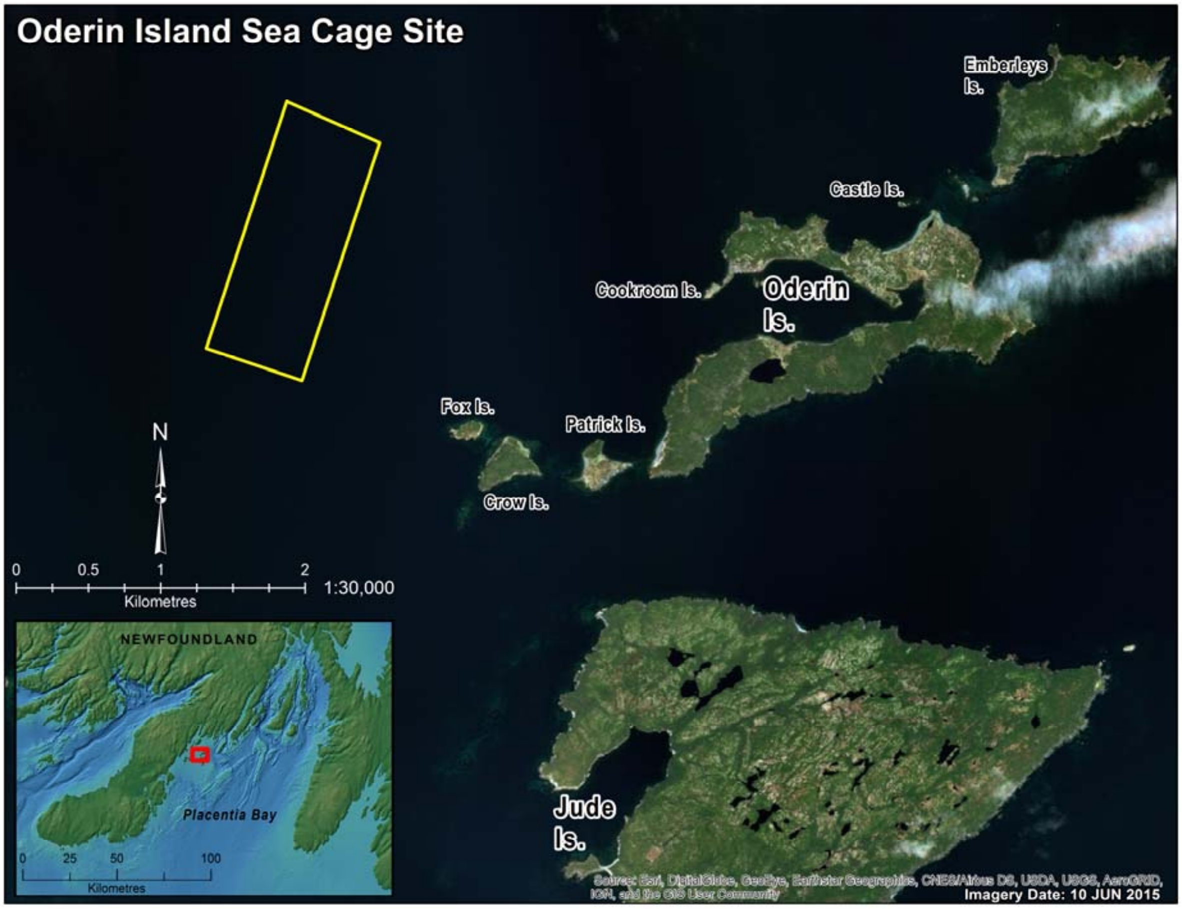


Figure 3. Aerial image of proposed Oderin Island sea cage site located in Rushoon BMA.

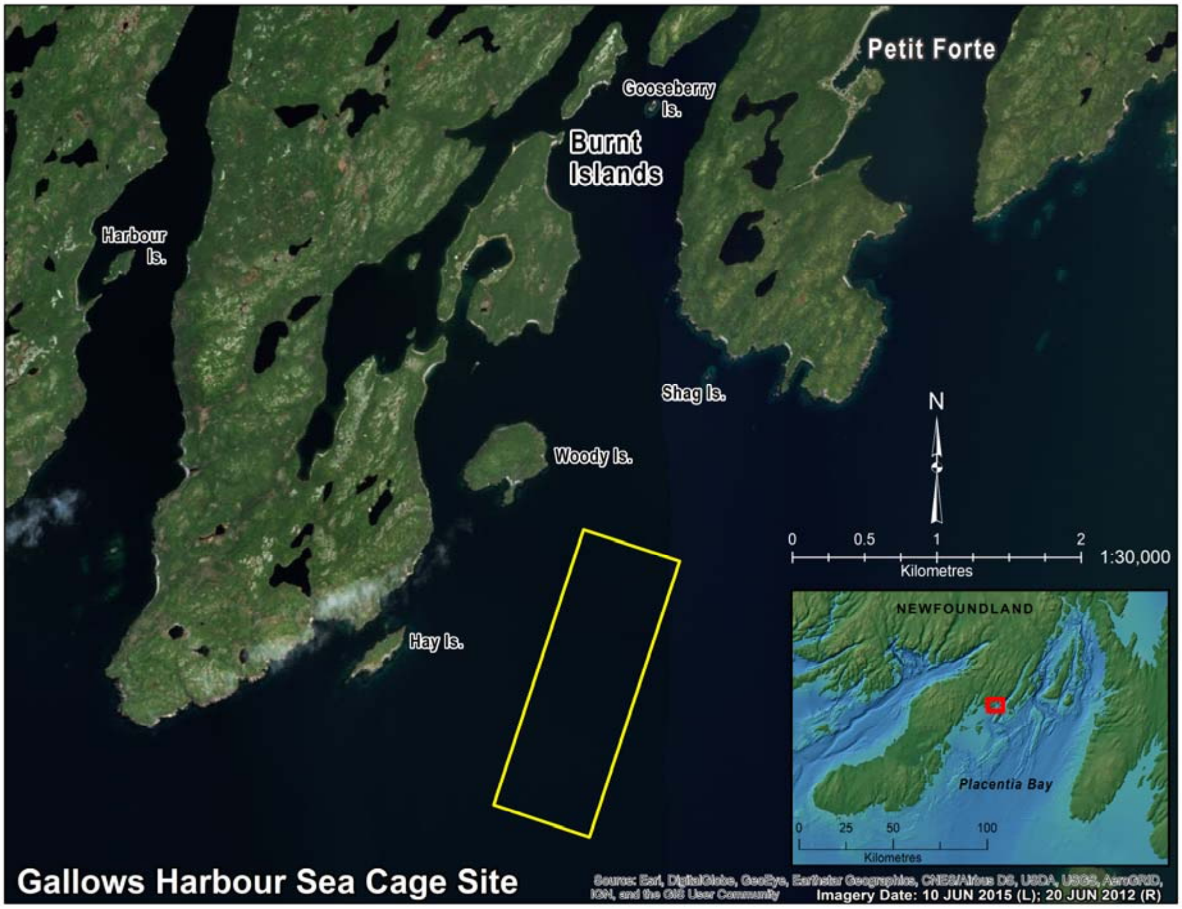


Figure 4. Aerial image of proposed Gallows Harbour sea cage site located in Rushoon BMA.

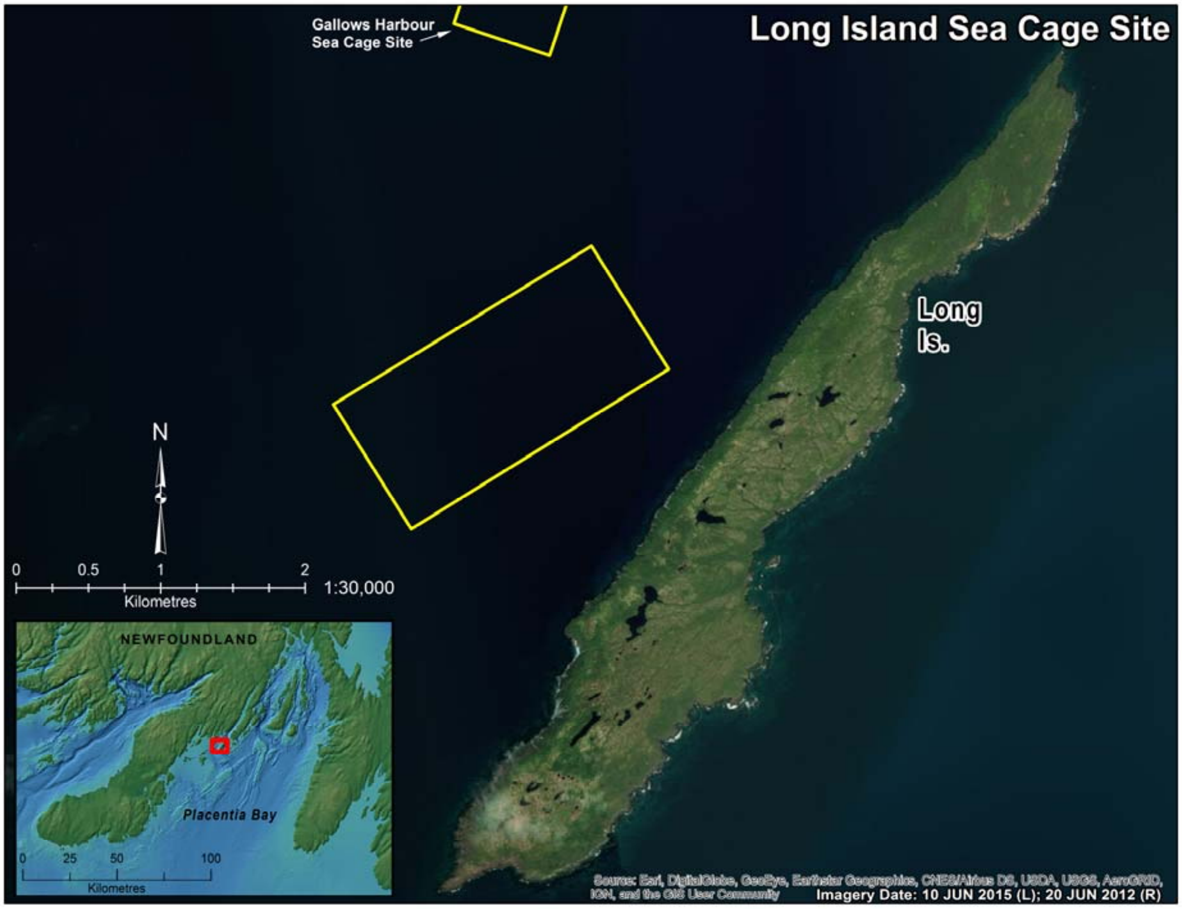


Figure 5. Aerial image of proposed Long Island sea cage site located in Rushoon BMA.

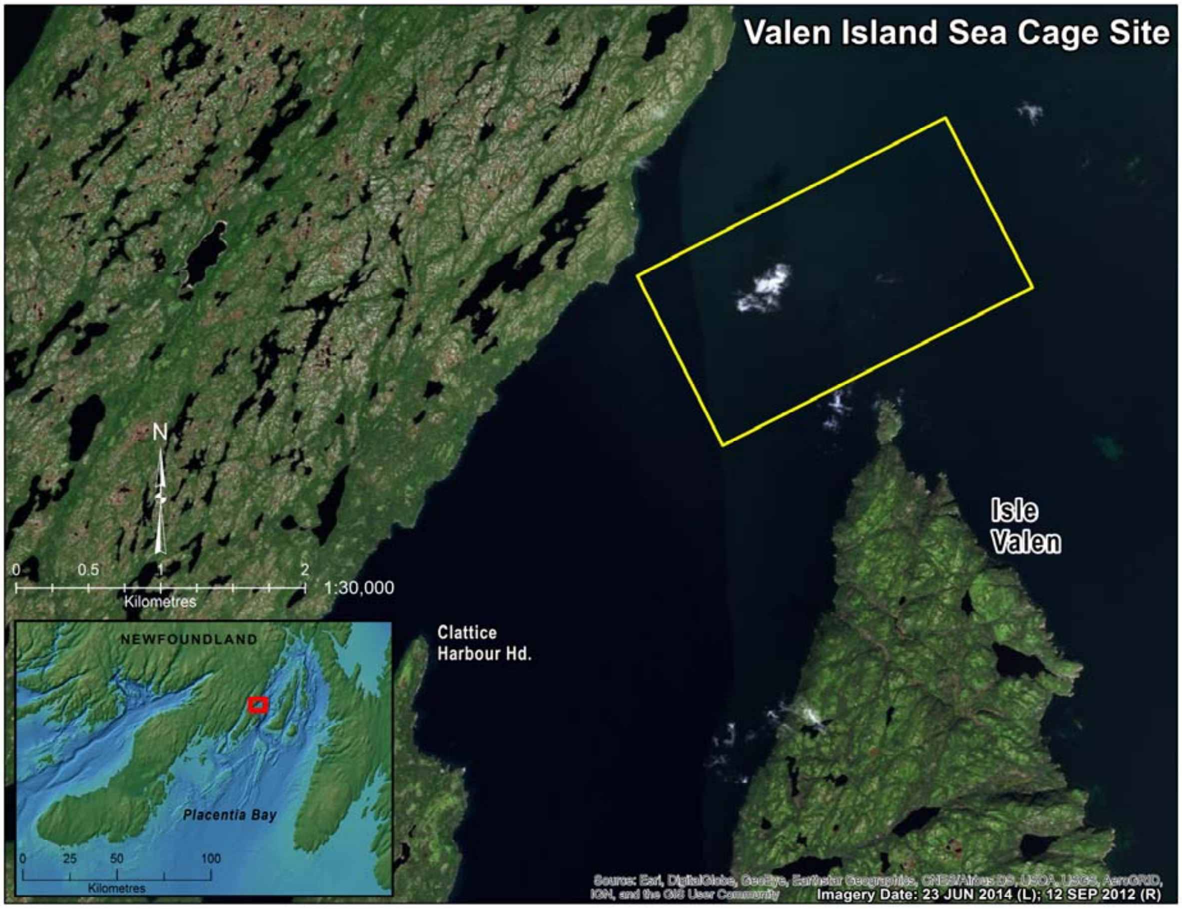


Figure 6. Aerial image of proposed Valen Island sea cage site located in Merasheen BMA.

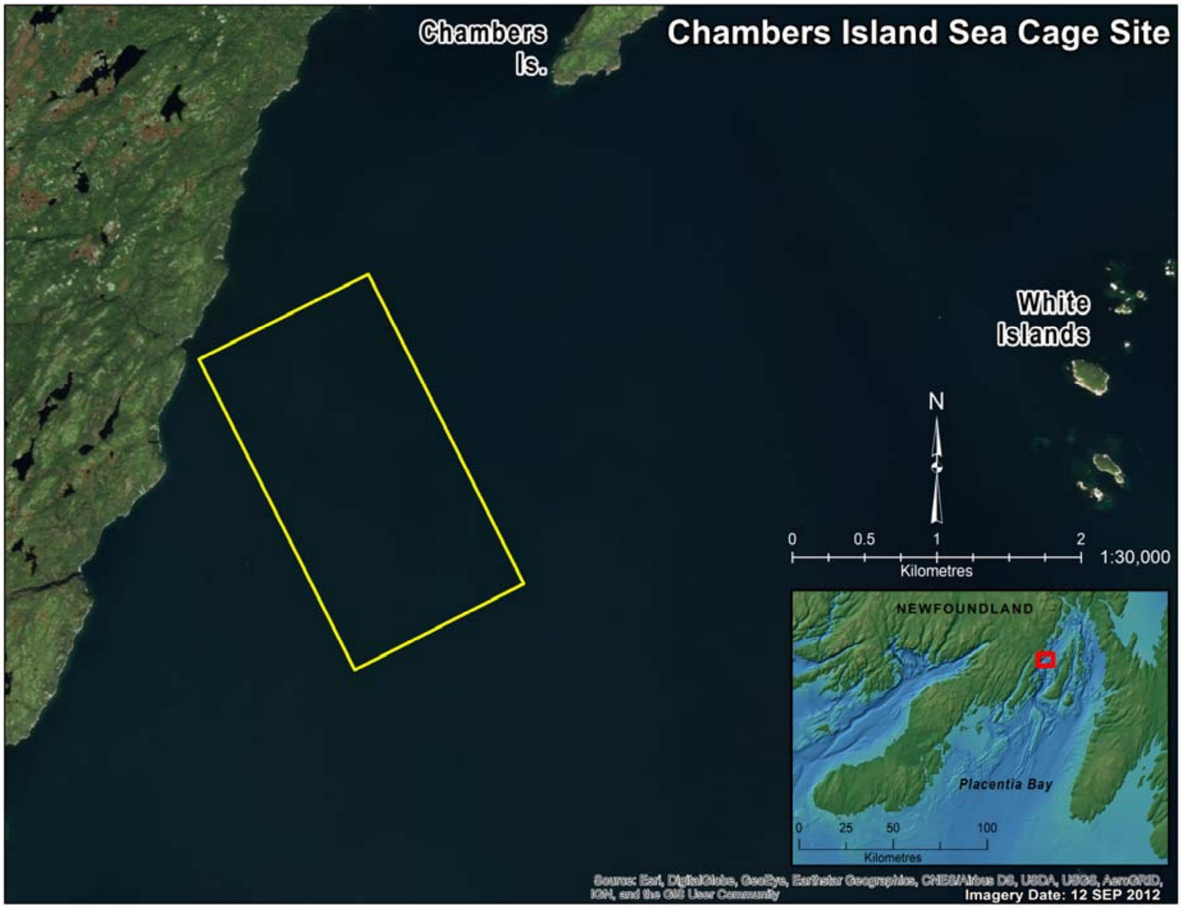


Figure 7. Aerial image of proposed Chambers Island sea cage site located in Merasheen BMA.

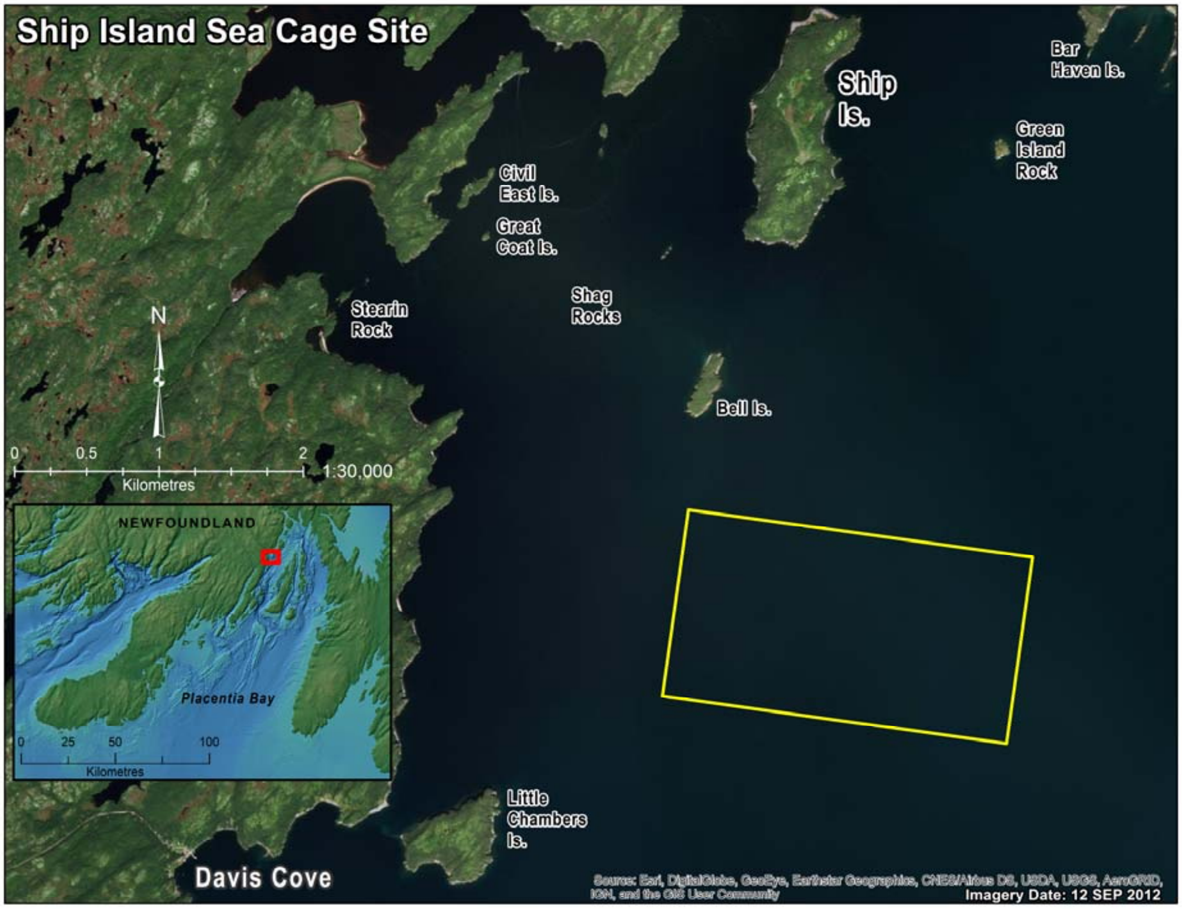


Figure 8. Aerial image of proposed Ship Island sea cage site located in Merasheen BMA.

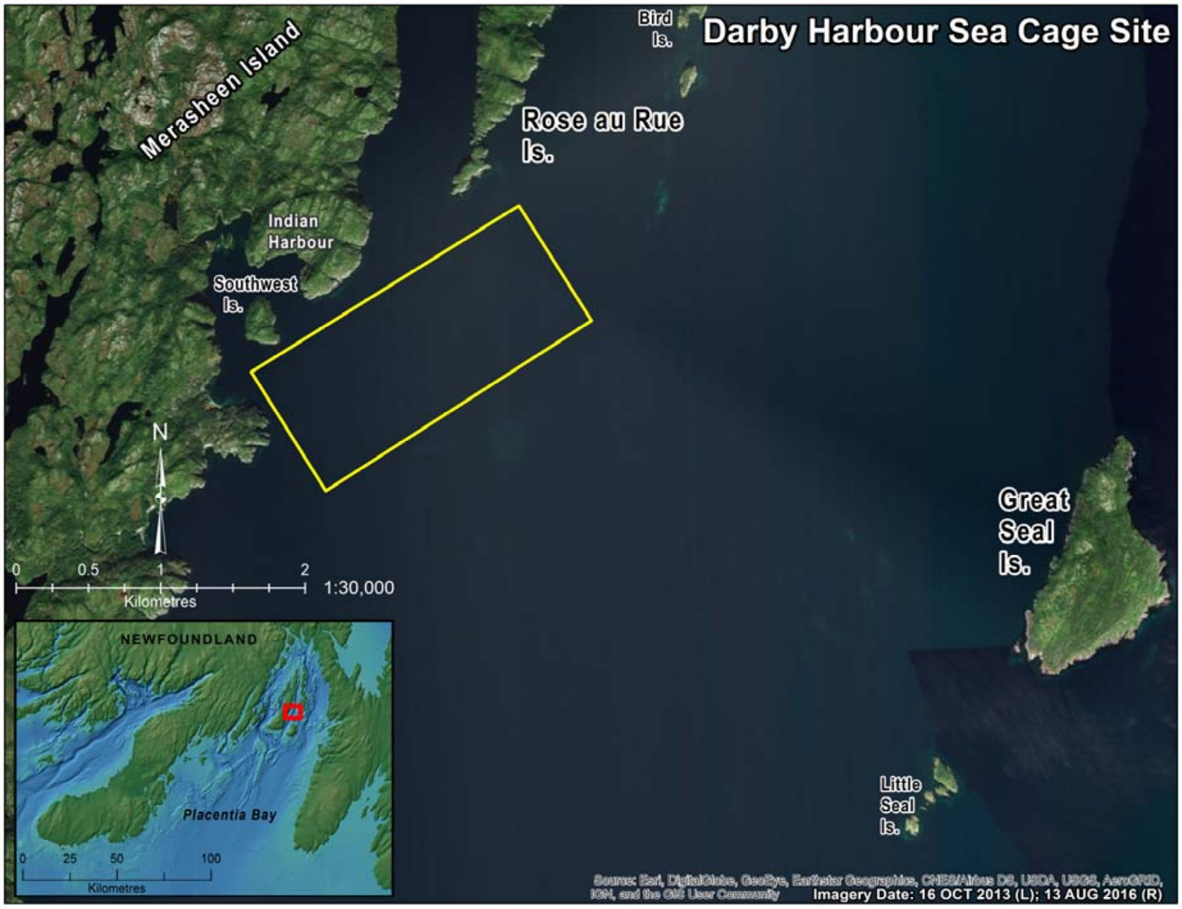


Figure 9. Aerial image of proposed Darby Harbour sea cage site located in Red Island BMA.

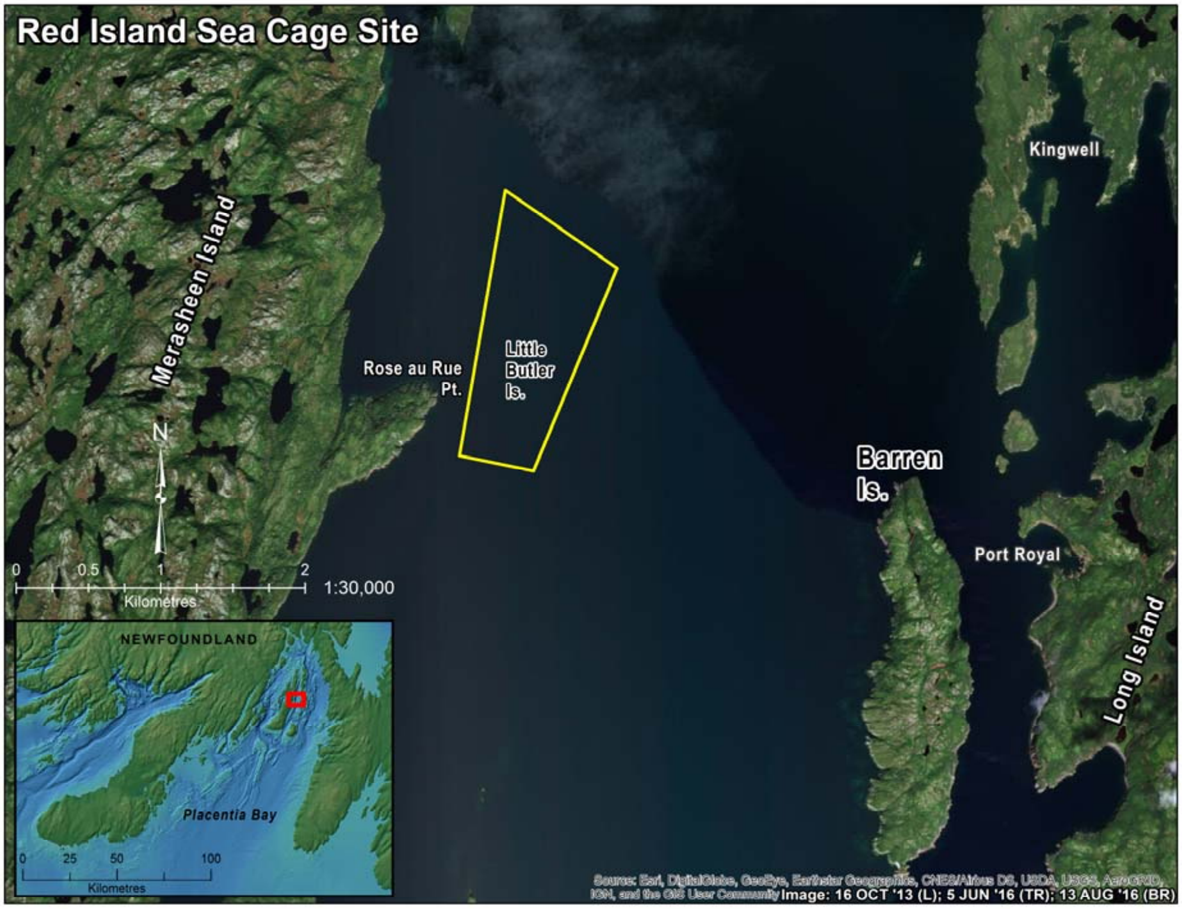


Figure 10. Aerial image of proposed Red Island sea cage site located in Red Island BMA.

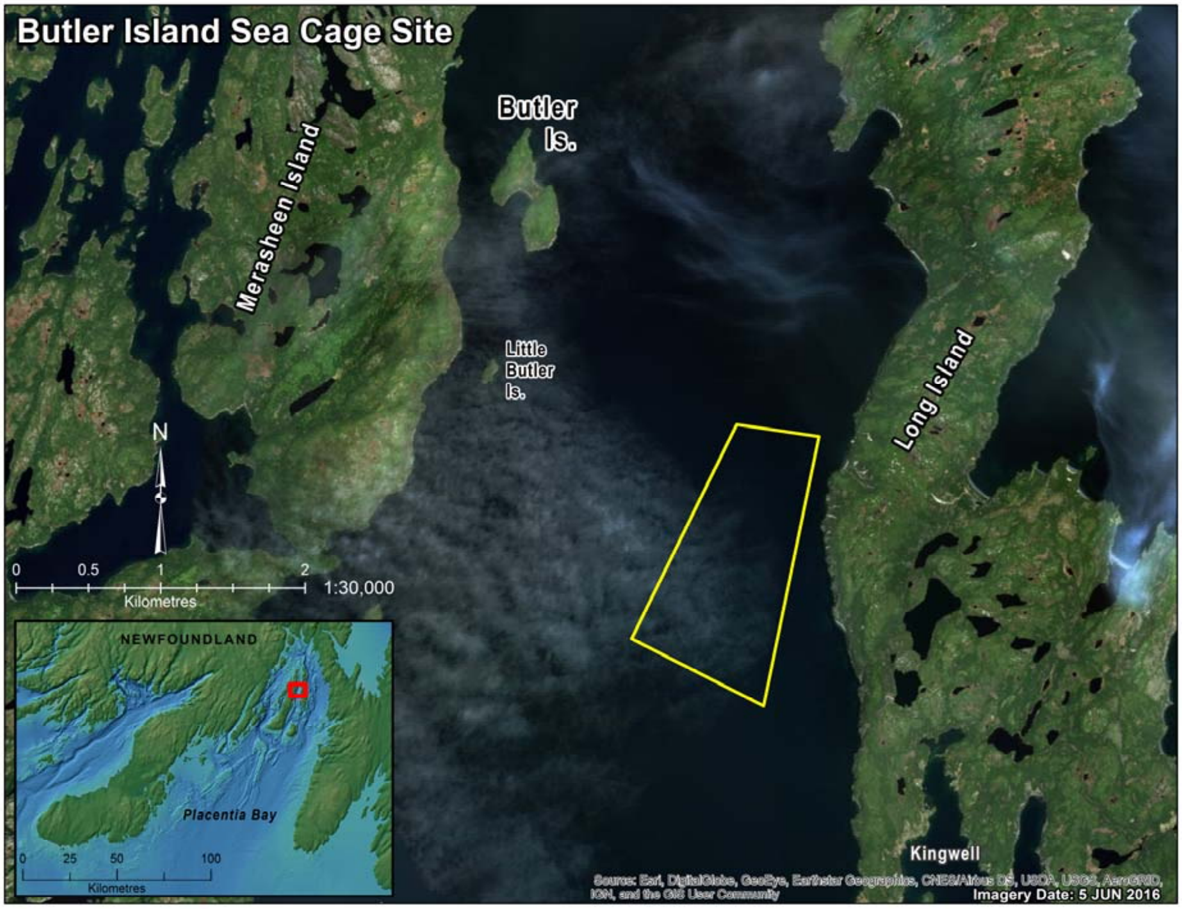


Figure 11. Aerial image of proposed Butler Island sea cage site located in Red Island BMA.

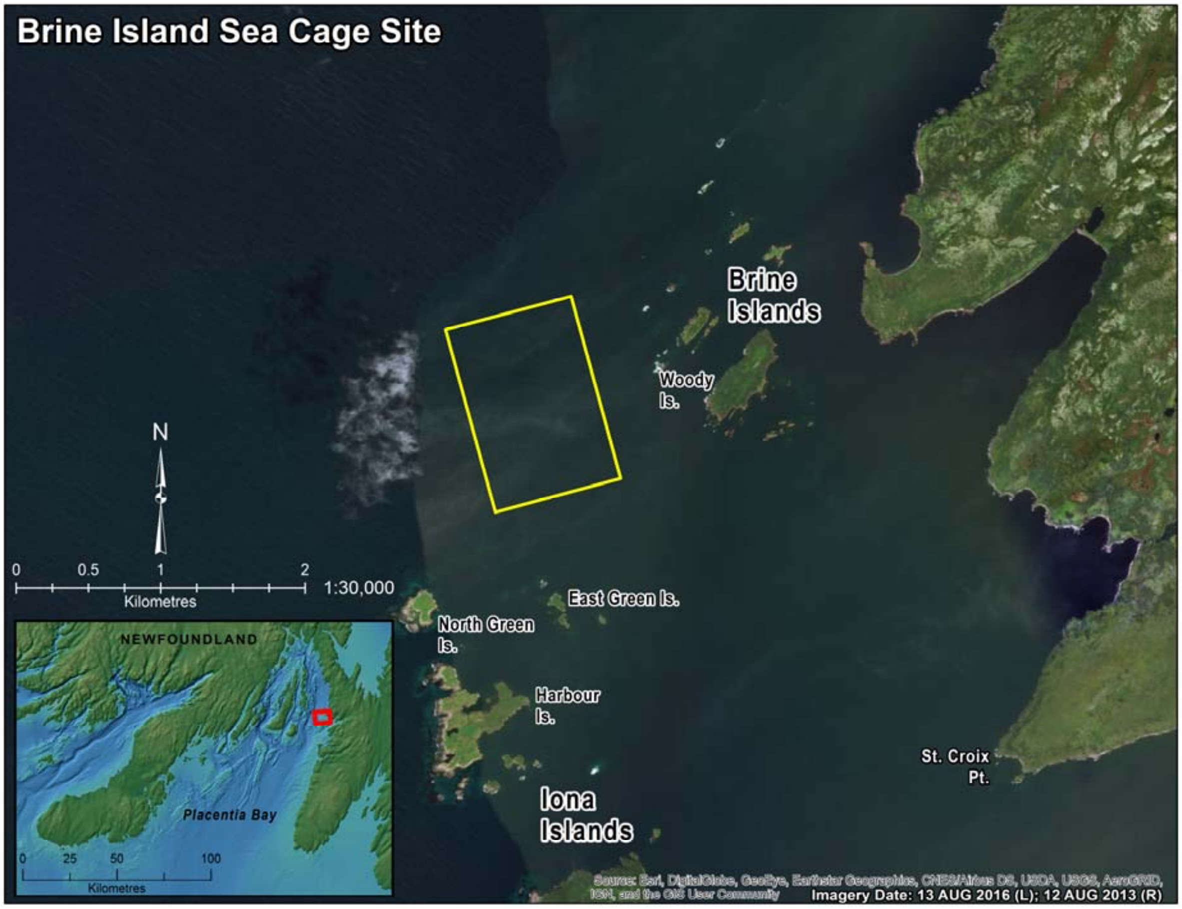


Figure 12. Aerial image of proposed Brine Island sea cage site located in seasonal Long Harbour BMA.

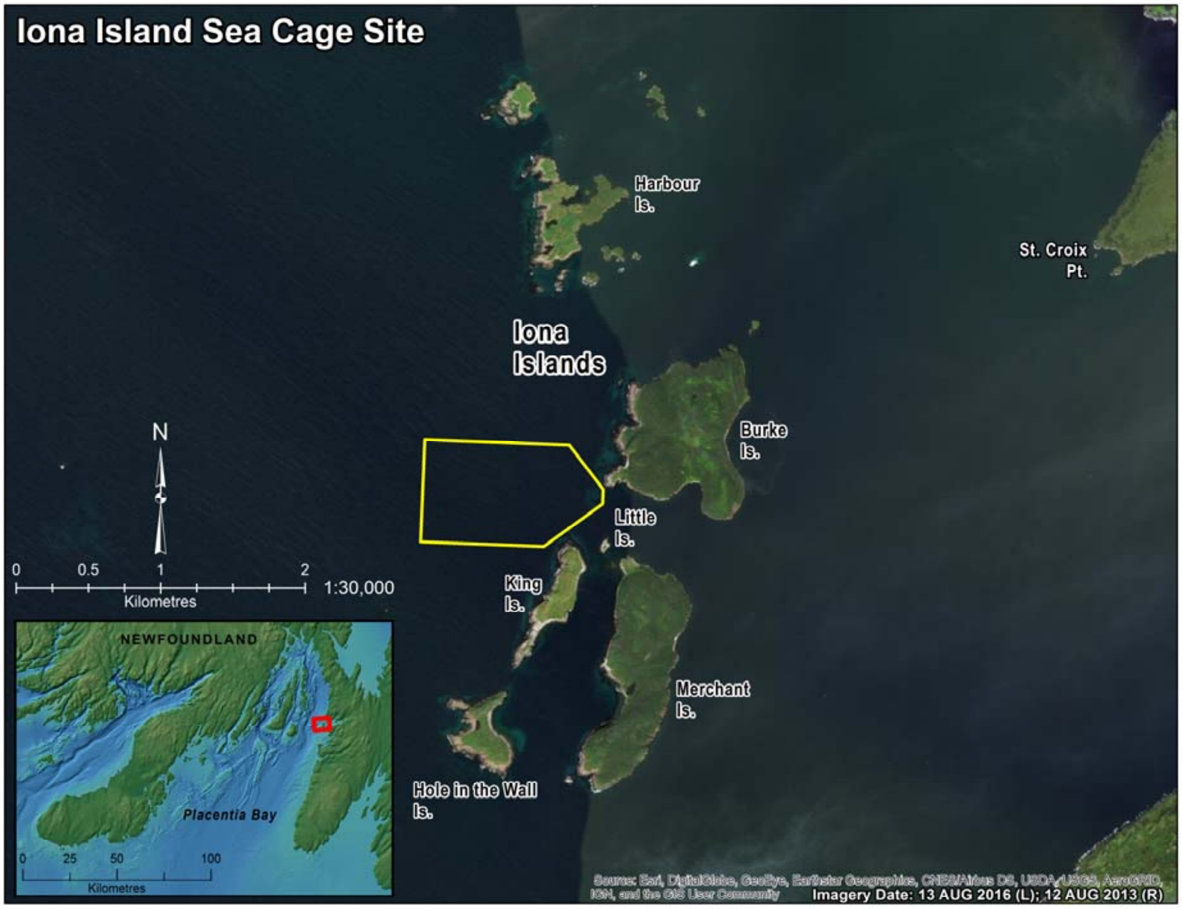


Figure 13. Aerial image of proposed Iona Island sea cage site located in seasonal Long Harbour BMA.

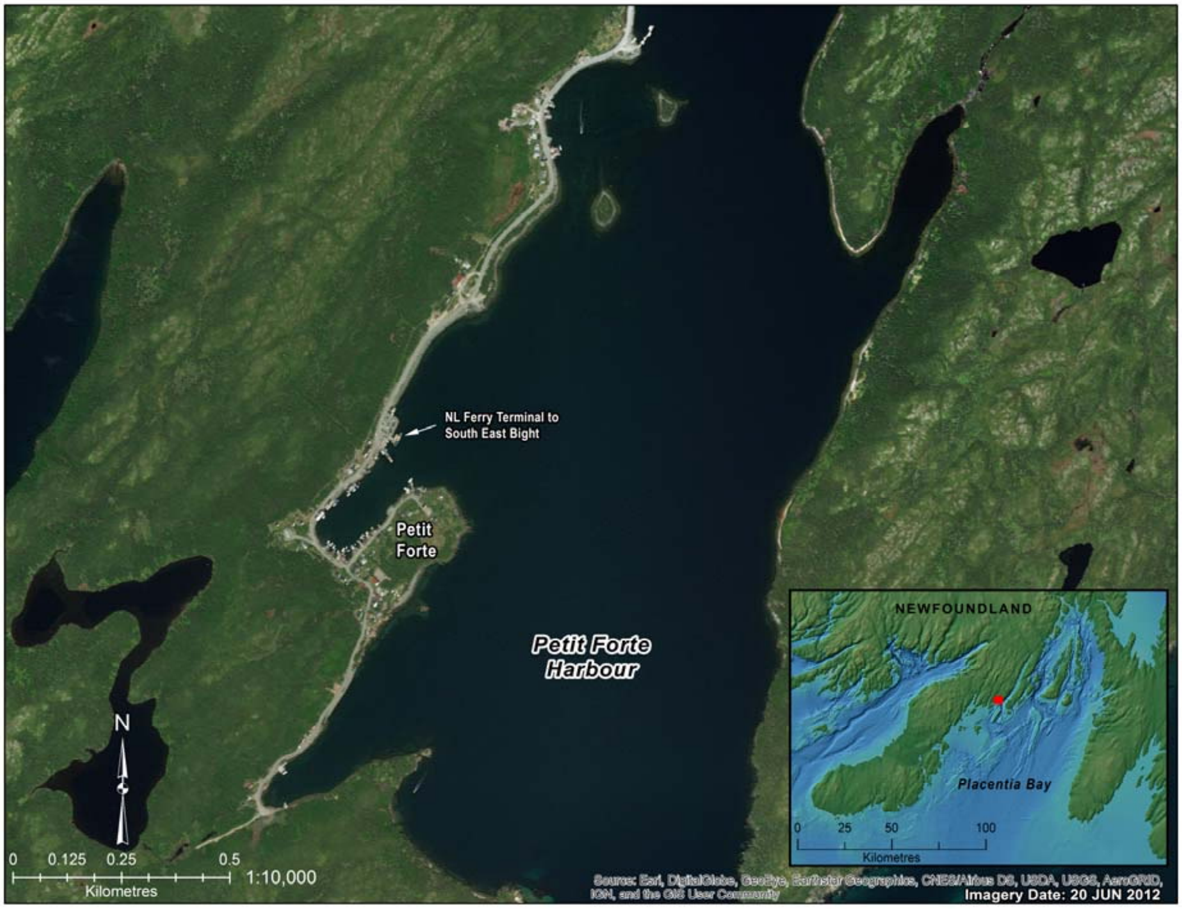


Figure 14. Aerial image of proposed docking stations (inflow and outflow) for employees at Rushoon, Merasheen or Red Island BMAs.

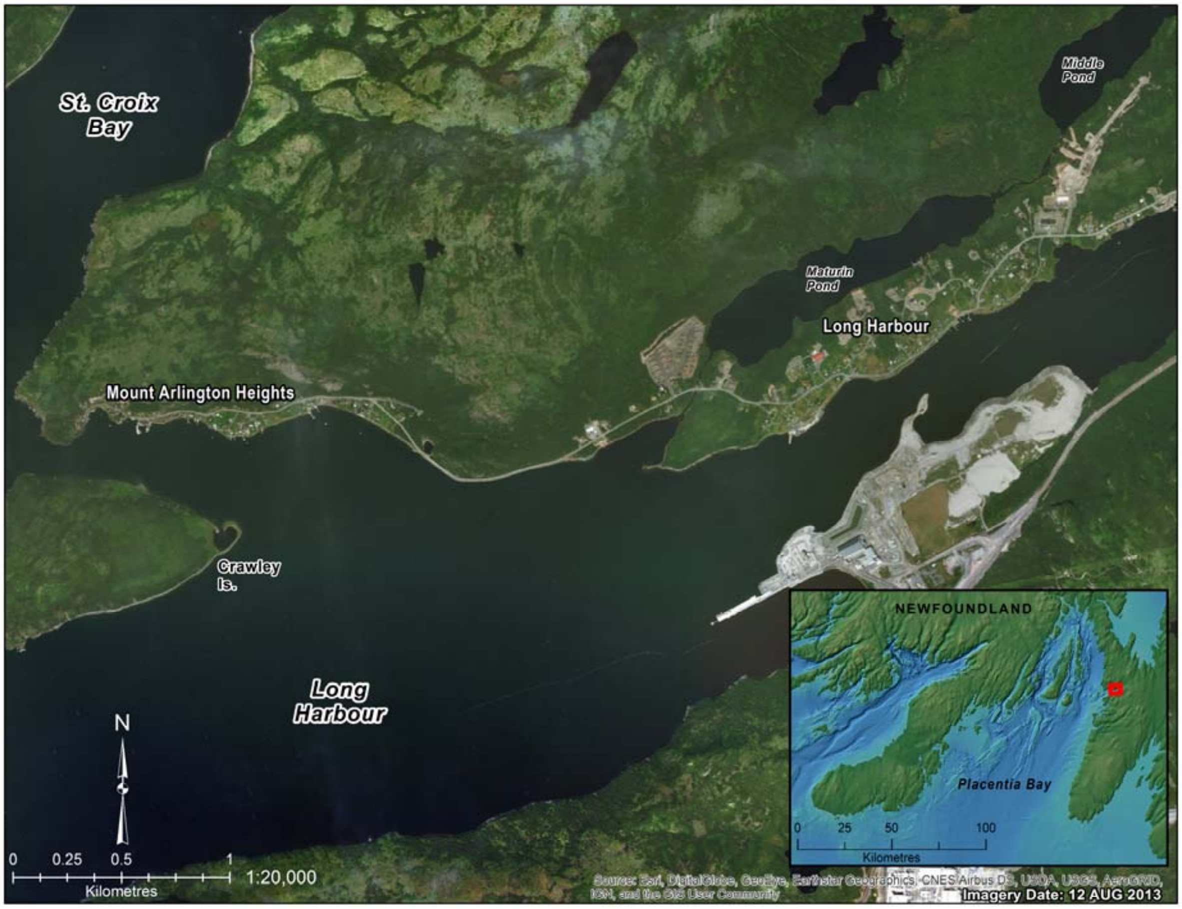


Figure 15. Aerial image of proposed docking stations (inflow and outflow) for employees at seasonal Long Harbour BMAs.

Figure 16. Aerial image of proposed docking station in Burin (inflow or outflow (TBD)) for supplies and equipment for all BMA's.

Figure 17. Aerial image of proposed docking station in Marystown (inflow or outflow (TBD)) for supplies and equipment for all BMA's.

Appendix R

Grieg NL Atlantic Salmon Stocking Schedule

Hatchery
At Sea
Wintering
Harvesting

BMA	Site	# cages	# fish to sea	Month Eggs Received	Month To Sea	# Mos in sea	# Mos growth (sea)	# Mos harvest	YEAR 2 J	F	M	A	M	J	J	A	S	O	N	D	YEAR 3 J	F	M	A	M	J	J	A	S	O	N	D
Rushoon	Oderin	4	666,525	Sept	Aug	16	13	2									egg	egg	2	4	13	31	40	50	111	208	350	Transfer				
Rushoon	Gallows Hbr	4	666,525	Sept and Oct	Aug and Sept	16	13	2									egg	egg	2	4	13	31	40	50	111	208	350	544	Transfer			
Rushoon	Long Island	4	666,525	Oct	Sept	16	13	2										egg	egg	2	4	13	31	40	50	111	208	350	544	Transfer		
Merasheen	Valen	7	999,788	June	May	14	11	3																		egg	egg	2	4	13	31	40
Merasheen	Chambers	7	999,788	Aug	July	14	11	3																				egg	egg	2	4	13
Merasheen	Ship Is	7	999,788	Oct	Sept	14	11	3																						egg	egg	2
Long Hbr	Brine Is	6	999,788	Feb	May	6	6	2																								
Red Is	Darby Hbr	6	999,788	June	June	15	12	3																								
Red Is	Red Island	6	999,788	Aug	July	13	10	4																								
Red Is	Butler Island	6	999,788	Nov	Oct	13	10	4																								
Long Hbr	Iona Is	3	999,788	Feb	May	6	6	2																								
Rushoon	Oderin	12	1,999,577	June	June	14	11	2																								
Rushoon	Gallows Hbr	12	1,999,577	Aug	July	14	11	3																								
Rushoon	Long Island	6	999,788	Nov	Oct	15	12	2																								
Long Hbr	Brine Is	3	999,788	Feb	May	6	6	2																								
Merasheen	Valen	12	1,999,577	June	June	14	11	2																								
Merasheen	Chambers	6	999,788	August	July	14	11	3																								
Merasheen	Chambers	6	999,789	Oct	Sept	15	12	2																								
Merasheen	Ship Is	12	1,999,577	Nov	Oct	15	12	2																								

Weight (g)

BMA	Site	YEAR 4 J	F	M	A	M	J	J	A	S	O	N	D	YEAR 5 J	F	M	A	M	J	J	A	S	O	N	D
Rushoon	Oderin			2.02 kg								4.9 - 5.6 kg													
Rushoon	Gallows Hbr			2.02 kg									4.4 - 5.1 kg												
Rushoon	Long Island			2.02 kg										4.4 - 5.1 kg											
Merasheen	Valen	50	111	208	350	544	Transfer									3.2 Kg					4.7 - 5.1 kg				
Merasheen	Chambers	31	40	50	111	208	350	544	Transfer							2.2 Kg							4.7 - 5.1 kg		
Merasheen	Ship Is	4	13	31	40	50	111	208	350	544		Transfer				2.02 Kg									4.9 - 5.3 kg
Long Hbr	Brine Is		egg	egg	2	4	13	31	40	50	111	208	350	544	800	1126	1250	1400	Transfer				4.4 - 4.6 kg		
Red Is	Darby Hbr						egg	egg	2	4	13	31	40	50	111	208	350	544	800	Transfer					
Red Is	Red Island								egg	egg	2	4	13	31	40	50	111	208	350	544	Transfer				
Red Is	Butler Island											egg	egg	2	4	13	31	40	50	111	208	350	544	Transfer	
Long Hbr	Iona Is														egg	egg	2	4	13	31	40	50	111	208	350
Rushoon	Oderin																		egg	egg	2	4	13	31	40
Rushoon	Gallows Hbr																				egg	egg	2	4	13
Rushoon	Long Island																							egg	egg
Long Hbr	Brine Is																								
Merasheen	Valen																								
Merasheen	Chambers																								
Merasheen	Chambers																								
Merasheen	Ship Is																								

Figure 1. Atlantic salmon stocking schedule (preliminary) by month at the four BMAs.

Hatchery
At Sea
Wintering
Harvesting

YEAR									YEAR 6												YEAR 7												YEAR 8												YEAR 9				
MONTH									J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M
BMA	Site	# cages	# fish to sea	Month Eggs Received	Month To Sea	# Mos in sea	# Mos growth (sea)	# Mos harvest																																									
Rushoon	Oderin	4	666,525	Sept	Aug	16	13	2																																									
Rushoon	Gallows Hbr	4	666,525	Sept and Oct	Aug and Sept	16	13	2																																									
Rushoon	Long Island	4	666,525	Oct	Sept	16	13	2																																									
Merasheen	Valen	7	999,788	June	May	14	11	3																																									
Merasheen	Chambers	7	999,788	Aug	July	14	11	3																																									
Merasheen	Ship Is	7	999,788	Oct	Sept	14	11	3																																									
Long Hbr	Brine Is	6	999,788	Feb	May	6	6	2																																									
Red Is	Darby Hbr	6	999,788	June	June	15	12	3			3.9 kg					4.8 - 5.6 kg																																	
Red Is	Red Island	6	999,788	Aug	July	13	10	4			2.2 kg						4.5 - 5.2 kg																																
Red Is	Butler Island	6	999,788	Nov	Oct	13	10	4			1.6 kg								4.9 - 5.3 kg																														
Long Hbr	Iona Is	3	999,788	Feb	May	6	6	2	544	800	1126	1250	1400	Transfer				4.3 - 4.6 kg																															
Rushoon	Oderin	12	1,999,577	June	June	14	11	2	50	111	208	350	544	800	Transfer								3.9 kg					4.8 - 5.6 kg																					
Rushoon	Gallows Hbr	12	1,999,577	Aug	July	14	11	3	31	40	50	111	208	350	544								2.2 kg						4.6 - 5.01 kg																			
Rushoon	Long Island	6	999,788	Nov	Oct	15	12	2	2	4	13	31	40	50	111	208	350	544	Transfer				1.9 kg										4.6 - 5.1 kg																
Long Hbr	Brine Is	3	999,788	Feb	May	6	6	2		egg	egg	2	4	13	31	40	50	111	208	350	544	800	1126	1250	1400	Transfer				4.3 - 4.6 kg																		
Merasheen	Valen	12	1,999,577	June	June	14	11	2						egg	egg	2	4	13	31	40	50	111	208	350	544	800	Transfer								3.9 kg					4.8 - 5.6 kg								
Merasheen	Chambers	6	999,788	August	July	14	11	3								egg	egg	2	4	13	31	40	50	111	208	350	544								2.2 kg						4.6 - 5.01 kg							
Merasheen	Chambers	6	999,789	Oct	Sept	15	12	2										egg	egg	2	4	13	31	40	50	111	208	350	Transfer						2.0 kg									4.9 - 5.2 kg					
Merasheen	Ship Is	12	1,999,577	Nov	Oct	15	12	2											egg	egg	2	4	13	31	40	50	111	208	350	544	Transfer				1.9 kg										4.6 - 5.1 kg				

STEADY STATE

Figure 1. Atlantic salmon stocking schedule (preliminary) by month at the four BMAs (Cont'd).

Appendix S
Lumpfish Broodstock Collection, Domestication and Spawning Techniques
Report 2017

NEWFOUNDLAND & LABRADOR, CANADA

MEMORIAL UNIVERSITY

GRIEG NL

Department of Ocean Sciences

Ocean Sciences Centre

0 Marine Lab Rd.
St. John's, NL Canada A1C 5S7
Tel: 709 864 3708
Fax: 709 864-3220

March 31, 2017

Ms. Anastasia Day
Atlantic Canada Opportunities Agency
The John Cabot Building
10 Barter's Hill, 11th Floor
P.O. Box 1060, Station "C"
St. John's, NL A1C 5M5

Mr. Sean Macneill
Canadian Centre for Fisheries Innovation
P.O. Box 4920
St. John's, NL
A1C 5R3

Dear Madame(s)/Sir(s);

Enclosed is an updated Progress Report #5 for the period (January 1– March 31, 2017) as per our agreement. The project is titled ***"Rognkjeks / Lumpfish Broodstock Collection, Domestication and Spawning Techniques",*** on behalf of Memorial University of Newfoundland's Ocean Sciences Centre (OSC) and GRIEG NL SEAFARMS LTD., a subsidiary company of Grieg Seafood ASA.

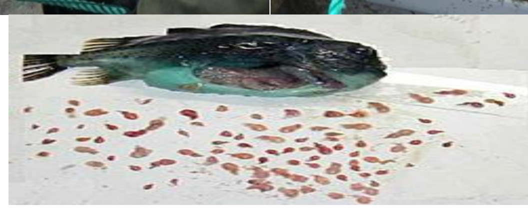
We met all milestones as outlined in our agreement. We continue to support ongoing research and the employment of high quality personnel at the Ocean Sciences Centre.   If you have further questions on this matter please feel free to contact me. We appreciate your continued financial support for this cleaner fish initiative.

Respectively Yours;

D Boyd

Facility and Business Manager
Dr. Joe Brown Aquatic Research Building

“Rognkjeks / Lumpfish Broodstock Collection, Domestication and Spawning Techniques”



Proponents:	**Dr. Garth Fletcher**	**Director, Ocean Sciences Centre**
	Mr. Danny Boyce	**Department of Ocean Sciences**
	Mr. Knut Skeidsvoll	**General Manager, GRIEG NL SEAFARMS LTD.**

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1.0 Introduction

The project is titled ***"Rognkjeks / Lumpfish Broodstock Collection, Domestication and Spawning Techniques",*** on behalf of Memorial University of Newfoundland's Ocean Sciences Centre (OSC) and GRIEG NL SEAFARMS LTD., a subsidiary company of Grieg Seafood ASA.

Grieg Seafood ASA is one of the world's leading fish farming companies, specializing in atlantic salmon. They have an annual production capacity of more than 90,000 tons gutted weight. The Group is today present in Norway, British Columbia (Canada) and in Shetland (UK), employing approximately 700 people. Grieg's operations are based on hands-on experience and innovative, technological solutions. Experience and competence is the foundation for safe, clean and efficient farming of high quality salmon. In order to secure knowledge sharing across the Grieg Seafood locations, they have formed a competence team where their employees meet to share innovation and experience.

Grieg Seafood's managers are employed for their leadership skills, their extensive experience in fish farming, as well as their ability to implement clever solutions, which increase the efficiency of their sites. Their salmon farmers are genuinely concerned in the environment, their profession and the welfare of their fish. They are proud to spearhead some of the most innovative solutions in fish farming.

The company was formed to establish a fish farming operation on the south east coast of Newfoundland with a principle marine base in Marystown. Marine operations will span the Placentia Bay coastline from Long Harbour (The Rams and Iona Islands) in the east and Merasheen, Long Island and Red Island in the central part of the Bay to Rushoon in the west (approx. 900 km^2). General direct employment will be in the order of 600 individuals. Production will include stocking 7 million Atlantic salmon smolts (*Salmo salar*) on a yearly basis. Output is estimated at 35,000 Metric Tonnes round.

The **lumpfish production facility** will have the capacity to hold multiple groups of domesticated photo-advanced broodstocks (plus back up broodstock at OSC/JBARB) and the capacity to hold one million juveniles.

1.1Environmental Challenges

The growth of our global aquaculture industry and in particular in Atlantic Canada has given rise to environmental challenges. Lice infestations are one of the biggest problems in salmon aquaculture today costing the producer up to C$500/tonne produced each year in losses and treatments. In most salmon farming countries (Canada, Norway, Chile, Scotland, and Ireland), prolonged use of chemical therapeutants (eg. SLICE) to control sea lice (*Lepeophtheirus salmonis)* infestation has led to the emergence of resistance in local lice populations and environmental concerns grow over the effect of these treatments on the surrounding flora and fauna. The seriousness of the developing chemical resistance issue in Canada has prompted interest in developing a tool, such as the potential utilization of local fish species such as cleaner fish.

These salmon are reared in cages in open waters. No surprise, perhaps that they can fall prey to parasites that naturally occur in the wild. Sea lice are tough, and they've been resistant to many of the new treatments devised to defeat them. Scientists around the world have developed environmentally-friendly disinfectants, in-feed treatments, growth regulators, bath treatments, and research is well underway on possible vaccines. But none, so far, has been perfect.

Cleaner fish are being reared to help protect the salmon. Cleaner fish love eating sea lice. This useful behaviour is being harnessed to create a natural defense for the farms.

Several European cold water hatcheries have developed rearing technology strategies for the lumpfish. Cage site deployment strategies are also being developed and implemented.

In order for lumpfish to be used as cleaner fish in an industry the size of the Atlantic salmon industry in Canada, it is obviously necessary to produce these fish in the hatchery rather than catch specimens locally.

Because of our ability to culture them and their scan-and-pick feeding behaviour both the cunner and lumpfish have received attention as candidates to serve as a cleaner fish for the Atlantic Canadian salmon industry. **However, Grieg is focusing specifically on the lumpfish for this project and their business model.**

We a have the North Atlantic **Lumpfish, *Cyclopterus lumpus*** family *Cyclopteridae.* Lumpfish can be used for all salmon sizes and in cooler waters.

2.0 Project Deliverables

The Newfoundland Aquaculture Industry Association (NAIA) through industry "consultations identified "Integrated Pest Management Strategies for Sea Lice Control" as the *number one ranked Research and Development Priority for our finfish aquaculture sector*.

Lumpsucker is a relatively new addition in the "cleaner fish" family and knowledge of biology, domestication and spawning use is somewhat limited. This best practice is based on the experiences so far, and will continuously be updated.

This project will enable us to identify lumpfish collection sites (through local fishers) and develop the optimal techniques for collection, domestication and spawning evaluation of lumpfish. This is in the best interest of Grieg's business model for successful salmon farming.

This project is providing the basis (broodstock) to help optimize the use of lumpsuckers as biological control of salmon lice in aquaculture and at the same time safeguard the lumpsuckers health and wellbeing at all stages.

The collection and domestication of broodstock is critical to ensuring that when this cleaner fish lumpfish facility opens, egg masses are available from the start. These egg masses will provide good quality larvae for the placement of juveniles in the sea cages of Greig NLSeafarms Ltd. The establishment of best practices for broodstock collection, domestication and pre and post spawning will be completed.

We are increasing our knowledge and production for lumpfish and make significant advances towards this species becoming an important tool to for use towards "Integrated Pest Management Control" on our salmon farms in the Atlantic region. This proposal is in alignment with the industry priorities for the province as well as in alignment with Grieg NL's approach to integrated pest management.

Deliverables - Training, Research and Demonstration in:

- Broodstock Management
- Spawning Techniques (Stripping vs. Natural)
- Post Capture and Spawning Mortality
- Technology and Knowledge Transfer
- Rural Sustainability for our Industry

3.0 Project Milestone and Activities

3.1 Description of Milestones

	Project Milestone	Indicator of Achievement	Date of Completion
M1	Completion of Broodstock Management / Domestication		July 31, 2017

3.2 Description of Major Activities

Activity #	Activity Title	Description of Activity	Start Date	Finish Date
M1- A1	Broodstock Collection	Collect Broodstock	June 1, 2015	August 31, 2016 Complete
M1- A2	Broodstock Maintenance/Domestication	Daily Husbandry	June 1, 2015	July 31, 2017
M1- A3	Broodstock a)Spawning Success b)Post Capture and Spawning Mortality c)Photo-Period Manipulation Techniques	Evaluation of Fish Maturation, Spawning evaluation – hand and tank. Stripping protocols	June 1,2015 June 1,2015 June 1,2015	July 31, 2017 July 31, 2017 July 31, 2017
M1- A4	Egg Production	Egg Collection, Disinfection, Quality and Incubation	June 1, 2015	July 31, 2017
M1- A5	Fish Health Surveillance	Sampling for Pathogens. AAHD Surveillance Program	June 1, 2015	July 31, 2017

4.0 Progress

4.1 A1 - Broodstock Collection

4.1.1 2015 Collection Area and Fishing Season Openings

The commercial fishery opens for lumpfish in specific areas around the island at various dates as indicated below by the Department of Fisheries and Oceans, Canada. The season opening, generally coincides with when traditionally, the lumpfish begin to move inshore for spawning and feeding. Females lay from 2 to 3 egg masses at intervals ranging from 8 to 14 days, and then return to deep waters leaving the males there to guard the eggs. We collected lumpfish in the **3L** division- Witless Bay/Bay Bulls and Champney's West during 2015. The season opened for lumpfish in area 3L June 3, 2015.

Below is information on season openings for commercial fish harvesters in specific NAFO regions of Newfoundland.

- Notre Dame Bay in NAFO Division 3K from North Head to Cape Freels at 06:00 hours on May 27, 2015.
- 06:00 hours on Monday, May 25, 2015 in a portion of NAFO Division 4R from Point Riche, north to Cape Bauld.
- Little Hr. Deep to Cape St. John in NAFO Division 3K at 0600 hours on Monday May 18, 2015.
- 3L opened on May 29 (that portion of NAFO Division 3L known as Bonavista Bay South - defined as south of a straight line drawn from the northern most portion of Offer Gooseberry Cove Island northwest to the northern most portion of Silver Fox Island and onward to the mainland).

- DFO wishes to advise harvesters that the Lumpfish fishery will open at 0600 hours on June 3, 2015 in the followings Lumpfish fishing areas:

1. NAFO Division 3L
2. Bonavista Bay (North)

License conditions are available through the online licensing system and fish harvesters should review their license conditions for specific management measures.

- Subject: Notice to Fish Harvesters - 2015 Lumpfish Openings in NAFO Sub-Division 3Ps - nf.15.106 FISHERIES AND OCEANS CANADA NOTICE TO FISH HARVESTERS, NF.15.106B 2015-070 Jun. 5, 2015 2015 Lumpfish Openings in NAFO sub-Division 3Ps DFO wishes to advise harvesters that the Lumpfish fishery will open at 0600 hours on Monday, June 8th, 2015 in the following Lumpfish fishing areas:
  1. NAFO sub-Division 3Ps
  a. Lawn Head to Dantzic Point
  b. Dantzic Point to Grand Bank Cape

c. Grand Bank Cape to Point Rosie

Harvesters are reminded that licence conditions are available through the National Online Licencing System (NOLS).

Twenty two lumpfish broodstock and one egg mass were collected during the summer of 2015. These broodstock and egg masses were collected from Bay Bulls / Witless Bay and Champneys West (Table 1).

Table 1: Lumpfish Broodstock collected 2015 season

Date	Species Collected	Location
June 26, 2015	4 Male Lumpfish	Witless Bay
July 9, 2015	6 Lumpfish + 1 egg mass by divers	Witless Bay + Bay Bulls
July 20, 2015	2 Male Lumpfish	Bay Bulls
July 28, 2015	10 Lumpfish	Champneys West

4.1.2 2016 Collection Area and Fishing Season Openings

The area of interest for our collection project is NAFO Division 3L- which includes both Witless Bay and Champneys. In 2016, the lumpfish fishery opened May 9 and closed June 29, 2016.

The DFO website is: http://www.nfl.dfo-mpo.gc.ca/NL/CP/Orders/Notices-List

NOTICE TO FISHERS nf.16.072
May 9, 2016, 2016-039
Lumpfish Opening in a portion of NAFO Division 3L
DFO wishes to advise harvesters that the Lumpfish fishery will open at 0600 hours on May 11, 2016 in the following Lumpfish fishing area:
NAFO Division 3L
Bonavista Bay (North)
The Regional Director General, Fisheries and Oceans Canada, Newfoundland and Labrador Regions gives notice that Variation Order 2015-154 has been revoked and Variation Order 2016-039 comes into effect on May 10, 2016.

NOTICE TO FISH HARVESTERS
nf.16.171, 6/27/2016
Lumpfish Fishery **Closing In NAFO Division 3L**

DFO advises harvesters that the Lumpfish fishery in NAFO Division 3L, Bonavista Bay North, will close at 2000 hours on June 29, 2016.
Harvesters are reminded that all gear must be removed from the water by closing time.
If you would like to have all "Notices to Fish Harvesters" for commercial fisheries sent directly to you by email please contact: amy.kavanagh-penney@dfo-mpo.gc.ca
Contact:
Erin Dunne
Resource Manager - Eastern Fisheries

Tel.(709) 772-5845
E-mail: erin.dunne@dfo-mpo.gc.ca

Forty eight lumpfish broodstock and were collected from Witless Bay and Champneys West (Table 2) during the early summer of 2016 and transported to the OSC.

Table 2: Lumpfish Broodstock collected 2016 season

Date	Species Collected	Location
June 6, 2016	24 Females & 2 Males	Witless Bay
June 24, 2016	22 Females	Champney's West

Milestone Complete

4.1.3 Capture Techniques

4.1.3.1 Witless Bay

In Witless Bay, local fishers used 10.5"/ 268 mm mesh gillnets to collect the lumpfish. Nets were set at 8, 15 and 20 fathoms at a time and then checked for lumps every few days. If lumps were collected from Witless Bay, they were brought to the OSC upon retrieval from the nets. Below are pictures of the boat use (Figure 1-2), area and water depths where nets were set in at Bear Cove/ Mutton Cove, Witless Bay (Figure 3) and transport vehicle used (Figure 4)

Figure 1: Longliner and tote used for collection via gill nets in Witless Bay, NL.

Figure 2: Local fisher off-loading lumpfish from boat to transport vehicle in Witless Bay, NL.

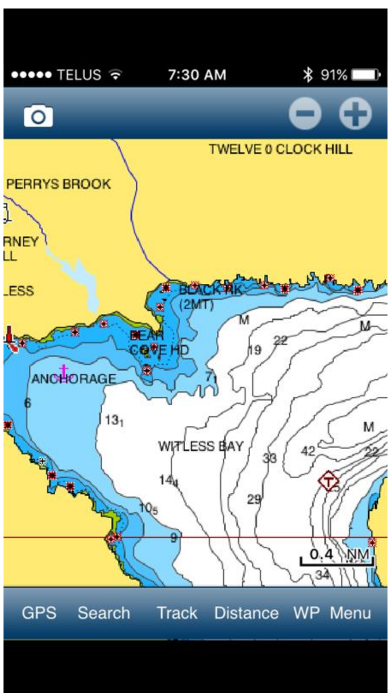


Figure 3: Gill nets were set in Bear Cove/ Mutton Cove, Witless Bay, NL.

Figure 4: Fish arriving by trailer holding insulated tubs from Witless Bay.

4.1.3.2 Champney's West

In Champney's West local fishers also used 10.5"/ 268 mm mesh gillnets (Figure 5-6) to collect the lumpfish broodstock. Nets were set for a couple of days at a time and then checked for lumps. Lumps collected from Champney's are held in a modified crab pot (Figure 7) until transport to the wharf by boat and then onto transport vehicle (Figure 4& 11) and brought to the OSC when the numbers warrant a trip (Figure 8-11).

Figure 5: Champney’s West Collection- Pulling Nets and a nice catch.

Figure 6: Champney’s West Collection- Pulling Nets/ removing kelp and a nice catch.

Figure 7: Holding lumpfish in modified crab pot prior to transport.

Figure 8: Champney's West Collection- Heading out to retrieve lumpfish in holding pots and transport vessel on wharf waiting for lumpfish to transport back to the Ocean Sciences Centre.

Figure 9: Champney’s West Collection- Modified holding tank for boat.

Figure 10: Champney’s West Collection- Grey foggy day and a few stages on the shoreline.

Best practices were used on transport from field via boat and truck transport (Figure 11). All animals were collected by local fishers (permits attained through DFO) and transported back to the OSC/JBARB via MUN's field services team and other transport vehicles.

Transportation of live fish requires oxygen for respiration and removal of the toxic gases and by-products that accumulate, such as CO_2 and ammonia. The lumpfish were transported live in water supersaturated with oxygen. Fish were also starved in holding pots for 24 – 36 hours before transportation. The transport tanks on the truck or trailer were between 500 and 2500L each and had oxygen supplied.

Densities for lumpfish were 25-35 kg/m3. Transport mortality was zero. Transport temperature was 10-11°C and oxygen levels maintained at 130-40% saturation. Transport duration was 1 hour from Witless Bay and 4 hours from Champney's West.

Figure 11: OSC Field Services Team – Ready to transport lumpfish from Champney's West to OSC.

4.2 A2 - Broodstock Maintenance

4.2.1 2015 Wild Stock

All (22) 2015 captured broodstock have died post spawning and / or have been culled for biosecurity reasons of pathogen transfer. These twenty two broodstock were collected during the spring of 2015 from Witless Bay and Champney's West (Table 1). All broodstock were assessed and pit tagged upon arrival. All broodstock were held in a 45m^3 tank with the temperature being maintained between 8-10˚C and oxygen between 110-115%.

We have decided to capture wild fish for egg production only during the spawning season (3-4 months) and rid thereafter, to minimize the chance of disease transmission that is likely from wild fish/stress in the facility.

We continue to maintain 490 of the largest of the 2015 YC cultured lumpfish juveniles to use as broodstock (based entirely on size/maturity at this point). They are currently being held in one 25m^3 tank and are being fed pelleted food (Skretting grower diet Europa 18- 6mm pellet – 50% protein and 18 % lipid), have been placed on an ambient photoperiod and are held at a temperature range of 6-10°C.

4.2.2 2016 Wild Stock

The newly (48) collected lumpfish broodstock (Table 2) broodstock are held in one 45m^3 tank with the water temperature being maintained between 8-10˚C and oxygen between 110-115%. Overall health of the wild collected lumpfish on arrival was great (Figure 12 & 13). There were no visible signs of external parasites and overall body condition was good.

Table 2: Lumpfish Broodstock collected 2016 season

Date	Species Collected	Location
June 6, 2016	24 Females & 2 Males	Witless Bay
June 24, 2016	22 Females	Champney's West

The size of the newly collected lumpfish ranged from a 402 gram male (Figure 12) to 4.893 kg females (Figure 13). Sex determination was easy for some females with swollen abdomens and males with distinct coloration.

Figure 12: Male lumpfish broodstock showing temporary sexual dichromaticism ready for spawning.

Figure 13: Female Lumpfish broodstock collected from Champney's West.

4.3 A3 - Broodstock Spawning , Post Capture and Spawning Mortality, and Photo-Period Manipulation.

4.3.1 Broodstock Spawning Success 2015

All newly collected broodstock were held in one 25m^3 ton tank with various hides and rocks. As indicated in the proposal, we have found via literature search, 2014 season here at JBARB and speaking with peoples at other facilities in the UK that two females and one male lumpfish are acceptable ratios during the spawning season in a single small tank (Figure 14). We did evaluate this in 2014 within a tank situation, however over multiple spawning times the eggs have not been fertilized. This may have been due to the fact that the males were either immature or reluctant to spawn under current tank conditions.

Our initial plans were to move some of the newly collected lumpfish to individual tanks in 2015. However, after just a few days of acclimation in their new tank, the lumpfish began to spawn within the hides provided in the larger tank (Figure 15). Three litres of fertilized eggs were collected from this tank within days.

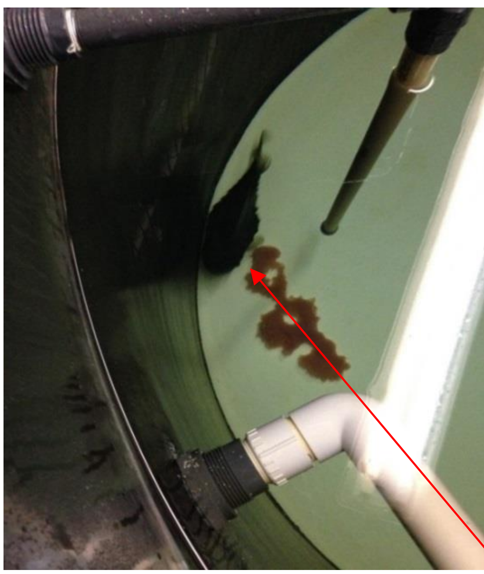


Figure 14: Lumpfish spawning in 3000L tank. Figure 15: Eggs released in shelters added in 25 ton tank and male guarding eggs inside hide.

Therefore, we decided to continue with the larger tank and monitor the quantity of eggs and fertilization/hatching success for the 2015 season.

- Post Capture and Spawning Mortality

100 % of all wild lumpfish broodstock captured in 2015, have since died or been culled due to poor condition. It appears that after spawning is complete or over a period of time in captivity, these larger mature fish just simply die. They are swimming and eating (moist) baits one day and thus dead the next. We have since decided to capture wild fish for egg production only during the spawning season (3-4 months) and rid thereafter, to minimize the chance of disease transmission that is likely from wild fish/stress in the facility. This is in keeping with other facilities globally.

The newest strategy is to retain and grow-out some of the medium to largest of the 2015 YC. Therefore, 500 lumpfish juveniles are being held (2015-2016 season) as potential broodstock (based entirely on size/maturity at this point).

In 2016 due to the size of the 2015 YC fish, lumpfish numbers have been reduced to 80 fish post 2016 season spawning season. Some of the 2015 YC broodstock were also used as parents in 2016 season as well for continued future broodstock. They are currently being held in 1- 25m^3 tanks and are being fed pelleted food (Skretting grower diet Europa 18- 4mm pellet – 50% protein and 18 % lipid), have been placed on an ambient photoperiod and water temperature is being held at 6-10°C seasonally.

We will also evaluate manual stripping techniques and SOP's for the 2016 season of wild broodstock- refer to section 4.3.2 below.

- Photo-Period Manipulation

The spawning cycle for wild lumpfish here in NL is June/July. The eggs hatch in late July or early August (temperature dependent) and thus by the time industry are ready to use the cultured juveniles / cleaners at the farm level for sea lice issues they are anywhere between 30-250 grams. These fish have been in the hatchery for 9 months (September to May for larval and juvenile) and thus this is too long in the nursery, very costly and the fish are larger than necessary. Industry requires juveniles at 20-30 grams for deployment after about 6 months in the hatchery. Therefore, we need to photo delay broodstock for the time frame/season indicated above. We are also trying a strategy of keeping the juveniles at low temperatures (2-4°C) during the latter grow-out stages- section 4.5.2.

We have been successful in the past with photo-period manipulation of cod, cunners etc., but have never attempted this with lumpfish. We aim to photo delay some of the 2015 domesticated cultured juvenile lumpfish when they begin to mature in 2017 and thus monitor success through spawning and egg evaluation trials (quality and hatch rates).

4.3.2 Broodstock Spawning Success 2016

Lumpfish

During the 2016 spawning season, the wild parents- cultured domesticated lumpfish began releasing eggs passively into the tank in early April. These batches of eggs were either not fertilized or had variable fertilization rates. In an attempt to increase fertilization rates we began strip spawning these broodstock on May 20th. Strip spawning proved to be quite successful in that we were able to obtain good batch sizes and fertilization rates were consistently high. Up to June 8, 2016 we have strip spawned 20 females (Figure 16) and 11 males (Figure 17) and created 20 different crosses (Table 3) from these fish We have also stripped eggs from one 2016 wild captured female and created a hybrid cross using milt from a cultured male.

Figure 16: Stripping and weighing lumpfish broodstock eggs.

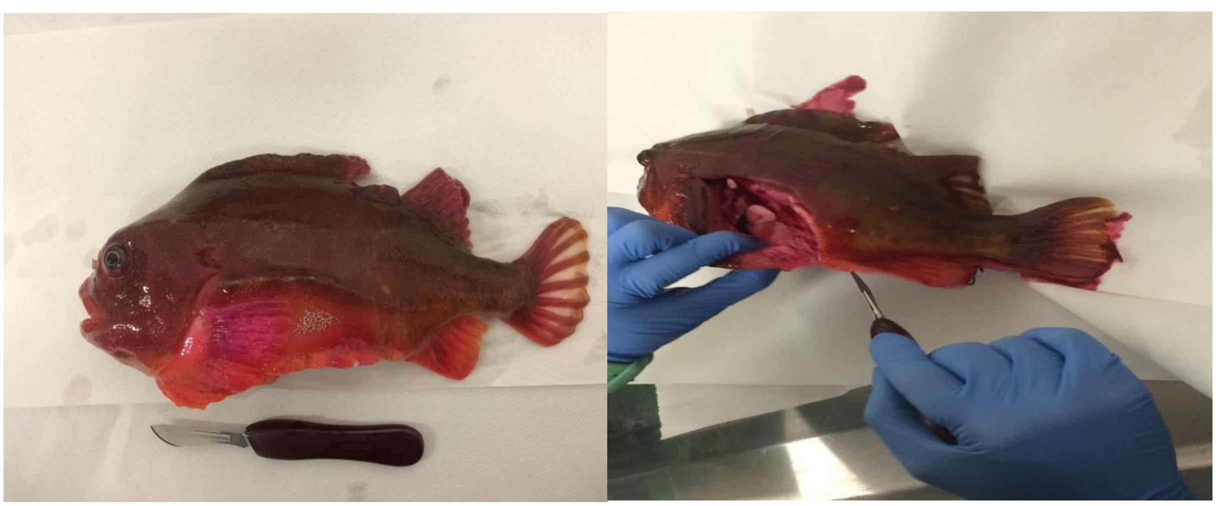


Figure 17: Harvesting gonad for milt from cultured domesticated lumpfish.

Table 3: Crosses to date from F1 generation strip spawned wild cultured lumpfish broodstock.

Date	Female #/ weight	Male #/ weight	Egg Weight (g)	Milt/Gonad Weight (g)
May 4, 2016	1	1 (744g)	219	15
May 13, 2016	2	2		
May 13, 2016	3	2		
May 19, 2016	4	3 (619g)		
May 19, 2016	5	3		
May 19, 2016	6	3		
May 20, 2016	7	4 (450g)		
May 21, 2016	8 (1700g)	5 (590g)		
May 22, 2016	9 (1820g)	5		
May 25, 2016	10 (2393g)	6 (618g) & 7 (497g)	310	11
May 26, 2016	11 (2000g)	7 (497g)& 8 (403g)	225	8
May 26, 2016	12 (1434g)	8 (403g)	285	7
May 26, 2016	13 (1298g)	8 (403g)	141	7
May 27, 2016	14 (1854g)	9 (525g)	135	3
May 29, 2016	15 (2048g)	9 (525g)	278	10
June 2, 2016	16 (1798g)	10 (505g)	230	3
June 2, 2016	Wild	10 (505g)	197	3
June 3, 2016	17 (1290g)	10 (505g)	234	4
June 3, 2016	18 (1888g)	10 (505g)	100	4
June 8, 2016	19 (1625g)	11 (460g)	205	6
June 8, 2016	20 (1460g)	11 (460g)	214	6

In order to obtain a milt sample from male lumpfish the gonad has to be harvested as a result it is necessary to sacrifice the male (Figure 17-18). Once a milt sample is obtained we are currently examining the possibility of extending the shelf life of the milt sample by using a product called Aquaboost-Spermcoat from Canada Cryogenetics Services.

Maureen Ritter, Managing Director **Canada Cryogenetics Services**. mobile 250-203-0333
Maureen.Ritter@cryogenetics.com. www.cryogenetics.com
Canada Cryogenetics Services is a Canadian Registered Company

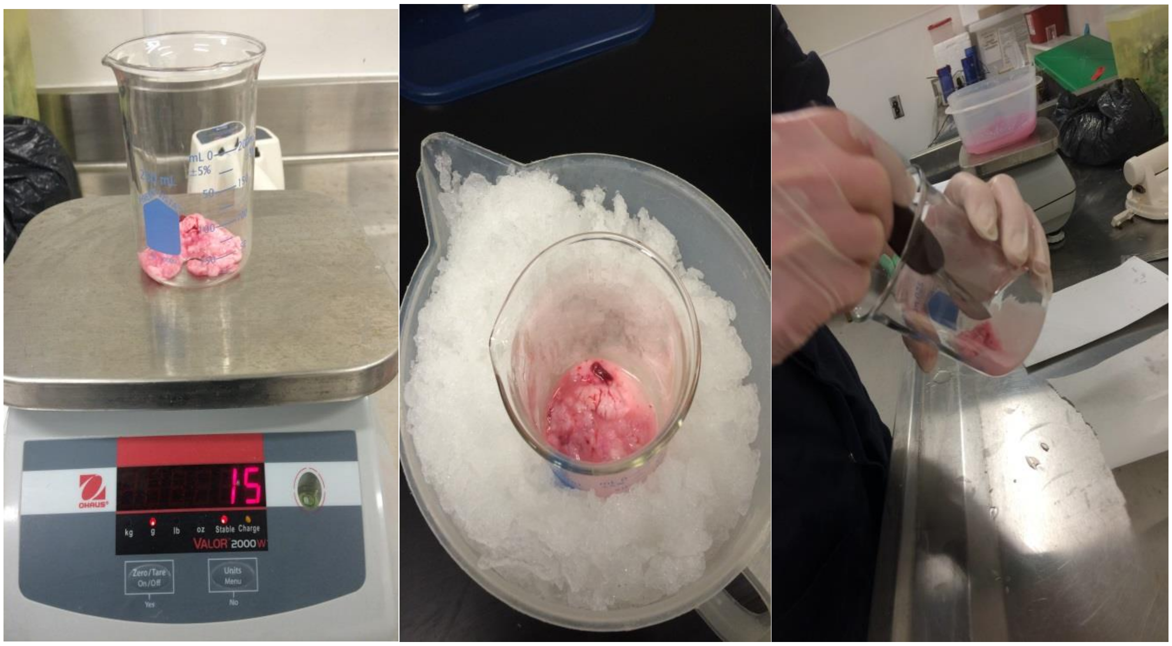


Figure 18: Gonad collected from male lumpfish and milt being extracted from testis.

The current protocol that is being used to strip spawn the cultured domesticated broodstock has been to check each female daily and assess “ripeness” (Figure 19). If a female is ripe then eggs are stripped using a gentle stroking motion (Figure 16). Once eggs are collected they are weighed and dry fertilized using milt collected lethally from running males (Figure 17). Once the milt is added to the eggs, it is mixed gently and placed in the refrigerator for approximately 25mins to enable fertilization. After removal from the refrigerator sea water is added to the eggs to enable them to water harden for a period of 15-30 minutes.

Fertilized eggs are then placed in an incubation basket/tray on a plastic grid (Figure 29a). This grid is used to enable the egg mass to form a single layer of eggs and is removed after 2-3 days once the mass has formed (Figure 29b). Fertilized eggs are monitored periodically throughout the incubation period to ensure they are developing properly (Figure 30)

Figure 19: Cultured domesticated female lumpfish broodstock waiting to be assessed for "ripeness"

- <u>Post Capture and Spawning Mortality</u>

100 % of all wild lumpfish broodstock captured in 2016 have been culled due to biosecurity risks.

In our program, we have decided to capture wild fish for egg production only during the spawning season (3-4 months) and rid thereafter, to minimize the chance of disease transmission that is likely from wild fish/stress in the facility. This is in keeping with other facilities globally.

The newest strategy is to retain and grow-out some of the medium to largest of the 2015 YC (80 fish). 500 lumpfish 2016 YC juveniles are also being held as broodstock (based entirely on size/maturity at this point). They are currently being held in $6m^3$ tanks and are being fed pelleted food (Skretting grower diet Europa 18- 2mm pellet – 50% protein and 18 % lipid), have been placed on an ambient photoperiod and water temperature is being held at 8-10°C seasonally.

We have evaluated manual stripping techniques and SOP's for the 2016 season of wild broodstock- refer to section 4.3.2. above.

4.4 A 4 - Egg Production –

4.4.1 2015 Season- Lumpfish Egg Production

As indicated in Table 1, on July 9th, 2015 we were successful in obtaining a wild egg mass from Bay Bulls, NL. The egg mass was pink in color upon arrival and continued to develop changing from pink to chocolate brown color just prior to hatch between 270 and 350 degree days. We can assume that these eggs were around 90 -100 degree days when they were collected.

On July 29/30, 2015 the captive broodstock released a large egg mass that weighed 3.0 kg. The egg mass was left in the broodstock tank and was being tended to by a male broodstock (Figure 15). The male broodstock adds funnel like depressions in the egg mass to ensure that eggs are getting oxygenated and there is good water flow/ distribution throughout the mass (Figure 20) to increase the success of hatch.


Figure 20: Lumpfish egg mass showing holes inserted by male broodstock to ensure mass was properly aerated

The wild and domesticated egg masses collected were incubated in baskets which were placed in 500L tanks (Figure 21). The tanks had a high water flow, high aeration and temperature was maintained at 9.5˚C. The egg mass is typically light pink in colour when it is first laid and as it develops the colour continuously darkens from pink, orange, grey, beige and finally a chocolate brown colour just prior to hatching. It is very difficult to tell if the eggs are fertilized early on as they are somewhat opaque in colour and it is difficult to see any signs of internal development. However, at approximately 100 degree days fertilized eggs usually become eyed (Figure 22) at this point you will know if they are fertilized for certain. Healthy egg masses tend to be firm to touch and are securely attached together (Figure 23).

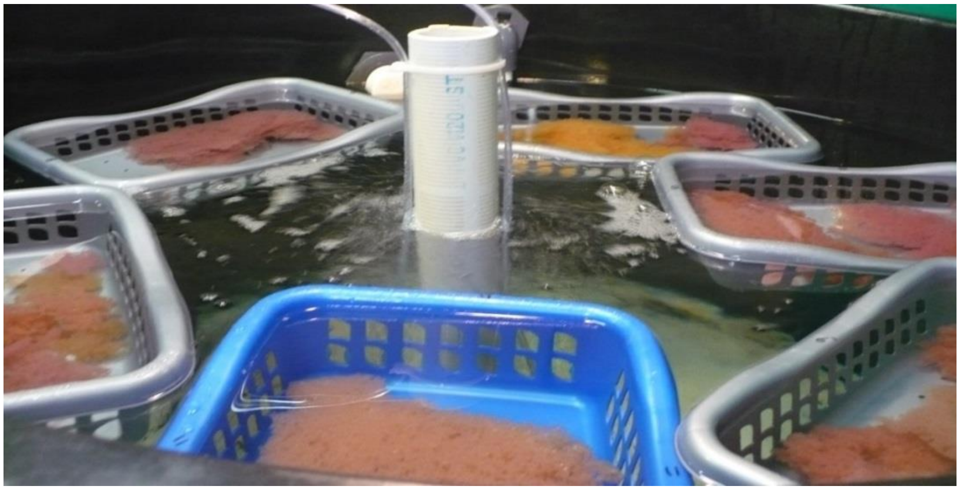


Figure 21: Baskets of eggs being incubated in a 500L tank.

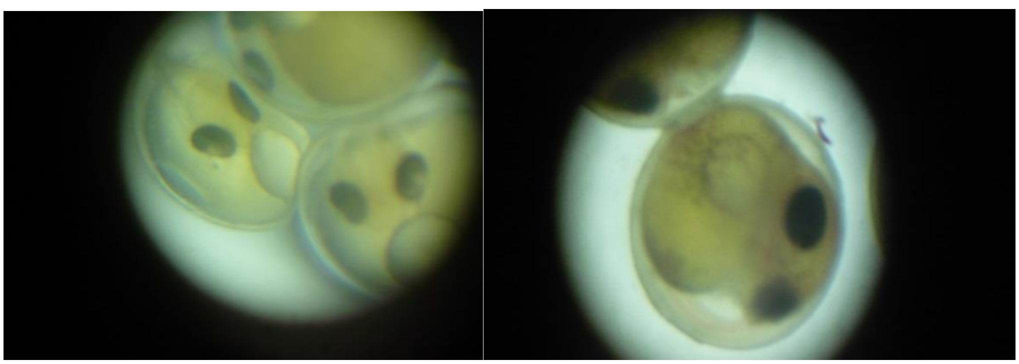


Figure 22: Eyed eggs as they are developing. Eggs on the left are 80 degree days in captivity and eggs on the right are 200 degree days in captivity.


Figure 23: Eyed lumpfish eggs at approximately 100 degree days and firm to the touch.

Between 270 and 350 degree days eggs masses will usually begin to hatch. At this stage of development, the baskets are removed from the incubation tank and placed in a clean tank to hatch. As the larvae begin hatching they are able to swim out through the hole in the basket directly into the larval tank (Figure 24).


Figure 24: Newly hatched lumpfish larvae swim.

4.4.2 2016 Season- Lumpfish Egg Production

As indicated in Table 3, section 4.3.1, we have obtained various batches of fertilized eggs from various broodstock fish. The wild captured broodstock that were collected in June (Table 2) began releasing fertilized egg batches directly into the tank (Figure 25a & 25b) on June 10, 2016 and as of June 30, 2016 released 12 egg masses weighing approximately 12.3 kilograms in total. There are approximately 100,000 eggs per kilogram of lumpfish eggs if they all hatched successfully.

Figure 25a: Egg mass released from wild captured broodstock directly in the holding tanks at JBARB. Egg mass has been laid in a rock nest and is being guarded by a male broodstock.

Figure 25b: Egg mass released from wild captured broodstock directly in the holding tanks at JBARB. Different egg colorations indicate different females spawned on the same day.

Viable egg masses passively released in the broodstock tanks are usually guarded and tended to by a male broodstock. The male broodstock will poke holes in the egg mass to ensure that all eggs are getting properly oxygenated and also ensuring sufficient water flow throughout the mass (Figure 20).

Strip spawned fertilized eggs (smaller quantities) are placed in an incubation basket/tray on a plastic grid (Figure 26a). This grid is used to enable the egg mass to form a single layer of eggs and is removed after 2-3 days once the mass has formed (Figure 26b). Fertilized eggs are monitored periodically throughout the incubation period to ensure they are developing properly (Figure 27).

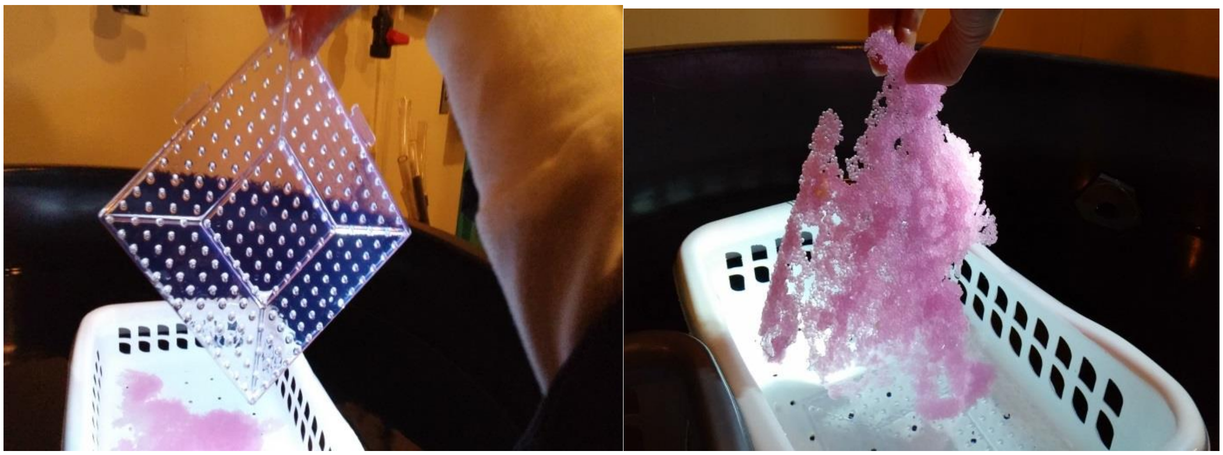


Figure 26a & 26b: Grid used to form single egg layer mass of strip spawned, fertilized lumpfish eggs.

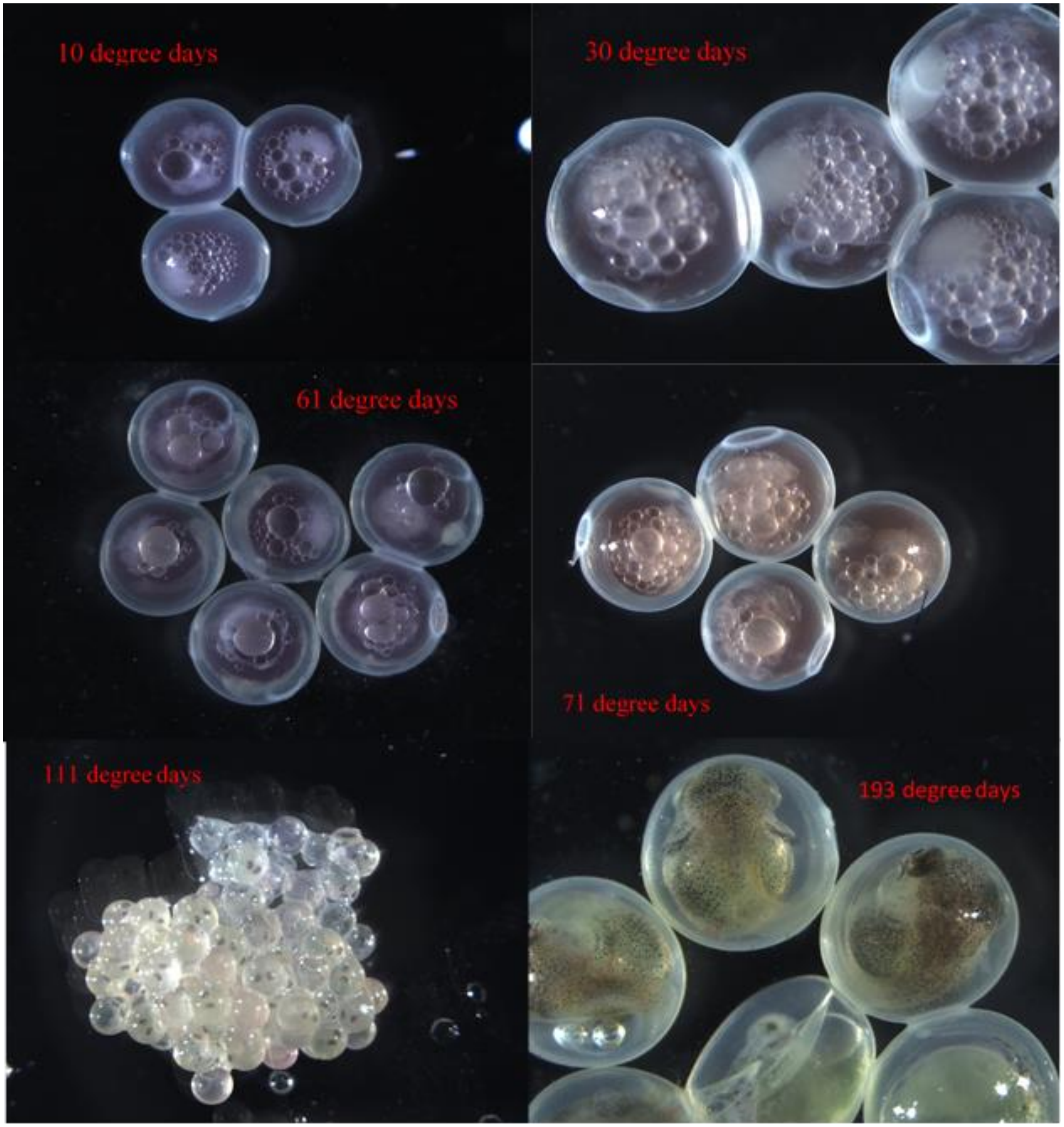


Figure 27: Developing lumpfish eggs

All wild and strip spanwed fertilized egg masses are incubated in baskets placed in 500L tanks (Figure 28) in the first feeding room or in modified baskets (Figure 29) placed in 50 or 250L incubators in the hatchery. The tanks had a high water flow, low aeration and temperature was maintained at 10-10.5 degrees. Egg masses are typically light pink in colour when they are first laid and as they develops the colour continuously darkens from pink, orange, grey, beige and finally a chocolate brown colour just prior to hatching.


Figure 28: Baskets of eggs being incubated in a 500L tank.


Figure 29: Basket of strip spawned eggs incubated in a 250 liter incubator.

4.5 Other notable work:

4.5.1 Juvenile Lumpfish Production

We have maintained 80 - 2015 YC lumpfish broodstock and 500 2016 YC lumpfish juveniles for future broodstock. They 2015 YC are currently being held in 1- 25m^3 tanks and are being fed pelleted food (Skretting grower diet Europa 18- 4&6 mm pellet respectively – 50% protein and 18 % lipid), have been placed on an ambient photoperiod and water temperature is being held at 6-10°C seasonally. The 2016 YC juveniles are being held in 6m^3 tanks and held at 8-10°C seasonally.

During the early larval stages lumpfish larvae do not swim frequently and seem to prefer to attach to a surface for the majority of the time (Figure 30). They will detach and swim freely only while foraging for food. As the larvae began to grow surface area in the tanks becomes limited with all fish trying to attach to the tank wall. To remedy this situation, black plastic sheets are suspended in the tanks and the larvae are able to attach to both sides (Figure 31). This space limitation only seems to be a factor until the larvae reach approximately 5.0 grams in size. At this point they seem to adopt a free swimming lifestyle and are continuously swimming throughout the water column (Figure 32). Larval lumpfish become aggressive and cannibalistic once they reach approximately two grams. Growth is monitored on these fish biweekly (Figures 33 & 34) and feed amounts adjusted accordingly. Once they reach 2 grams average weight they must be graded using a box type graders (Figure 35) to minimize mortality. This behaviour seems to recur whenever the size range in a particular tank gets too large and as a result these fish have to be size graded every 2-3 weeks initially and this gradually slows to 4-6 weeks as the size differences in the tanks become less pronounced. During grading the fish are divided into a small, medium and large size grade.

Figure 30: Lumpfish juveniles attached to inlet pipes and tank walls.


Figure 31: Lumpfish juveniles attached to plastic sheets suspended in the water column of the tank.


Figure 32: Lumpfish juveniles free swimming in the tank.

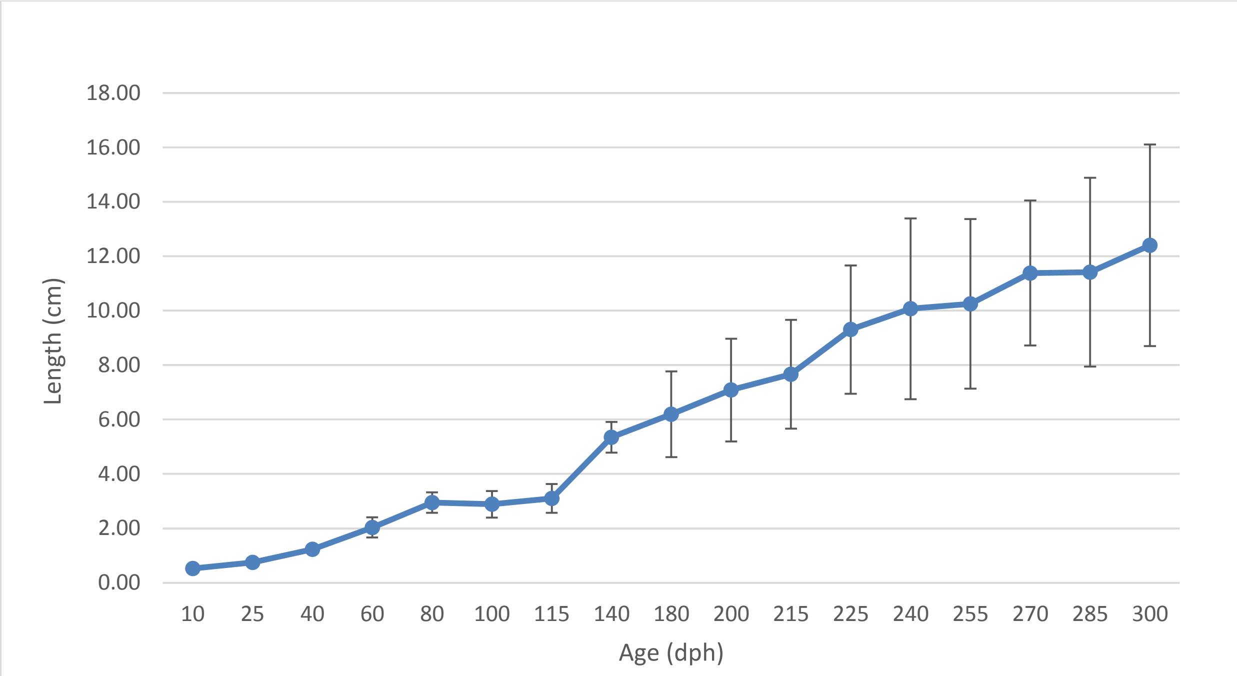


Figure 33: Average length (cm) of 2015 year class lumpfish.

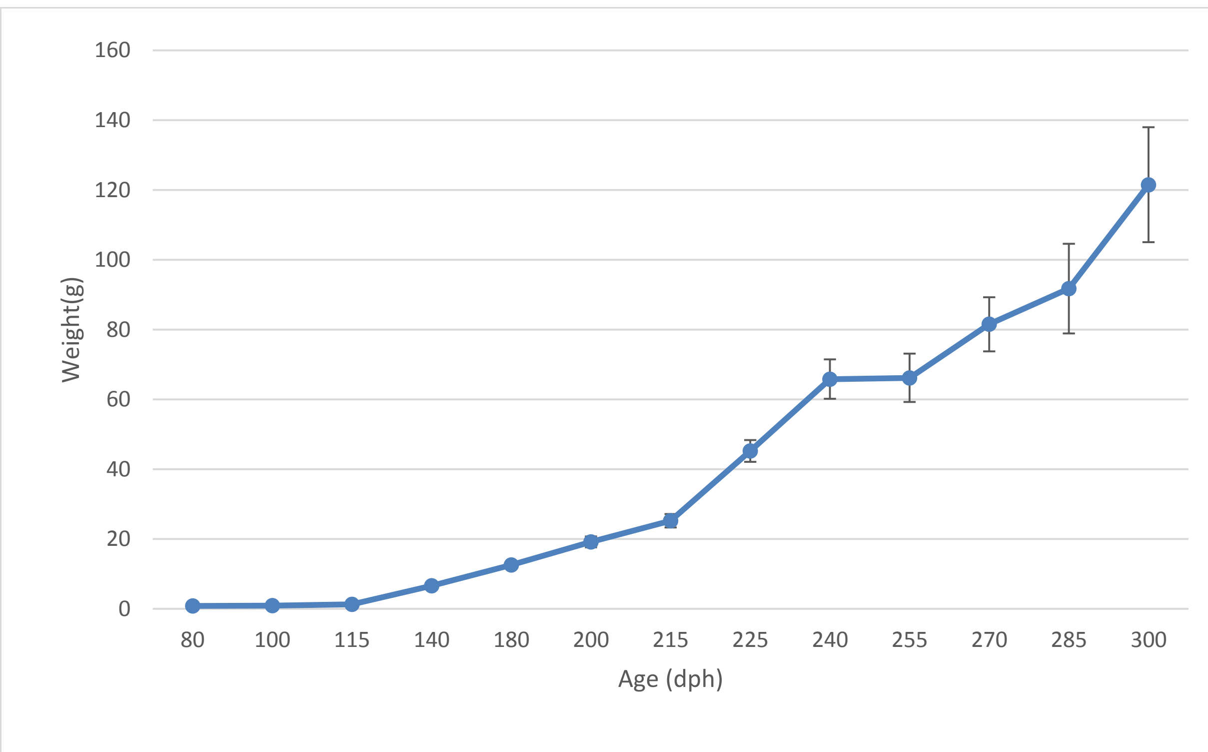


Figure 34: Average weight (g) ±standard error of 2015 year class lumpfish

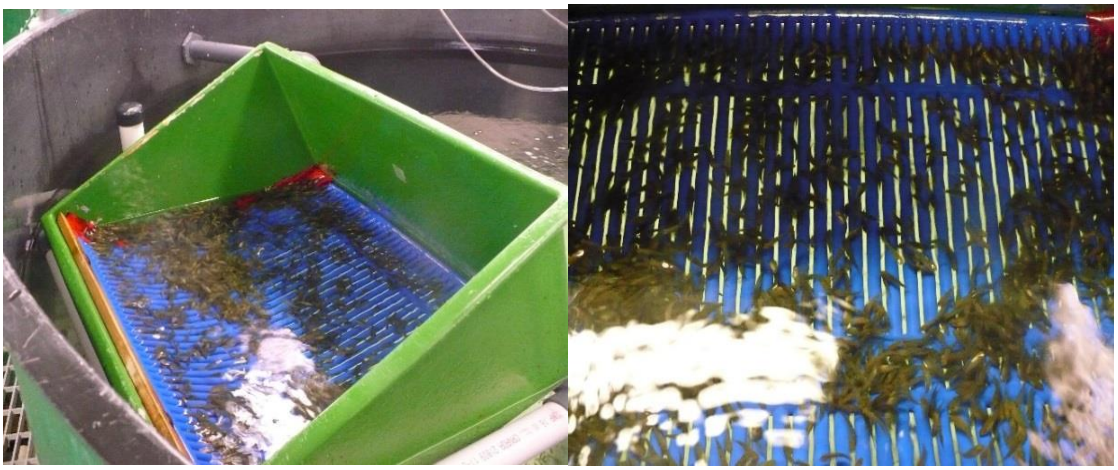


Figure 35: Box type graders used to size grade lumpfish larvae and juveniles.

Growth rate of the juvenile lumpfish (September 30, 2016 is Day 100) is monitored biweekly (Figures 36 & 37) to enable feeding rates to be adjusted as needed and to help determine when grading is necessary.

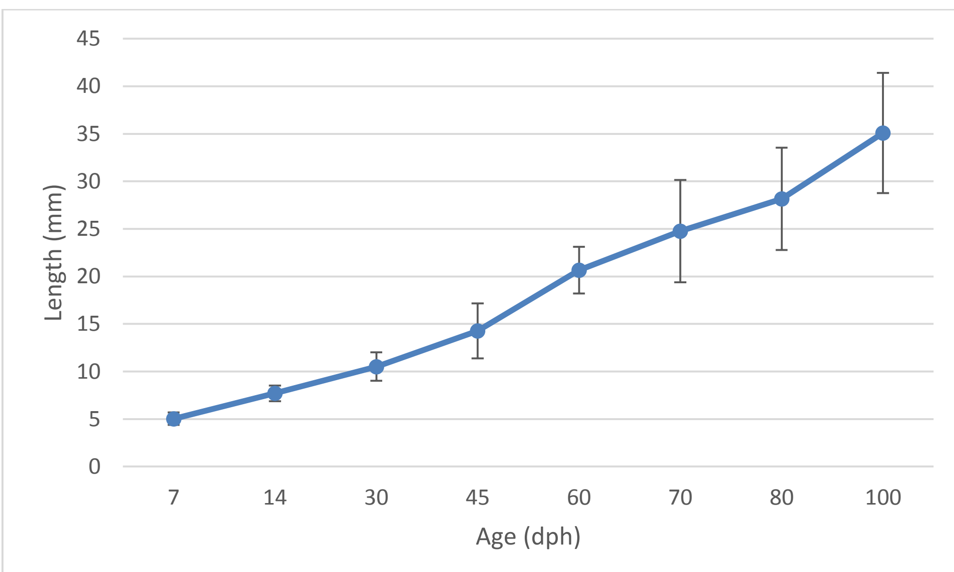


Figure 36: Average length (mm) ± S.D. of 2016 Year class lumpfish.

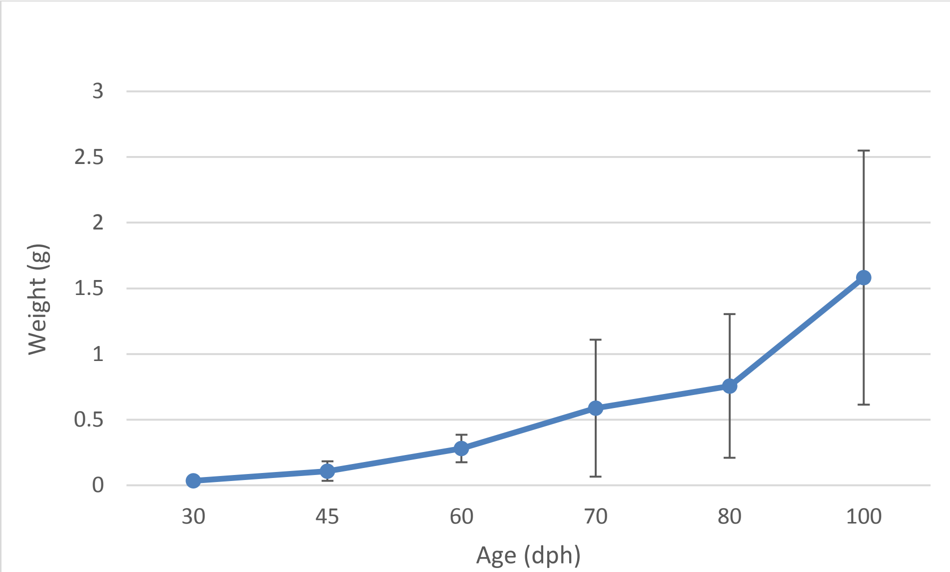


Figure 37: Average weight (g) of 2016 year class lumpfish.

Growth rate (Day 270 is March 31, 2017) of the juvenile lumpfish is monitored biweekly (Figures 38 & 39 to enable feeding rates to be adjusted as needed and to help determine when grading is necessary. It is also beneficial to compare growth rates performances from each year (Figure 40). Our 2016 year class of lumpfish juvenile in terms of growth is on par with 2014-2015 YC (Figure 40).

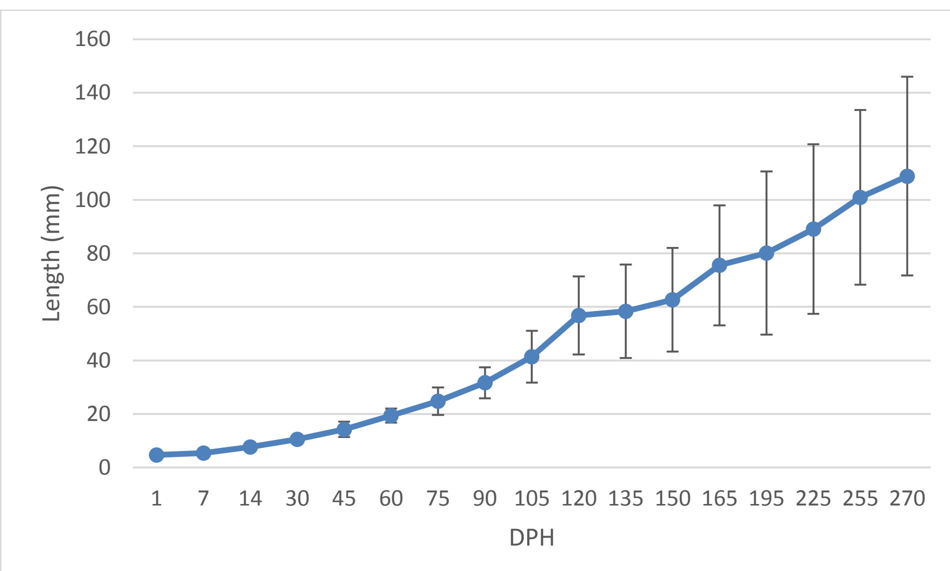


Figure 38: Average length (mm) ± S.D. of 2016 Year class lumpfish.

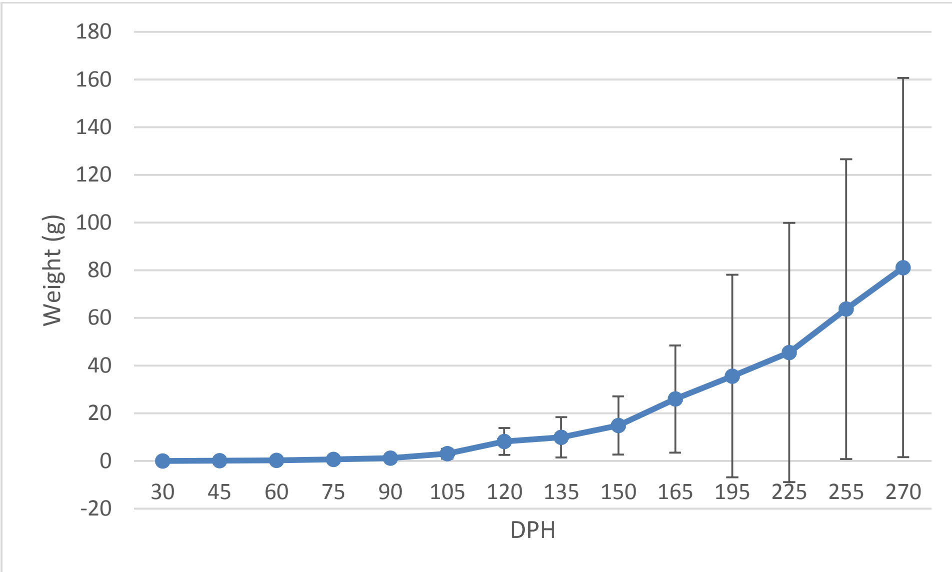


Figure 39: Average weight (g) of 2016 year class lumpfish.

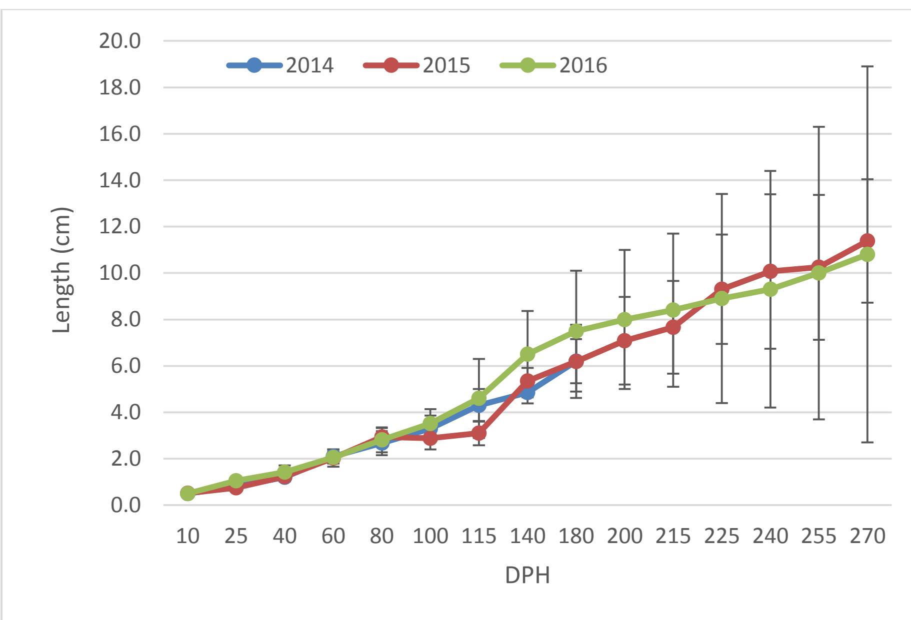


Figure 40: Growth rates of three different year class juvenile lumpfish.

4.5.2 Lumpfish On-Growing Temperature Trials

Lumpfish juveniles have a very high growth rate and as a result can very quickly exceed optimum stocking densities in available on-growing tanks. Therefore, space can be a limiting factor with the holding capacity of juveniles in a nursery.

A constraint that has to be dealt with here is the fact that our lumpfish broodstock typically spawn in late spring-early summer, with optimum time to transfer these cleaner fish to the sea cage being the spring of the year. This means that juvenile lumpfish will go through a ten month growth period in holding tanks prior to transfer. As a result, these fish are often larger (80-120 gram) than the size considered for use (20-30 gram). In an attempt to deal with this issue we conducted two temperature trials throughout the winter of 2015/2016 using lumpfish juveniles from the 2015 year class season to determine if it was possible to stop or slow the juvenile growth through the winter months by a reduction in water temperature without compromising health. The reduction in water temperature (energy) and feed cost lowers the cost per unit of individual lumpfish.

4.5.2.1 Lumpfish 4°C vs 8°C

The first trial ran for 90 days in duration, beginning on December 21, 2015. Four tanks were stocked with 200 lumpfish juveniles with an initial average weight of 2.9 ± 1.8g. Two tanks of fish were held at 4°C, and two tanks of fish were held at 8°C. Each tank was fed 1% body weight per day using a belt feeder. Throughout the trial 10 fish were weighed and measured monthly from each tank (20 per treatment) with 25 fish per tank weight sampled at the end of the trial (Figures 41).

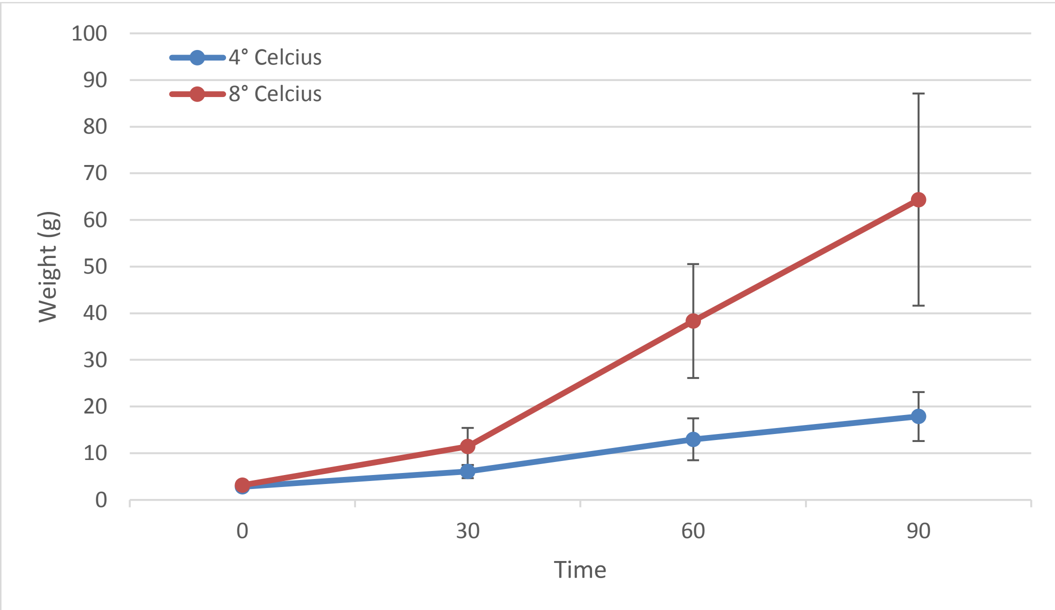


Figure 41: Average weights ± standard deviation of lumpfish juveniles reared for a period of 90 days at two different temperatures.

Results show that the growth of the juvenile lumpfish was lower in the tanks maintained at 4°C versus 8°C. At the end of the trial, juveniles weighed 64.3g and 17.9 g respectively. Fish health was not compromised.

4.5.2.2 Lumpfish 2°C vs 4°C

The second trial ran for 28 days in duration. Four tanks were stocked with 150 lumpfish juveniles with an initial average weight of 20.5 ± 11g. Two tanks of lumpfish were held at 2-3°C, and two tanks of lumpfish were held at 4-6°C. Each tank was fed 1% body weight per day daily using a belt feeder. Throughout the trial 10 fish from each tank (20 per treatment) were weighed and measured biweekly with 15 fish weight sampled at the end of the trial (Figure 42).

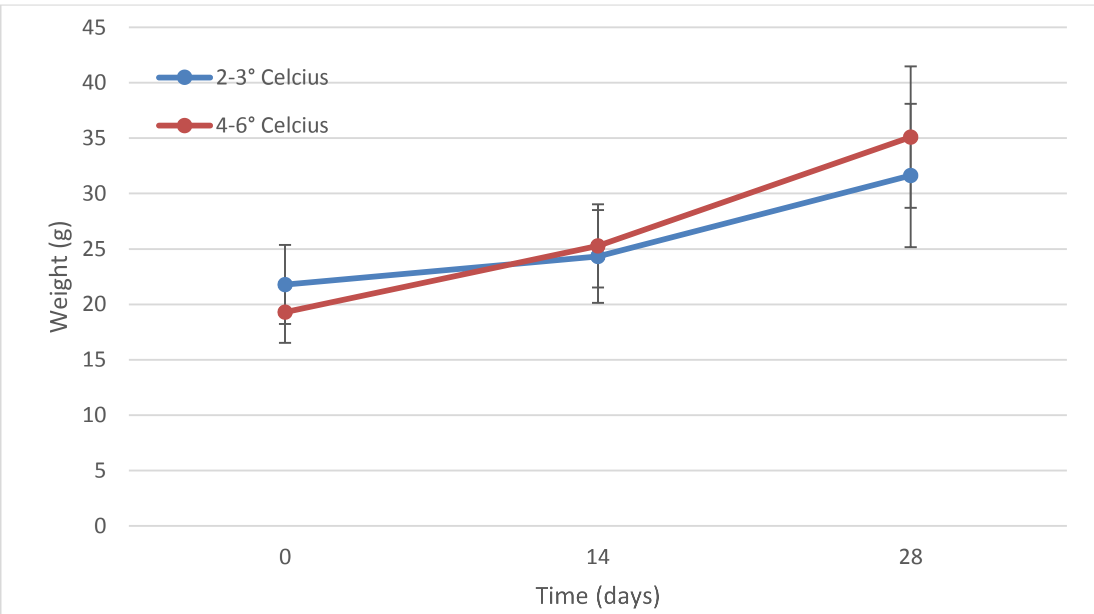


Figure 42: Average weights ± standard deviation of lumpfish juveniles reared for a period of 28 days at two different temperatures- 2-3°C vs 4-6°C

At the end of this 28 day trial the fish weighed 31.6 and 35.1 grams respectively. A difference of 3.5 grams over a 28 day period in growth was not significant. We plan to do a similar trial next season with 2 gram fish at these temperatures.

From these trials, it was determined that by lowering the water temperature we are able to reduce the growth of the juvenile lumpfish, considerably through the winter months. We are able to reduce/ slow the growth by holding fish at a water temperature of 4°C. Reducing the temperature further to 2°C, does not appear to provide the same decrease in growth rate which is understandable. The reduction in water temperature (energy) and feed cost lowers the cost per unit of individual lumpfish.

NEWFOUNDLAND & LABRADOR, CANADA

MEMORIAL UNIVERSITY

GRIEG NL

"Rognkjeks / Lumpfish Broodstock Collection, Domestication and Spawning Techniques."

5.0 Highlights

- Industrial Partnership. This project –is a collaborative partnership between Memorial University of Newfoundland's Ocean Sciences Centre (OSC) and GRIEG NL SEAFARMS LTD., a subsidiary company of Grieg Seafood ASA.

- This project is in alignment with the industry priorities for the Atlantic region as well as in alignment with GRIEG NL SEAFARMS LTD. approach to integrated pest management. This work is allowing us to increase our knowledge and production for cleaner fish –(lumpfish) and make significant advances towards this species becoming an important tool to use towards "Pest Management" strategies in our salmon farms in the Newfoundland region.

- Lumpfish is a relatively new addition in the "cleaner fish" family and knowledge of broodstock biology, domestication and spawning use is somewhat limited and based on the experiences so far. Further refinement includes broodstock collection, broodstock maintenance, artificial hide designs in tanks for spawning, egg incubation and larval techniques.

- Continuing with Fish Health Surveillance Program and data being collected through the continuation of the active and passive surveillance program with routine diagnostic testing at JBARB.

- Further refinement in transport broodstock protocols - land (short hauls).

- Increased Networking – National Cold Water Marine Aquaculture Center- USDA in USA, Weymouth Hatchery in UK, Skretting Aquaculture Research Centre in Norway, , NOFIMA- Norway, Benchmark - Fish Vet Group Maine, University of Iceland, Faroes Islands and Ireland - Marine Harvest, University of Ireland- CARNA and DFA NL and NAIA, Benchmark) Stofnifiskur in Iceland, Grieg Seafood ASA.

- Identifying lumpfish collection sites (through local fishers) and developing the optimal techniques for collection, domestication and spawning evaluation of lumpfish is in the best interest of Grieg NL's business model for successful salmon farming. We have identified a network of fisher people in rural areas for collection of lumpfish broodstock and OSC divers for egg collections. We have also been developing a new technique for holding lumpfish broodstock at sea for short periods of time.

- The JBARB will continue to offer GRIEG NL SEAFARMS LTD its support for research and development activities during the initial start-up and during their production phases. Grieg will also duplicate this service by supporting our students through research activities and employment opportunities for graduates of Memorial. Over the two year period, students through various programs and courses (OSSC 2001, 3000, Aquaculture program-IRO's, work-terms, MUCEPs) will have access to broodstock, eggs and larvae to full fill their program requirements.

- Photos

Grieg NL Company Signs in Marystown



Industrial Park in Marystown- Kaetlyn Osmond Drive.

Employment Session


Employment Session Line-up, Marystown October 2016.10.17.
Over 1000 people attended.

Meet the Ambassador- Visit to the Ocean Sciences Centre
Holding a Cleaner Fish

H.E. Anne Kari Hansen Ovind - Norway's Ambassador to Canada.
The Royal Norwegian Embassy in Ottawa
150 Metcalfe Street Suite 1300, Ottawa, Ontario K2P 1P1**Tel:** 613-238-6571 / (+47) 23 95 28 00
Fax: 613-238-2765 **E-mail:** emb.ottawa@mfa.no

6.0 Cleaner Fish Networking, Local, National and International Collaborations

Aquatic Animal Health and Integrated Pest Management Session at the 2016 AAC St. John's, NL, Canada.
Cleaner Fish

Session Chairs: Mr. Danny Boyce, Dr. Jillian Westcott and Dr. Mark Fast.

SESSION: AQUATIC ANIMAL HEALTH AND INTEGRATED PEST MANAGEMENT
Aquatic animal health management is vital to the sustainability of aquaculture operations. Disease and pests of finfish, molluscs and crustaceans are managed in part through the implementation of sound biosecurity measures which act to minimize the risk of introduction and spread of disease into or between aquatic animal populations. Disease surveillance and a broad

range of existing and newly developed technologies related to disease prevention and control are also employed.

Integrated Pest Management (IPM) is a broad-based scientific approach that integrates a combination of chemical and biological practices for economic control of pests. Industry managers, aquaculturists, academia and government continue to work in partnership to develop the elements of an IPM program for sea lice management and control in Canada. The key elements of an IPM program are prevention, monitoring and intervention. Cleaner fish, such as cunners and lumpfish, is an example of an innovative and eco-friendly tool for the mitigation and control of sea lice on Atlantic salmon.

The focus of the first half of this session was on IPM strategies (**Cleaner Fish**) for sea lice control on Atlantic salmon. The second half of the session focused on animal health issues affecting finfish, molluscs and crustaceans cultured in Canada. Presentations were welcomed from those offering an international perspective related to either topic.

This session was divided into two days:

DAY ONE: ***Cleaner Fish- Session (Chairs: Dr. Jillian Westcott and Mr. Danny Boyce)***

The Cleaner Fish session had representatives from Iceland, Norway, Ireland, UK, USA and Canada. The session had representatives from private industry and Academic Institutions (Industry - Cooke Aquaculture, StofnFiskur – Benchmark Iceland, Zoetis- Pharmaq Norway, Canada Cryogenetics Services-Canada, Skretting Group-Marine Hatchery Feeds Norway, Dorset Cleaner Fish UK; Academic Institutions Memorial University- Ocean Sciences Centre, USDA National Cold Water Marine Aquaculture Centre, University of Galway-CARNA, University of Swansea and NOFIMA- Norwegian Institute of Food, Fisheries and Aquaculture.

Prior to the conference, all cleaner fish speakers had an opportunity to attend a tour of The Department of Ocean Sciences (refer to pictures below). This gave representatives an opportunity to meet each other and MUN personnel, discuss their programs, view first-hand the cleaner fish R&D activities ongoing at Memorial and its showcase its research capacity. Some companies gave presentations to OSC community as well prior to the conference.

NOFIMA Scientist: Dr. Atle Mortensen, Dr. V. Puvanendran, Dr. Oyuind Hansen and Mr. Danny Boyce standing outside Ocean Sciences Centre.

Cleaner Fish Tour: Session Speakers visiting The Ocean Sciences Centre prior to conference. Paul Howes, Swansea University Wales; Richard Prickett-RSP Services, UK; Nils Steine-Zoetis, Pharmaq Norway; Majbritt Bolton-Warberg- National University of Ireland Galway; Mike Pietrak- USDA ARS National Cold Water Marine Aquaculture Center; Solvi Sturluson-StofnFiskur, Iceland; Maureen Ritter Cryogenetics Canada.

Cleaner Fish Tour: Session speakers visiting The Ocean Sciences Centre prior to conference. Nick King- Fish Vet Group, Eamonn O'Brien and Martin Davidson- Skretting Marine Hatchery Feeds, Solvi Sturluson- StofnFiskur, Iceland.

Cleaner Fish Tour Group: Sturle Skeidsvoll-Norway, Dr. Rodrigue Yossa, Ph.D.Scientific Director – Aquaculture, Coastal Zones Research Institute, NB, Robin Clarke - Elanco, PEI, Dr. Thomas Ogilvie - Elanco PEI, Geoff McBriarty, Cleaner Fish Huntsman, Cooke Aquaculture NB.

The session was very well attended with between 150-200 people in attendance. The speakers of the session focused their presentations and discussions on areas of innovative methods and technology related to cleaner fish production, fish health and farm management.

The speakers identified that Sea Lice is #1 problem in Norway, Iceland, Ireland, Scotland & Canada.

Strategies for Sea Lice Removal are many:

- Integrated pest management
- Chemicals/Drugs
- Diets - Shield
- Non Biological controls (lasers, Ultrasound)
- Vaccines/Genetics
- Chemotherapy
- Natural Biological controls (Cleaner Fish, hot freshwater)

It was clearly demonstrated that Cleaner Fish is playing a pivotal role as a tool for Integrated Pest Management for the salmon industry globally.

Cleaner Fish Session: Day One

At the end of the day one cleaner fish session, a networking session was organized where all speakers gathered and 50 invited guests attended to further enhance the day's agenda. Subsequently, a cleaner lumpfish network was formalized which encompasses six cleaner fish producing countries. This network session was funded by Skretting Marine Hatchery Feeds, Zoetis- Pharmaq, Fish Vet Group and Memorial University.
This network will help foster innovation and technology transfer through academic and industry participation.


Networking reception - some speakers.

Research gaps identified for the cleaner fish program include, but not limited to the following:

- Cultured Broodstock Development and Year Round Egg Accessibility (Lumpfish)
- Broodstock Feed Development (Lumpfish)
- Fish Health and Vaccine Development (Lumpfish)
- Hatchery Production (Lumpfish)
- Farm Management Techniques (Cunners and Lumpfish)

The outcome was a Cleaner Fish Network group was formalized which represents both industry and academic from six different countries. This group has been very productive to date and have already begun sharing information from around the world on a daily to weekly basis on relevant topics. Meetings and site visits have since taken place in Norway for November 12-21, 2016 with Memorial-OSC, Cooke Aquaculture, Skretting Norway, Zoetis- Pharmaq Norway, Nofima and Akvaplan-niva.

Cleaner Fish Speaker Bios:

1) **Jennifer Monk**

Jennifer has a MSc. Aquaculture, Advanced Diploma in Aquaculture and a Bachelor of Science Major- Biology from Memorial University of Newfoundland. Jennifer has 14 years of experience in marine finfish production, specifically around R&D at Memorial.

2) Richard Prickett

Richard works with RSP Services and is a British citizen with 40 years experience in marine finfish aquaculture and has worked on a variety of projects world-wide including successful rearing of cod juveniles at the Ocean Sciences facilities at MUN, NL. In recent years, he has been working closely with the Norwegian and Scottish salmon producers in pioneering the culture of several species of cleaner fish for salmon lice particularly ballan wrasse (*Labrus bergylta*), goldsinny wrasse (*Ctenolabrus rupestris*) and Lumpfish, *Cyclopterus lumpus* .

3) Eamonn O'Brien

Eamonn is the International Product Manager Skretting Marine Hatchery Feeds. Established in 2006, Skeretting Marine Hatchery Feeds (MHF) has become the undisputed market leader in delivering specific products and services to marine fish and shrimp hatcheries. Skretting MHF unit combines local market knowledge, innovation and experience to deliver the highest quality products and services. MHF's product portfolio meets every aspect of the animals' early lifecycle, from feeds suited to the specific stages of conditioning, maturation, spawning and recovery of broodstock, through to green water application products, live feed components and early weaning, nursery, pre-ongrowing and transfer diets. MHF has made a name for itself by working together with clients and developing novel approaches to production bottlenecks.

4) Majbritt Bolton-Warberg

Majbritt is the senior post-doctoral researcher at Carna Research Station, National University of Ireland Galway. She completed her PhD in 2012, which focussed primarily on the development of farmed cod in Ireland (EIRCOD project). Her primary research interests include optimising larval rearing strategies, examination of the development of the larval and juvenile gut and growth and feeding in marine fish. Majbritt has been the project manager for lumpsucker production and research at CRS since 2014. In 2015, more than 100,000 lumpsucker were transferred to sea cages for use as cleaner fish in salmon cages from CRS. She maintains active links with industry and research groups on both a national and international level, recently receiving ICUF visiting researcher funding to visit with Canadian cleanerfish producers in Newfoundland and New Brunswick.

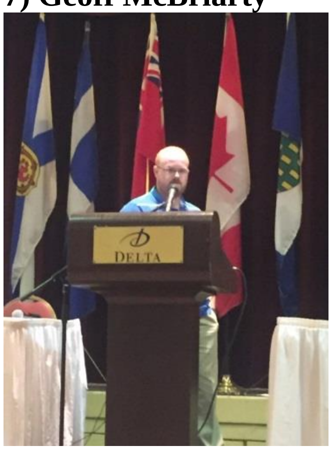
5) Solvi Sturluson

Solvi is the Staion Manager of a lumpfish hatchery in Hafnir, Iceland. Stofnfiskur is one of the world's leading companies in selective breeding and production. In 2014, Stofnfiskur became a part of Benchmark Breeding and Genetics (BBG), a leading international breeding company in developing, producing and selling salmon ova. In spring 2014 Stofnfiskur, in cooperation with the Marine Institute in Iceland, started commercial production of lumpfish juveniles. Based on their previous experience in marine species, the farming of lumpfish has been successful, delivering 2 million juveniles in the first year of operation. Production is carried out at StofnFiskurs dedicated lumpfish farm in Hafnir on the western Reykjanes peninsula of Iceland. The farm was initially constructed for the farming of Atlantic cod. During the past two years, the site has been rebuilt, modified and adapted to the needs of a lumpfish hatchery. Their short term goal is to deliver lumpfish fingerlings every week of the year to customers in the UK and the Faroe Islands. For the future, we are setting up a selective breeding program with the aim of developing a strain of lumpfish that is more resistant to disease, and better at cleaning lice.

6) Oyvind Hansen

Oyvind was educated and currently works as a Scientist at NOFIMA in Tromso, Norway. He has worked with cod aquaculture for almost 15 years, to years in a commercial hatchery and 13 years as a scientist for the national breeding program for cod in Norway. He has worked with severals species , cod, halibut, lemon sole, eel, turbot and the two last years with lumpsucker.

7) Geoff McBriarty



Geoff has an MSc in Biology in which the focus was on the effects of Slice (EB) on non-target invertebrates.He has been with the Kelly Cove Salmon/ Cooke Aquaculture on Cleaner Fish project now for 4 years in St. Andrews, NB. In Geoff's time there, they have managed to build the project into a successful operation with Cunner production and are working towards integrating lumpfish production as well. This year will also mark their first trials at an active NB production site with hatchery-reared Cunners and Lumpfish.

8) Paul Howes

Paul Howes is the manager of the Centre for Sustainable Aquatic Research at Swansea University in Wales UK. The centre is a hub for aquaculture research in Wales and acts as an important bridging mechanism between research, academia and industry. Currently the centre is involved in many projects including; a major contract with Marine Harvest to explore lumpfish production, husbandry and research. Additionally, the centre is involved in various genetics based projects, invasive species projects and animal welfare focused projects in a range of species. The centre also houses the largest algal research infrastructure of any higher education institution in the UK.

9) Velmerugu Puvanandran

Puvy completed his PhD at Memorial University back in the late 1990’s and currently works as a Scientist at NOFIMA in Tromso, Norway. He has worked with cod aquaculture for 25 years, and 10 years as a scientist for the national breeding program for cod in Norway. He has worked with several species and the two last years with lumpsucker.

10) Nils Steine:

Nils Steine is born in Bergen, Norway 1968. He is educated with an MSc in Aquaculture /fish health, in Norway an Authorized Fish Health Biologist. Nils has worked in the independent fish health services in Northern Norway in the late 90's and as Fish Health Manager for the production company Atlantic Salmon of Maine from 2000-2004. He moved to BC, and worked as fish health consultant, with emphasis on physiology /smolting, vaccines and fish health services, from 2004-2008. He then moved with the family to Stavanger Norway, and has worked with PHARMAQ since, serving as a technical and sales representative for Canada and parts of Norway.

11) **Mike Pietrak**

Mike started working with sea lice and the Maine aquaculture industry in 2000. He completed my masters at the University of Maine in 2002 and then went to work for the Maine Aquaculture Association. After serving as the project manager there for 6 years, he went back to the University of Maine for his PhD under Dr. Ian Bricknell examining the interactions of various fish pathogens in a mussel-salmon IMTA system. He then went on to a post doc at University of Maine looking at sea lice ecology and wild fish interactions in Cobscook Bay Maine. He is currently a research associate at the USDA ARS National Cold Water Marine Aquaculture Center. He is currently working on non-drug based control strategies for managing sea lice in the US salmon farming industry.

12) **Maureen Ritter**

Maureen is the Managing Director for Cryogenetics in Canada and is based out of BC, Canada. Cryogenetics offers services and technology for an effective fish reproduction. Cryopreservation is a powerful tool for preservation of genetic diversity in wild species and as an integral part of both commercial aquaculture and other fish breeding programs. Prior to joining Canada Cryogenetics in 2010, Maureen has worked with several Aquaculture Companies on the BC coast. Since starting with the industry in the early 1980's Maureen has seen the industry evolve from the mom and pop operations to the highly technical operations of today. With her background in hatchery management it was a natural fit to join the Cryogenetics team.

Appendix T

Grieg NL Emergency Response Plan

2018

Emergency Response Plan

Grieg NL

5/7/2018

Getting Immediate Help

*To Report an Emergency from the facility dial	911
Marystown Ambulance	(709) 279-2121
Marystown Fire Department	(709) 279-1333
Burin Peninsula Health Care Centre	(709) 891-1040
Marystown Police Station	(709) 279-3001
Poison Control (Newfoundland)	1-866-727-1110
* When utilizing 911, a follow-up call should be made to the appropriate key personnel using the numbers listed below.	

General Manager	(709) xxx-xxxx
Lead Veterinarian	(709) xxx-xxxx

Marine Emergencies

Search and Rescue	(709) 772-5151 or 1-800-563-2444
Canadian Coast Guard	(709) 772-4423
Environmental Emergencies (Marine Pollution Line)	1-800-563-9089 or VHF Channel 16
Emergency Response Organization (RO)	TBD
Navigational Hazards (Marine Communication and Transport Center), Placentia	709-227-2181 or 709-227-2182
Marine Mammal in Distress	1-888-895-3003
Poaching and Fisheries Violations	Crime Stoppers at 1-800-222-TIPS (8477) or 709-292-5161 (DFO Grand Falls)
Invasive Aquatic Species	1-888-435-4040

Fish Escape:

Department of Fisheries and Land	(709) 538-3725
Department of Fisheries and Oceans	(709) 772-0183 or (709) 772-3265

Emergency Evacuation Meeting Location: TBD

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Glossary

Accident. An unexpected event that results in loss or injury to a person and/or damage to property or the environment.

Dangerous Goods. Goods defined in section 2 of the *Transportation of Dangerous Goods Act* (Canada) and regulated in the federal regulations. Dangerous goods include explosives, compressed and liquefied gases, flammable and combustible materials, oxidizing materials and organic peroxides, poisonous and infectious substances, radioactive materials, corrosives, and miscellaneous dangerous goods.

Emergency. In the context of these guidelines, an accidental situation involving the release or imminent release of dangerous goods or other substances that could result in serious adverse effects on the health and/or safety of persons or the environment. An emergency may be the result of man-caused or natural occurrences such as, but not limited to, process upsets, uncontrolled reactions, fires, explosions, threats, structural failures, earthquakes, floods, and storms.

Emergency Response (Contingency) Plan. A detailed program of action to control and/or minimize the effects of an emergency requiring prompt corrective measures beyond normal procedures to protect human life, minimize injury, to optimize loss control, and to reduce the exposure of physical assets and the environment from an accident.

First Responder. Those individuals who respond upon being notified of an incident or pending threat. Grieg NL has determined that all potential threats will be communicated immediately to Senior management personnel. They will conduct an assessment and coordinate the level of activation after consultation with a Supervisor who will make the final determination of the level of response required.

Hazard. A situation or condition with the potential for human injury, damage to property, damage to the environment, or some combination thereof.

Level 1 Threat. A threat that minimally affects areas of life and safety, infrastructure, research, administrative operations, environment and/or reputation. Such threats would not require the establishment of an emergency operations center, nor the activation of an emergency response team. These threats are handled by administrative offices as part of normal day-to-day operations.

Level 2 Threat. A threat that substantially affects life and safety, infrastructure, research, administrative operations, environment and/or reputation. Such a threat will require full activation of the emergency center operations group, partial or full activation of emergency response team and could involve the establishment of an emergency operations center.

Level 3 Threat. A threat that critically affects life and safety, infrastructure, research, administrative operations, environment and/or reputation. Such a threat will require full activation of emergency response team and the establishment of an emergency operations center.

Risk. The chance of a specific undesired event occurring within a specified period or in specified circumstances. It may be either a frequency or a probability of a specific undesired event taking place.

Risk Analysis. The identification of undesired events that lead to the materialization of a hazard, the analysis of the mechanisms by which these undesired events could occur and, usually, the estimation of the extent, magnitude, and likelihood of any harmful effects.

Risk Assessment. The quantitative evaluation of the likelihood of undesired events and the likelihood of harm or damage being caused by them, together with the value judgments made concerning the significance of the results.

Risk Frequency. The number of occurrences per unit of time.

Risk Management. The program that embraces all administrative and operational programs that are designed to reduce the risk of emergencies involving hazardous or dangerous materials. Such programs include, but are not limited to, ensuring the design safety of new and existing equipment, standard operating procedures, preventive maintenance, operator training, accident investigation procedures, risk assessment for unit operations, emergency planning, and internal and external procedures to ensure that these programs are being executed as planned.

Spill. An unauthorized release or discharge of a dangerous substance into the environment.

Disclaimer

All individuals at the Grieg NL RAS Hatchery and sea cage sites are expected to adhere to the emergency procedures outlined in this plan. Refusal to evacuate a building/site or follow the direction of emergency first responders, for example, is unacceptable and may be cause for discipline.

Grieg NL

Emergency Response Plan

Document Number:

Rev. 00

Prepared by	
Department	
Title	
Name	
Signature	

Approved by	
Department	
Title	
Name	
Signature	

Document Revision Record

Issue Date	Revision No.	Prepared by	Approved by	Issue Purpose

This Grieg NL Emergency Response Plan is a living document that will be reviewed and updated prior to Project commencement and throughout the duration of the Project. This document should be read in the context of other, related plans, including the Grieg NL:

- *Spill Management Plan;*
- *Environmental Protection Plan;*
- *Waste Management Plan; and*
- *Fish Health Management Plan.*

1.0 Introduction

This Emergency Response Plan is designed to provide guidance in the event of an emergency and was developed to optimize Grieg NL's organizational awareness and responses. The procedures outlined in this document are intended to mitigate against possible injuries and/or environmental impacts should an emergency situation occur at Grieg NL's land-based Recirculating Aquaculture System (RAS) Hatchery or marine-based sea cage sites. This Grieg NL Emergency Response Plan is a living document that will be reviewed and updated prior to Project commencement and throughout the duration of the Project. This document should be read in the context of other related plans including the Grieg NL Spill Management Plan, Fish Health Management Plan, Waste Management Plan, and Environmental Protection Plan.

2.0 Purpose and Scope

2.1 Introduction

The purpose of this Emergency Response Plan is to prepare personnel for unexpected situations and reduce the negative effects of an emergency situation. The goal is to reduce the possible consequences of the emergency by:

- Preventing fatalities and injuries;
- Minimizing damage to property (buildings, stock, equipment) and the environment; and
- Accelerating the resumption of normal operations.

Emergency management in Canada is guided by the federal/provincial/territorial document published by Public Safety Canada entitled *An Emergency Management Framework for Canada*[1]. This framework describes the major components of emergency management, and recommends common definitions, principles and response models which many municipalities and organizations across Canada have adopted. The framework supports legal and policy frameworks, programs, activities, standards and other measures to enable and inspire all emergency management partners in Canada to work in better collaboration to keep Canadians safe.

Grieg NL has adopted many of these emergency management components and modified them to fit the aquaculture environment. This framework recommends four strategic pillars to consider in any emergency management planning process. These four pillars are defined under this framework as:

- **Preparedness** – to be ready to respond to a disaster and manage its consequences through measures taken prior to an event; for example, emergency response plans, mutual assistance agreements, resource inventories and training.
- **Prevention and Mitigation** – to eliminate or reduce the risks of disasters to protect lives, property and/or the environment.
- **Response** – to act in the event of an incident so as to manage its consequences. Response actions include emergency public communication, search and rescue, emergency medical assistance and evacuation.
- **Recovery** – to repair or restore conditions to an acceptable level following an incident (e.g., recapture of escaped fish).

[1] http://www.publicsafety.gc.ca/prg/em/_fl/emfrmwrk-2011- eng.pdf

3.0 Pre-Emergency Planning

Grieg NL will adopt seven generic principles to guide the implementation of and approach to emergency management preparedness:

1) **Collaboration:** Grieg NL will build consensus while providing strategic direction, facilitate strong communication practices for broadcasting of accurate information, create a team atmosphere, encourage trust, build consensus and delegate responsibility wherever appropriate.
2) **Co-ordination:** Grieg NL will strive to synchronize this plan with that of the applicable municipality and all applicable internal/external partners. This includes utilizing and sharing knowledge of notification systems, definitions and decision-making processes.
3) **Communication:** Grieg NL will develop an Emergency Communications Plan which will support preparedness, prevention/mitigation, response and recovery initiatives company-wide. It will prepare staff and stakeholders for potential emergencies, through an education and awareness campaign, and achieve timely communications during a response.
4) **Comprehensiveness:** Grieg NL will conduct an analysis of all hazards, including all phases of emergency management, and work with all stakeholders within the company for speedy mobilization of human and material resources when and wherever required.
5) **Flexibility:** Grieg NL will utilize existing emergency planning knowledge, be creative in delegating, cross training, and seconding employees outside of normal day-to-day responsibilities, and appoint key resource personnel as needed to committees.
6) **Integration:** Grieg NL will engage all levels of the company, and all staff will be asked for input; senior administrative support will be involved for scope of activity, approval, direction and approach.
7) **Progression:** Grieg NL will take measures to educate staff with respect to the contents of this plan and their responsibilities within the plan. We will ensure their knowledge of early assessments of situations which may pose threats, ensure prevention and mitigation strategies are in place where possible, and conduct exercises to test the plan with internal/external partners.

3.1 Prevention and Mitigation Strategies

Prevention/mitigation strategies will be incorporated and shared across many facets of Grieg NL in normal day-to-day management and planning activities. These strategies consist of operational elements which can control, prevent, or mitigate a potential threat/hazard. They could be in the form of staffing resources, facility access, health and safety protocol, fire/evacuation procedures and other related emergency procedures. Some of these strategies that are applicable to the Grieg NL facilities, vessels and marine sea cage sites include:

- Holding fire/spill/emergency drills at a minimum annually;

- Maintaining an updated list of all visitors;
- Applicable safety training for employees (e.g., First Aid, MED, and WHMIS);
- Updating fire procedures with the local fire department in all areas of the facility;
- Installation and operation of video surveillance system;
- Installation of alert/notification systems (security as well as operational processes);
- Communications systems and computing systems; and
- Acknowledgement of a well-established Health & Safety Committee.

3.2 Hazard Identification

Grieg NL recognizes that forecasting a potential emergency with a high degree of accuracy is difficult, if not impossible. Nevertheless, each workplace presents potential hazards that could result in an emergency. An assessment of workplaces and work activities can serve to identify and avoid potential hazards. Additionally, major external events can affect almost any workplace or activity and therefore it is essential to adopt an all-hazards approach. This approach will increase efficiency by recognizing and integrating common emergency management elements across all hazard types.

3.3 Risk Analysis

Emergency prevention/mitigation processes will require regular review and revision. Grieg NL will:

- Identify mitigation strategies that address the company's current capability to lessen the effect from potential emergencies and improve the response time. Table 1 outlines examples of risks and mitigation strategies; and
- Identify essential and time critical services which will need to be maintained.

3.4 Legislation

Grieg NL has reviewed and intends to follow guidelines and recommendations as developed by the Department of Municipal Affairs and Environment, Environment and Climate Change Canada, Transport Canada, Fisheries and Oceans Canada and the Canadian Coast Guard. Final building designs by architects will not be completed until the Project has been released from further Environmental Assessment. Once released, final building designs will be developed to meet Occupation Health and Safety requirements. These designs will also meet The Canada Labor Code for land-based structures (Buildings). All emergency plans, will meet the Occupation Health and Safety requirements and The Canada Labor Code for buildings. Not all suppliers for the marine-based vessels have been finalized. However, once finalized, Grieg NL will ensure that all regulations (Transport Canada fire and safety requirements for vessels) will be met.

Table 1. Risks and mitigations for Grieg NL RAS Hatchery and marine sea cage sites for Atlantic salmon.

Risk	Possible Causes	Preventative Action	Contingency Plan
Water quality impairment (RAS and Marine)	Contamination or pollution (spills of food, pesticides, chemicals, fuels, hazardous material or natural occurrences such as harmful algae blooms, parasites such as sea lice)	Water analyses will be conducted and monitored daily, weekly and monthly (parameter dependent) in addition to in-situ constant computer monitoring of core parameters. Physical and behaviour monitoring of fish for signs of stress, disease or illness.	An extensive Spill Management Plan has been developed to outline procedures and all staff will be familiar and trained. RAS: A desalination system followed by UV treatment will be installed as an emergency backup for freshwater wells Marine: containment booms maintained on site to isolate potential floating spills
Water quality (RAS) impairment	Biofilter failure	Biofilter is not one large unit but rather many small sections allowing the unit to continue to function should any section need replacement or repair (trickling filter)	A water by-pass enables the recirculation and oxygenation system to continue operation without passing through the biofilter should the biofilter need to be isolated for any reason.
Water supply (RAS) interruption	Pump failure	Pump maintenance will occur on a routine schedule to ensure optimum performance	The total system can operate multiple weeks without addition of new water using the internal usable water storage capacity which is 7 tank volumes in Smoltification Facility and 3 tank volumes in Post-Smolt Facility.
Water supply (RAS) interruption	Flooding/ water loss in system	Flooding from external sources is prevented with building floor elevation above surrounding land area. Flooding within from loss of water from a tank automatically drains into the pump sumps or into the waste treatment sump. The water is not lost from the system.	A main drain valve allowing water to flow into the waste treatment/denitrification is normally closed and open only during specific drain operations.
Salmon egg supply (RAS) compromised	Contamination	Only disease-free certified production facilities will be utilized as an egg supply source	Additional sources of triploid eggs (Salmobreed and AquaGen) are available should the need arise.
Salmon egg supply (RAS) delay	Delays or interruptions from supplier	Salmon egg shipments will be closely monitored to ensure a steady supply, if delays occur, production schedules within the hatchery can be modified accordingly and adjusted to minimize impacts and bottlenecks.	Stofnfiskur is equipped to supply all female sterile triploid eggs weekly year-round however, additional sources of all female triploid eggs (Salmobreed and AquaGen) are available should the need arise
Compromised Feed Supply (RAS and Marine)	Feed contamination	Only qualified, reputable feed manufacturers with complete analysis and certification will be utilized as suppliers; Storage areas will be designed, built and maintained to reduce moisture and pest entry.	Technical analysis can be performed at the facility in Marystown with regard to sinking times, quality (dust) as well, samples can be collected for additional analysis.

Risk	Possible Causes	Preventative Action	Contingency Plan
Compromised Feed Supply (RAS and Marine)	Feed delivery delays or interruptions	RAS: A feed warehouse will hold (at least 2 deliveries in store (1-month supply)) to ensure any delays or interruptions will have a minimal impact on the hatchery production; Marine: Feed barges will hold at least one-week supply of feed.	Contracted feed supplier will have resources available should issues arise to ensure there is no interruption in deliveries. In addition, an agreement will be established with supplier to establish a feed manufacturing plant in Marystown once salmon production increases
Biosecurity: disease and parasite transfer (RAS and Marine)	Staff	All staff will be trained in biosecurity procedures to ensure disease and or parasite transfer within the facility between units as well as between the hatchery and the external environment is minimized.	RAS: restricted entrances with magnetic cards, clothes changing facilities as well as facility design will ensure biosecurity procedures must be followed. Marine: Designated Bay Management Areas; designated inflow/outflow for personnel movements as well as designated equipment per BMA.
Biosecurity: disease and parasite transfer (RAS and Marine)	Visitors	Visitors will not be permitted in the RAS Hatchery. Strict procedures will be in place for any visitors to the marine sea cages.	a viewing window will be established for visitors but prevent entry into the production facility
Biosecurity: disease and parasite transfer (RAS and Marine)	Visits by vets and regulators	Any personnel required to enter outside of trained staff will be escorted and ensure procedures followed	
Biosecurity: diseased fish (RAS and Marine)	Disease inadvertently introduced	RAS: Any fish production tank can be isolated from the module recirculation system allowing specialized treatment on an individual tank; RAS & Marine: Treatment of affected tank(s)/cage(s) if deemed appropriate (advice from veterinarian (private and Provincial); restriction on personnel and equipment movements	RAS: Should the diseased fish be deemed not treatable or a risk factor, the tank can be isolated and biosecurity procedures for culling would be enforced. Isolation of any tank can be accomplished by closing the drain valves and directing water flow out of the water circulation system; RAS & Marine: Harvest or depopulate
Biosecurity: mortalities (RAS and Marine)	Improper handling of mortalities	RAS: The mortality collecting system will remove morts daily from near the tank bottom at the tank center. The collection system will flow water from the tank bottom center to a collection device at the edge of each tank, morts will be separated and the water sent through the normal treatment system. Mortalities will be transported via a Busch vacuum system to be ensilaged; Marine: A Mortex system will safely transport mortalities from the bottom of the net to a tank on the barge for ensilaging	RAS: Mortality fish will be transferred from each module to a receiving station on the outside of the facility perimeter road for collection and disposal according to approved protocol.

Risk	Possible Causes	Preventative Action	Contingency Plan
Biosecurity: Fish Escapes (Marine)	Equipment failure during transfer of fish to well boat and sea cage sites	From RAS and at sea cage sites, cameras, counting devices and a flow monitoring system will be in place. Any decrease in flow rate will immediately alert that there is a potential leak and cameras and counters can be used to verify numbers.	Employees will be monitoring transfers at strategic points and can raise an alarm if there is an equipment failure during transfers.
Biosecurity: Fish Escapes (Marine)	Predator attack	Daily removal of mortalities from sea cages to minimize attraction	A predator net could be installed if predator attacks become an issue
Biosecurity: Fish Escapes (Marine)	Ice accretion or presence	Rubber mallets can be used to reduce ice accretion on cages. Monitoring ice reports will allow for preparation of ice events in Placentia Bay.	Implement Grieg NL's ice management plan. A third party multipurpose service vessel with ice capacity could be contracted to assist with ice diversion. If necessary, cages could be towed or harvesting occur
Biosecurity: Fish Escapes (RAS)	Escapes during internal procedures such as grading, transfer between tanks or facilities	The closed system design of the RAS facility prevent fish from escaping. The only water released from the system will be as part of the sludge. Floor drains are not connected to municipal, so any fish escaped to the floor or sump areas will be retained within the system and most times will be euthanized appropriately and disposed with mortality fish. There may be selected cases where these fish can be returned to the appropriate fish tanks as approved by management.	Within the fish transfer/mortality collection system there are valves that prevent fish movement into the system prior to testing of all fish pump connections. The fish transfer connections and fish pump are located in the fish transfer sump that is below the floor elevation and will contain any amount of accidental release of fish or water with the manual option to drain water to the biofilter water storage or to the waste treatment facility discharge sump.
Biosecurity compromise; animals, pests (RAS and Marine)	Animals accessing feed storage, facilities or cages	RAS: All facility entrances will remain closed and all feed will be properly stored as will domestic waste be properly disposed to minimize pest problems. The site will be fenced to prevent larger animals from entering the areas adjacent to each building. Marine: feed will be properly stored as will domestic waste be properly disposed to minimize pest problems. Bird nets will be in place over cages with fish to prevent access.	Should it be deemed necessary, a pest control company will be contracted to monitor, collect and control any pest infestations.
Electro-Mechanical: module system fails (RAS)	Failure of a module	All modules are independent and the failure of one does not affect the others. Other modules will remain operational	Should one module become disabled, a fish transfer pump will be used to transfer fish from the disabled module to another operational module.
Electro-Mechanical: water circulation system (RAS)	Failure of water circulation pumps or pipes	The water circulation system is installed in duplicate. Two operating pumps and pipelines allow switching should one experience operational issues or failure.	A third pump is on stand-by to automatically start should the other two fail. In addition, a standing agreement will be established with a local company to provide services as needed.

Risk	Possible Causes	Preventative Action	Contingency Plan
Electro-Mechanical: oxygen system - individual tank compromise (RAS)	Oxygen dissolving system (ODS) failure	Each tank in early rearing and smoltification has one ODS/tank so a failure will be limited to a tank, not the facility. The larger fish in post smolt have three ODS units/tank in case of failure of any one ODS	All fish production tanks have an emergency oxygen system to automatically add oxygen if concentrations fall below a set point. This is monitored via computer system equipped with audible and visible alarms indicating oxygen concentrations below set point.
Electro-Mechanical: oxygen system compromise - facility level (RAS)	Failure of oxygen generator	Three oxygen generators (one main and 2 backup). Each capable of running the entire system.	Three days supply of liquid oxygen will be maintained on-site.
Electro-Mechanical failure: Electrical system (RAS)	Power failure (main power supply)	A stand-by electric generation system will automatically start with any disruption to the public electric supply	A duplicate generation system will be installed in the event the back-up system fails each of the 3 generators can run the whole facility.
Electro-Mechanical: Electrical system failure (RAS)	Power failure (internal backup power supply)	A duplicate generation system will be installed in the event the first back-up system fails	An emergency oxygen tertiary non-mechanical system will engage to provide oxygen to all systems should both internal systems fail
Lost/estranged gear (Marine)	Storms, equipment failure	Routine inspection schedules will identify issues of equipment that may be wearing or broken and can be repaired or replaced before becoming lost or estranged. If storms are approaching these issues will be addressed immediately. Secure loose equipment with impending storms.	Routine surveillance of shoreline, particularly after storms to retrieve lost gear.

3.5 Emergency Organization and Responsibilities

Grieg NL will develop organizational charts detailing emergency response structure and steps. Responsibilities by organizational unit will also be developed prior to RAS Hatchery and sea cage site operations commencing. An updated response plan complete with organizational and responsibility charts will be in place prior to Project commencement.

Preparedness begins at the individual level - all personnel at Grieg NL have a responsibility to ensure that their workplace is safe.

All **staff** of Grieg NL shall:

- Self-educate with respect to all-hazards emergency planning for the company. This includes being knowledgeable of procedures and protocols and knowing how to respond appropriately (e.g., knowing when to evacuate or not to evacuate a building);
- Become self-prepared, identifying all mitigation strategies for protection when and wherever possible;
- Know the local emergency telephone numbers – **See Getting Immediate Help** at the beginning of this plan;
- Know the evacuation route, assembly points and reception centre for the area in work areas;
- Participate in any applicable emergency management training and safety drill as related to the duties and responsibilities; and
- Become familiar with persons who work in the area who have disabilities or challenges. Be prepared to assist in emergencies to ensure their safety.

3.5.1 Documentation and Record Keeping

Employee training is routine, mandatory and covers general knowledge and actions Grieg NL employees are required to know. All employee documentation and training records will be kept on file (paper copy and/or electronic) at the Grieg NL head office.

These records will include, but are not limited to:

- Training needs and training undertaken by employees
- Training certificates for all employees
- Emergency action plans
- Incident reports and associated corrective actions
- Inspection reports for equipment and response kits
- Team meeting records

Employee training records will be kept for the duration of employment plus a minimum of five years after.

3.6 Emergency Contact Directory

Emergency Numbers	
Marystown	
Ambulance	**(709) 279-2121**
Fire Department	**(709) 279-1333**
Medical Clinic	**(709) 891-1040**
Police -- RCMP	**(709) 279-3001**
Poison Control Center	**1-866-727-1110**
MARINE EMERGENCIES	
Search & Rescue (Marine Distress)	**1-800-563-2444 or (709) 772-5151**
Marine Pollution Line	**1-800-563-9089 or VHF Channel 16**
Emergency Response Organization	**TBD**
Coast Guard (General Inquiries)	**(709) 772-4423**
Marine Communications and Traffic Services (MCTS)	**(709) 227-2181**
Marine Mammal Incidents	**1-888-895-3003**
Report Illegal Fishing Activities	**Crime Stoppers 1-800-222-TIPS or 709-292-5161**
Environmental Emergencies (Land)	
1-800-563-9089 or 1-709-772-2083	
Fish Escape Event	
Department Fisheries and Land Resources (DFLR)	**1-709-538-3725**
Department Fisheries and Oceans (DFO)	**1-709-772-0183 Or 1-709-772-3265**

Contact Numbers of Key Personnel				
		Newfoundland (709)		
Location	**Phone**	**Cell**	**Fax**	**E Mail**
Grieg NL Office	**279 3440**		**279 3450**	**admin@griegseafarms-nl.ca**
Marystown Town Office	**279 1661**		**279 2862**	info@townofmarystown.ca
St. Lawrence Town Office	**873 2222**		**873 3352**	townofstlawrence.nf.aibn.com
Come By Chance Town Office	**542 3240**		**542 3121**	townofcbc@eastlink.ca
Arnold's Cove Town Office	**463 2323**		**463 2362**	townofarnoldscove@nf.aibn.com
Long Harbour Town Office	**228 2920**		**228 2900**	towncouncil@longharbour.net
Placentia Town Office	**227 2151**		**227 2323**	townofplacentia@placentia.ca
Grieg General Manager		**xxx-xxxx**		
Human Resources		**xxx-xxxx**		
Administration		**xxx-xxxx**		
Production Manager		**xxx-xxxx**		
Assistant Manger RAS		**xxx-xxxx**		
Lead Veterinarian		**xxx-xxxx**		
Water Quality Specialist RAS		**xxx-xxxx**		
Marine Site Manager A		**xxx-xxxx**		
Marine Site Manager B		**xxx-xxxx**		
Marine Site Manager C		**xxx-xxxx**		

3.7 Internal Alerting

Internal Alerting encompasses who should be involved, who has the responsibility to notify these individuals, how the notification is accomplished (e.g., mobile phones) and the use of "fan out" (a call to one person/agency who in turn calls one or more key individuals during major emergencies). These numbers and checklists will be included in the updated version of this plan and posted in critical areas of the RAS Hatchery and on Project vessels for ready use.

3.8 External Alerting

Alerting fire and police departments, emergency measures organizations, Federal (Canadian Coast Guard, Environment Canada, Department Fisheries and Oceans) and Provincial (Department Fisheries and Land Resources) authorities, news media, and volunteer or off-duty workers during working and non-working hours responsibility will be determined once staffing for the RAS Hatchery and sea cage sites is complete and prior to operations commencing.

3.9 Public Affairs

Inquiries will normally be received from the media, government agencies, local organizations and the general public. An Information Officer (TBD) that is well-equipped and trained in media relations will be designated. Staff are to refer any and all enquiries to the designated spokesperson. Staff are to make no comments to media or general public, other than a referral to the designated Information Officer.

4.0 Emergency Response

4.1 Response Action Decision – 3 Levels of Emergency

The primary objective for emergency management response is to provide a coordinated effort from all affected areas and all the necessary supporting agencies required to respond to either a localized or widespread emergency.

Grieg NL will adopt three levels of emergency in which to control its operational response to reported incidents. The three levels of emergencies may be identified below.

Level 3:

A threat that critically affects life and safety, infrastructure, production, administrative operations, environment and/or reputation. Such a threat will require full activation of the emergency response team and the establishment of an emergency operations center. The threat could involve one or more of the following:

- Fatality;
- Serious injury;
- Serious acts of violence;
- Serious threats which could damage company property and the surrounding area;
- Serious health issues for stock (e.g., reportable disease resulting in mass mortality); or
- Major infrastructure damage (e.g., an entire building or all cages at a site).

These threats could result in the closure of the full operation or specific aspects of the operation and attract heightened public (media and political) interest.

Level 2:

A threat that substantially affects life and safety, infrastructure, production, administrative operations, environment and/or reputation. Such a threat will require full activation of the emergency operations group, partial or full activation of emergency response team and could involve the establishment of an emergency operations center. The threat could involve the following:

- Injuries;
- Moderate health issues for stocks (e.g., reportable disease event causing increase in mortality);
- Threats that are localized to the company property; or

- Moderate damage to infrastructure (e.g., damage to one tank or sea cage). These threats could result in a partial closure of the land-based facility and attract localized media and political interest.

Level 1:

A threat that minimally affects areas of life and safety, infrastructure, production, administrative operations, environment and/or reputation. Such threats would not require the activation of an emergency response team nor the establishment of an emergency operations center. These threats are handled by management as part of normal day-to-day operations. The threat could involve the following:

- localized threats (e.g., a small chemical or feed spill).

These threats could result in the need for a first response from local fire departments, police departments, or ambulance services. The first person arriving at the scene of an incident should follow the process outlined in the Emergency Management Activation Flowchart (Figure 1). The first responder will vary depending on the identified threat. The notified first responder will follow the protocol outlined in the remaining sections of this flowchart to assess the potential impact and to determine the level of emergency and will initiate contacting appropriate management if they assess the need to declare a Level 2 or 3 response.

4.2 Plan Activation and Response Mobilization

Responsibilities for First Responders

The first person arriving at the scene of an incident should follow the process outlined in Figure 1.

- Make every effort to ensure the life and safety of people is a first priority.
- Assess the threat and provide information to a supervisor who will determine Level 2 or 3 response requirements.
- Contact applicable departments/units (TBD) depending on the type of emergency as per Section 4.1.
- Assume responsibility to ensure safety until an incident commander is appointed.
- Oversee the scene to ensure the integrity of the incident scene is protected for investigative purposes.
- Submit accurate and detailed reports at post-incident debriefings.

4.2.1 Emergency Management Activation Flow Chart

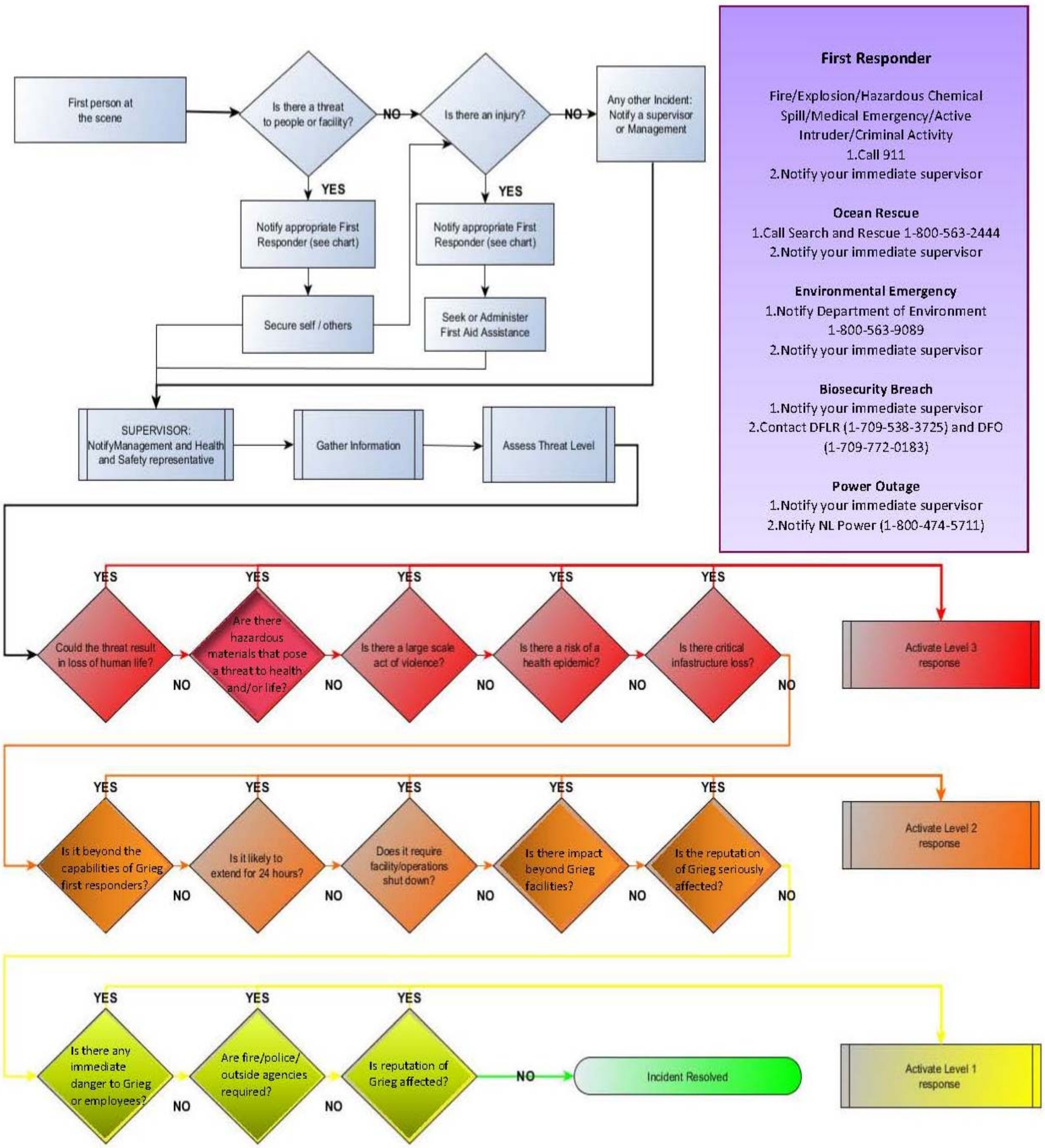

Figure 1. Emergency Management Activation Flow Chart for Grieg NL.

4.3 Response Action/Containment/Cleanup

Emergency response equipment including first aid kits, automated external defibrillators (AED), and spill kits will be placed at various locations in the RAS Hatchery and sea cage sites. The exact locations will be provided in the updated version of this plan.

Personnel trained and certified in First Aid and AED should be responsible for administering and using this equipment.

All personnel using chemicals will be trained in spill response and be aware of Material Safety Data Sheets (MSDS) as well as the Spill Management Plan. A detailed Spill Management Plan has been developed and will be integrated into this Emergency Response Plan prior to Project commencement. Details on spill response for both the RAS Hatchery and sea cage sites can be found in Appendix M of the EIS.

Absorbent materials such as vermiculite or spill pillows, pads or socks may be used to both contain and cleanup spilled material. Ensure traffic is minimized on and around contaminated areas. Contaminated materials will be disposed of by an approved hazardous waste disposal facility. Additional details on waste disposal can be found in Grieg NL's Waste Management Plan (Appendix J of the EIS).

4.4 Evacuation

Evacuation route maps will be posted in each work area. The following information is marked on evacuation maps:

- Emergency exits;
- Primary and secondary evacuation routes;
- Locations of fire extinguishers;
- Fire alarm pull stations' location; and
- Assembly points.

Site personnel should know at least two evacuation routes.

Evacuation route maps will be developed and integrated into this Emergency Response Plan once final architectural design of buildings and vessels are completed.

4.5 Restoration and Remediation

The directive of an emergency response plan is to ensure that company operations are restored as quickly as possible with the co-operation, support and assistance of all staff. Grieg NL will ensure services and programs are in place to address:

- the psychological and emotional effect that emergencies could have on the employees;
- the business and production effect;
- environment and community effects; and
- litigation and insurance issues.

Restoration and remediation action will take place to restore elements affected to their pre-incident condition. Restoration can include physical removal of contaminated surface materials, high-pressure washing, chemical cleaning, replacing of contaminated materials, restocking of tanks/cages, and bioremediation.

5.0 Training and Practice Drills

5.1 Training

Competency in responding to emergency incidents requires a complete understanding of the roles and duties of each member of the response team. Comprehensive training in the use of emergency response equipment and personnel protection devices and tactics is necessary to ensure the best response capability. Provision for training is an integral part of a complete emergency response planning and implementation program. Initial training must be followed by periodic updates to maintain familiarity with all aspects of the plan.

Training should be provided in the following situations:

- for new employees during their orientation period
- for existing employees when there is a change in their duties
- when new equipment or materials are introduced
- when emergency procedures are revised
- when a drill indicates need for improvement
- as dictated by recertification's (expiry of certifications)

Specialized training content could include, but is not limited to, specifics of the Emergency Management Plan, emergency notification procedures, fire safety evacuation procedures, critical incident stress management (CISM), media training, basic emergency management, first aid, emergency flare training, field safety and WHMIS. Copies and records of certifications for all employees will be maintained on file.

5.2 Practice Drills

Drills may be conducted in various forms such as desktop, on-site or computer-simulated. The complexity of the drill may be increased as the response team gains proficiency. Drills will be frequent enough to ensure that the response team maintains proficiency in all aspects of the Emergency Response Plan. Drills will be conducted in a variety of situations such as Fire, Spill, and Fish Escape. It is also desirable to include if possible, mutual aid organizations and public emergency response organizations in these drills.

Discussion Based Exercises

- Q&A Exercise: Selected "What If" questions will be discussed with a facilitator.
- Paper Exercise: Specific scenarios will be presented and solutions arrived at using the knowledge of the plan.
- Table Top Exercise: Incident scenarios, maps, photographs and/or other media will be used to test various elements of the plan.

Operations-Based Exercises

- Drills: Live drills on specific elements of operations will be conducted.
- Functional Exercise: Test individual elements of the emergency management structure.
- Full Scale Exercise: Exercise all elements of the plan in a full-scale simulation. This exercise will normally involve the participation of many external emergency services, as well as municipal, provincial, and/or federal officials.

6.0 Plan Evaluation and Updates

The purpose of evaluation of an Emergency Response Plan is to determine the adequacy and thoroughness of the plan, and to seek opportunities for improvement. The ease of understanding and using the plan will also be important considerations.

The Emergency Response Plan will be reviewed annually to ensure that all information and procedures contained are up to date. Changes and amendments can be made based on the evaluation. The Plan will be reviewed and updated as deemed appropriate following every response incident.

7.0 Emergency Procedures

All emergency plans, whether on land or sea will meet the Occupation Health and Safety requirements, the Canada Labor Code for land-based structures (Buildings) or Transport Canada fire and safety requirements for vessels.

7.1 Fire Emergency Plan (Land-Based RAS Hatchery)

The safe storage and placements of fire extinguishers will follow the regulations set forth in the legislation.

All fire extinguishers will be marked and easily accessible to anyone who may need to use them. The classes of Fire extinguishers are:

(A) Class A - Cloth, wood, paper, and rubber
(B) Class B - Oils, Paint, Grease, Solvents and flammable liquids
(C) Class C - Wiring, fuse boxes, electrical equipment, and computers
(D) Class D - Combustible metals such as magnesium, potassium, titanium, and sodium
(E) Class K - Cooking fluids such as fats and oils

<u>There are steps to follow when a fire is spotted:</u>

- Assess the initial severity of the fire and any immediate smoke.
- Identify the source of the fire. (Where, What)
- Determine the size of the fire and see if it can be extinguished.
- Notify the proper personnel.
- Immediately stop work, control all sources of further ignition.
- If possible and safe to do so, extinguish any fire and stop any leaks that may be present.

<u>If the fire is too large to extinguish:</u>

- Isolate the fire by closing doors as you exit the building
- Verbally notify those around you of a fire as you move towards the exit
- Sound the fire alarm by pulling the closest manual hand pull located next to each exit door
- Get to a safe place and call 911 to report the fire
- Evacuate the building using primary or secondary evacuation routes (Maps To be developed after final design and architect review)
- Report to the Emergency Muster Location, to be accounted for by your supervisor.

<u>If you hear/see the fire alarm, evacuate following these guidelines:</u>

- STAY LOW – smoke and heat rise
- Feel doors for heat with the back of your hand before opening
  - If the door is hot, keep it closed. Place a wet towel or available article at the base of the door to prevent smoke from entering and call 911 to report your location
  - If the door is not hot, slowly open it while staying low
- Check the hallway for smoke or fire
  - If smoke or fire is in the hallway, close the door. Place a wet towel or available article at the base of the door to prevent smoke from entering and call 911 to report your location
  - If no smoke or fire, continue to the nearest exit
- Prevent the spread of smoke and fire by closing doors as you exit the building
- Evacuate the building using primary or secondary evacuation routes (Maps To be developed after final design and architect review)
- Report to the Muster assembly point, to be accounted for by your supervisor (Figure 2).

In all Cases Use CARE:

- **Contain** the fire by closing all doors as you leave
- **Activate** the nearest Fire Alarm pull station
- **Report** the fire by dialing 911
- **Evacuate** or extinguish (In most cases, it is best to Evacuate)

<u>Emergency Evacuation Drills:</u>

Emergency evacuation drills/fire drills are conducted minimally, on an annual basis, without notice and under varying conditions. **It is mandatory that all visitors and employees participate.** Prior to each drill, the Fire Department will be contacted via the non-emergency number and notified of the impending drill activity.

Records of each drill will be kept on file in the main administration area; a fire drill record sheet is affixed to this plan.

Upon completion of the drill, the employee supervising will call for the distinct "all clear" signal to sound, signifying that the building is safe to re-enter. **No person** will re-enter the building prior to the signal.

The supervising employee will also notify the fire department when the drill has concluded and the facility has resumed normal operations.

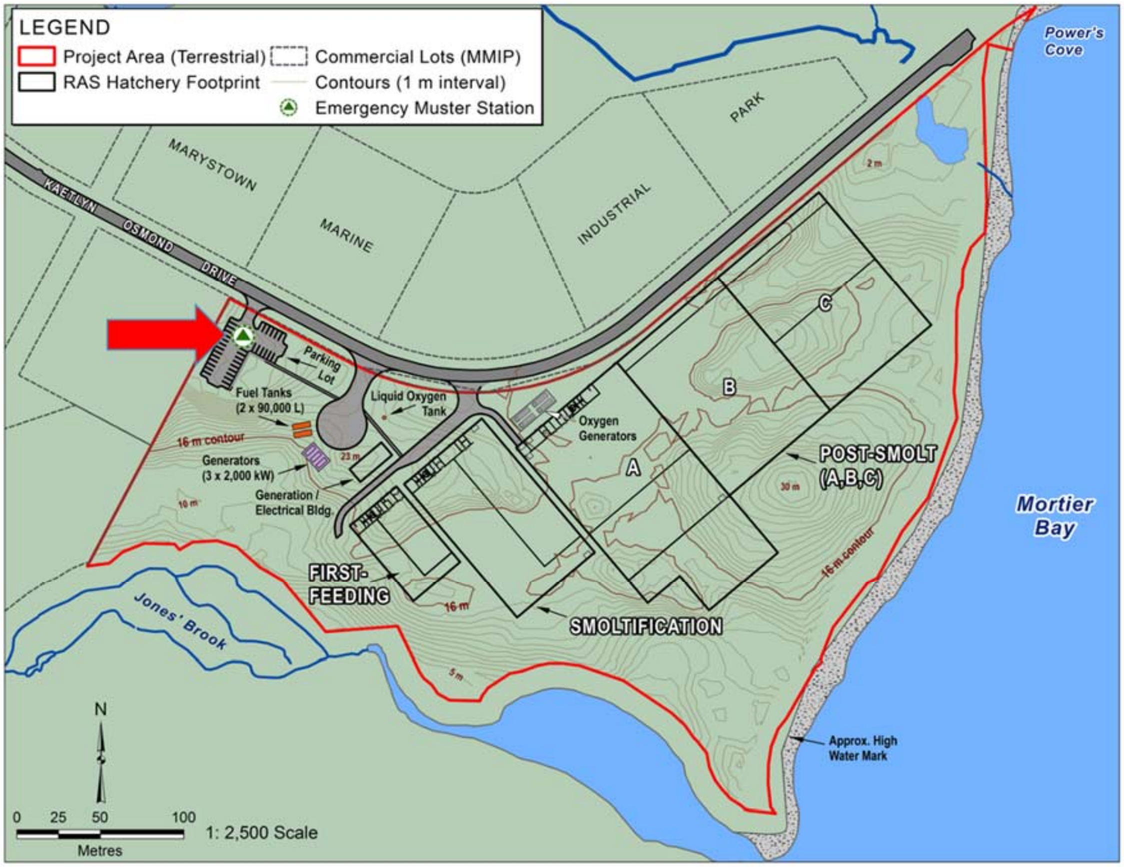

Figure 2. **Emergency Muster Location for all facilities at the land-based RAS.**

Fire Fighting Equipment:

There are existing fire hydrants located in the Marystown Marine Industrial Park. In addition, a volunteer Fire Department is located approximately 2 km from the Industrial Park. All buildings will be required under the Canada Labor Code to abide by the set standards in the Labor Code. This plan will be updated as the design of each facility is completed. Detailed equipment will be provided after reviews by the architect in conjunction with Fire and Life Safety Service NL. Fire equipment for the land-based RAS facilities may include but not be limited to:

- Sprinklers systems
- Fire Axes
- Acceptable length(s) of fire hose, couplings
- Fire extinguishers (All Classes)
- Alarms, sensors and control systems
- Fire blankets
- Other fire-fighting and life saving items deemed necessary by the architecture review in conjunction with Fire and Life Safety division of Service NL

7.2 Fire Emergency Plan (Marine)

A ship's main emergency fire system consist of a specific number of fire hydrants located at strategic positions on the ship. A series of dedicated pumps are provided to supply to these fire hydrants. The number and capacity of pumps required for a particular type of ship is decided by a governing body with knowledge of the marine vessel. Grieg NL will adhere to all safety aspects of Emergency planning on all its marine vessel. This consists in both the building of the vessel as well as implementing any safety or emergency plan that may be needed before for use of the vessel.

All Grieg NL vessels will have a safety plan to follow in the event of an emergency. Diagrams will be located in each sealed area with locations of safety equipment, primary and secondary escape routes and muster stations, emergency contacts, and emergency procedures. Barges will be equipped with emergency lighting in the event of power failure to allow safe passage to the muster station.

Design of service vessels for Grieg NL is still underway and detailed fire plans and equipment lists will be developed after design is completed. Proposed accommodation and satellite feed barges are designed by Akva Group. Examples of detailed fire plans and equipment lists are shown in Figure 3 (satellite) and Figure 4 (accommodation). The crew vessel supplier has not yet been identified. Once identified, Grieg NL will ensure that all Transport Canada fire and safety requirements for vessels will be met.

All fire extinguishers will be marked and easily accessible to anyone who may need to use them. The classes of fire extinguishers are:

(A) Class A - Cloth, wood, paper, and rubber
(B) Class B - Oils, Paint, Grease, Solvents and flammable liquids
(C) Class C - Wiring, fuse boxes, electrical equipment, and computers
(D) Class D - Combustible metals such as magnesium, potassium, titanium, and sodium
(E) Class K - Cooking fluids such as fats and oils

There are steps to follow when a fire is spotted:

- Assess the initial severity of the fire and any immediate smoke.
- Identify the source of the fire. (Where, What)
- Determine the size of the fire and see if it can be extinguished.
- Notify the proper personnel.
- Immediately stop work, control all sources of further ignition.
- If possible and safe to do so, extinguish any fire and stop any leaks that may be present.

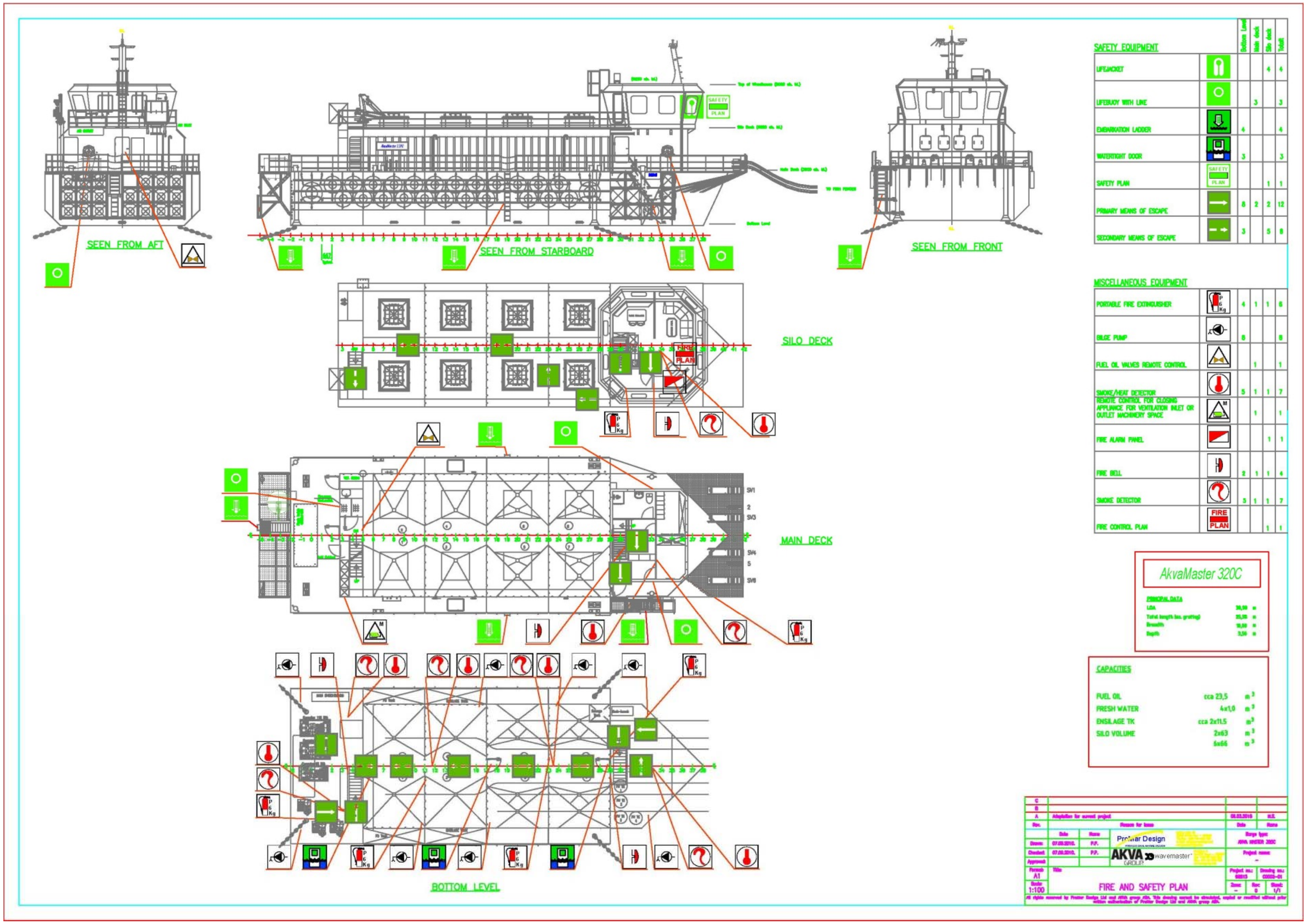

Figure 3. Detailed fire plans and equipment lists – satellite barge.

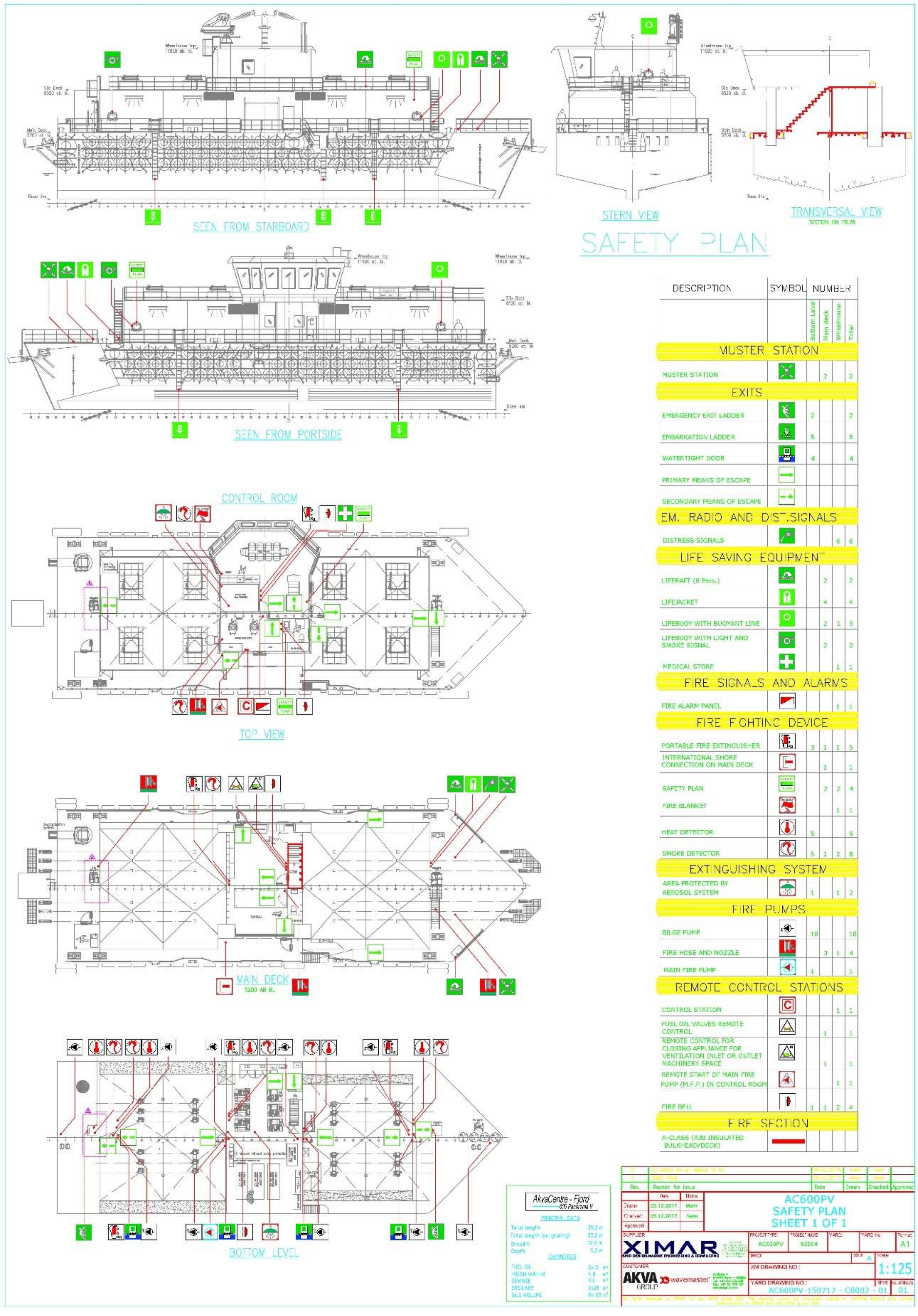

Figure 4. Detailed fire plans and equipment lists – feed/accommodation barge.

Procedures to follow if a fire on vessel is too large to extinguish:

1. Alarm sounds alerting all staff on board
2. Send DSC (Digital Selective Calling) alert
3. Send distress call on VHF CH 16
    a. Switch to VHF CH 16
    b. MAYDAY, MAYDAY, MAYDAY
    c. This is _____________(vessel name 3 times)
    d. MAYDAY followed by vessel name and MMSI (Maritime Mobile Service Identity) number
    e. Position
    f. Nature of distress
    g. Aid required
    h. Number of person on board
4. Activate EPIRB (Emergency Position Indicating Radio Beacon)
5. Follow the appropriate route to the muster station
6. Dress with life jackets and survival gear
7. Board safety vessel

Emergency Evacuation Drills:

Emergency evacuation drills/fire drills are conducted minimally, on an annual basis, without notice and under varying conditions. **It is mandatory that all guests and employees participate.**

Records of each drill will be kept on file in the main administration area, a fire drill record sheet is affixed to this plan.

Upon completion of the drill, the employee supervising will call for the distinct "all clear" signal to sound.

Safety and Fire Fighting Equipment:

Fire equipment for the marine vessels will be determined based on regulations from Transport Canada and may include but not be limited to:

- Lifejacket
- Lifebuoy with line
- Embarkation ladder
- Watertight door
- Safety plan
- Portable fire extinguisher
- Bilge pump

- Fuel oil valves remote control
- Smoke/heat detector
- Remote control for closing appliance for ventilation inlet or outlet machinery space
- Fire alarm panel
- Fire bell
- Fire control plan
- Muster Station
- Emergency Exit ladder
- Distress Signals
- Liferaft (8 person)
- Lifebuoy with light and smoke signal
- Medical store
- International shore connection on main deck
- Fire blanket
- Fire hose and nozzle
- Main fire pump
- Remote start of main fire pump (M.F.P.) in control room
- A-Class (A30 Insulated bulkhead/deck)

7.3 Ice Management

Sea ice and iceberg conditions may vary each year and by location, dependent upon the variation in winter conditions and seasonal wind patterns. Based on a review of Canadian Ice Service data and discussions with the Placentia Marine Communications and Traffic Services (MCTS), 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. To mitigate the effect that occurrences of sea ice and ice accretion may have on the marine sea cages, the following procedures will be followed:

Ice Accretion on Cages: 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.

Sea Ice in Placentia Bay: 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" to the CCG on this 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) 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 Canadian Coast Guard 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 will harvest the fish or tow the sea cage(s) to a safe location. The sea cage(s) can only be towed when water temperatures are suitable for the health and welfare of the fish (between 4 ˚C - 18 ˚C).

7.4 Security Breach: Building and Marine Site Security

7.4.1 CCTV

Grieg NL will use Closed Circuit TV (CCTV) systems around the land-based facility (outside and inside) covering many of the vulnerable areas, public access points and adjacent streets. The CCTV system and all its recordings are owned by Grieg NL and the system will be operated by Grieg NL security.

Grieg NL will use CCTV to protect life and property and to prevent crime. It is used for no other purpose. The images captured are recorded and retained if they may be needed as evidence of criminal activity.

All images from the CCTV system are treated in accordance with the principles under Canadian Privacy Statutes which govern the collection, use, disclosure and management of personal information in Canada. In Newfoundland, this is the Federal *Personal Information Protection and Electronic Documents Act* (*PIPEDA*). Under this statute, individuals, who have been monitored by a CCTV system, have a right of access to their recorded images.

Marine sea cages will also be monitored via CCTV. Cameras on feed barges will provide managers and site workers with real time video of the cage sites.

7.4.2 Alarms

Grieg NL will use perimeter breach, intruder and panic alarms which are continuously monitored (24 hours per day/7 days per week/365 days per year) from the Security Control Room. Security will respond immediately to the activation of these alarms at the land-based RAS Hatchery. If assistance is required, law enforcement may be contacted by calling 911.

At the marine site, on-site staff will monitor (visually and with CCTV) the sea cage sites. Should unauthorized persons enter the marked cage site perimeter, the persons will be advised of biosecurity concerns. Should assistance be required, law enforcement (DFO Fisheries officers) will be contacted 1-800-222-TIPS (8477).

7.4.3 Security Patrols

Members of Grieg NL Security Team will carry out regular patrols of the buildings to provide a visible deterrence to criminal activity and to check for any potential or impending conditions that might represent an emergency incident.

On the marine sites, Grieg NL will work closely with Fisheries Officers (DFO) to coordinate any aspects of their regular monitoring patrols that could be proximate to the sea cage sites.

7.4.4 Access

Normal Working Hours for RAS Hatchery (Monday – Friday 8:00 am – 5:00 pm)

- All visitors must sign in and be issued a numbered visitors badge.
- All visitors will be accompanied by a member of staff at all times and access will be limited to the viewing area and office of the facilities.
- When leaving all visitors will sign out and their numbered visitors badge returned and noted by the receptionist or other authorized staff member.
- All employees are to refuse access through any security locked doors unless the individual has a security badge or is authorized to enter.
- All security doors shall be kept secure so that access is only via a security code, key, swipe card or similar. No doors leading to the confidential areas of the building shall be left unbolted, unlocked, or otherwise propped open. This also applies to all emergency exit doors.

Outside Normal Working Hours (RAS Hatchery)

- Approval must be obtained from the management prior to scheduling off-hour activities.

- Access to the public and visitors will be restricted to selected publicly accessible meeting rooms and washroom facilities.
- All security doors shall be kept secure so that access is only via a security code, key, swipe card, or similar. No doors leading to the confidential areas of the building shall be left unbolted, unlocked, or propped open. This also applies to emergency doors.

Procedure for Accessing the Building Out of Hours for Staff

No staff may enter the building unless they have out-of-business hours access approval. If for any reason access is required, then the following procedure is to be followed.

1. Get approval from your supervisor
2. Speak to security to let them know that your will be present during identified time periods
3. Sign-in records of out-of-hour access will be maintained for safety and biosecurity purposes.

Marine Sea Cage Sites

For biosecurity reasons, only Grieg NL personnel and service providers authorized at each Bay Management Area and sea cage site should enter the marked perimeter of the sea cage site and/or board barges or sea cages.

7.5 Measures for the Recapture of Escaped Fish

Identification:

Company: Grieg NL
Licensed Aquaculture Sites (License # and Location): TBD
Species on Site: All-Female, Triploid, Atlantic salmon

Recapture Provider:

All Grieg NL marine site employees will be trained in the deployment and retrieval of recapture gear. If necessary, Grieg NL will collaborate, by sharing recapture gear, or enter into an arrangement with local fishermen to ensure that adequate recapture efforts are implemented. Depending on the magnitude of escape Ocean Choice International (OCI) vessels may also be involved in recapture response.

Response Details:

As soon as possible after an escape is suspected, the Site Manager will notify both the Production Manager and Regulatory Agencies (DFO and DFLR) of the escape or suspected escape.

If necessary, licenses may be issued for the recapture of escaped fish if DFO and other stakeholders decide to authorize a recapture event.

All Grieg NL marine sites will be prepared for such an event and will have an escape response kit fully stocked and will contain a minimum:

- Four 50-fathom long gillnets
- One of each mesh size 3 ½", 4", 4 ½" and 5"
- Dip nets

In addition to maintaining an escape response kit, Grieg NL will also prepare for such an event by performing escape response drills 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, reviewing kit contents and reviewing standard operating procedures.

In the event of an escape or suspected escape, site staff will immediately assess the sea cage to find the suspected source of the escape. When a hole or suspected hole is near the surface, staff will attempt to lift the affected net out of the water and make appropriate repairs. If it is not possible to physically remove the net from the water, a Remotely Operated Vehicle (ROV) can be equipped with a fish net sewing machine attachment that can repair underwater holes or tears quickly. If the hole or tear is deemed too large for such fixes and require additional mitigation measures, with approval from DFO, staff will use both the on-site escape response kit and a harvest seine to cover the suspected source of escape. Escape response kits will be deployed in a manner that best suits prevailing current conditions.

If the Regulatory Agencies (DFO and DFLR) authorize a recapture and third-party providers such as local fishermen or OCI vessels are required, these providers will be engaged to assist as quickly as possible. Recapture nets will be deployed only if all licenses and approvals are in place. All recapture nets will be checked four times daily while deployed. Except where the retention of an incidental catch is expressly authorized, all non-farm origin fish captured must be released immediately at the place they were caught and where it is alive, in a manner that causes it the least harm.

Within 24 hours after the discovery of an escape or evidence of escape, the event is to be reported to DFO/DFLR. This shall include the date and time of the suspected escape as well as any therapeutants that may have been administered and the fish still within the withdrawal period.

If farmed fish are observed just outside of the cages either within or outside the containment nets, efforts will be made to retrieve the escaped fish with a dip net. Efforts with a dip net will only be made if the fish is confirmed to be an escaped fish and the risk of incidental catch is low.

If there are any deviations from the above, managerial staff will develop additional response and corrective actions.

Disposal Plan:

All recaptured fish will be counted, euthanized, and processed. The recaptured fish will either be used as ensilage or in the production of fish oil.

Reporting:

From the code of Containment for the Culture of Salmonids in Newfoundland and Labrador (March 2014), if any escape of fish has occurred or is suspected, both DFLR (**709-292-4111**) and DFO (**709-772-5202**) will immediately be notified and if authorized, recapture efforts will commence within 24 hours of the incident. Any tears in netting will be noted and immediately repaired or removed.

Grieg NL will file a written report (Annex 1, Code of Containment) within 72 hours of the escape incident to the Director, Aquaculture Management, Fisheries Management Branch, Fisheries and Oceans Canada, P.O. Box 5667, St. John's, NF, A1C 5X1. Reports will be forwarded by DFO to DFLR.

Grieg NL will maintain records of all recapture fishing activity in accordance with conditions of licence in the form of a logbook (Annex 2, Code of Containment). Normally, catch and effort will be reported daily or weekly to DFO or in accordance with licence conditions to Aquaculture Management, Fisheries Management Branch, Fisheries and Oceans Canada, P.O. Box 5667, St. John's, NF, A1C 5X1.

Grieg NL will provide a daily report of all recapture activities and the recapture period will be a minimum of 7 days or once recapture methods are not proving effective.

A post escape incident report will be completed once the sea cage site involved has been secured and any associated recapture efforts have been concluded (Appendix 8 – Post Escape/Incident Review, Code of Containment).

7.6 Fish Health Emergencies

Grieg NL recognizes that a fish health emergency could occur. A fish health emergency is any situation where the health of the fish population is suddenly at risk. This may be due to a sudden, severe decrease in water quality or availability, or due to significant pathogens such as the Infectious Salmon Anemia (ISA) virus. Vigilant monitoring and early detection are the cornerstones of fish health emergency management. Immediate notification of veterinarians (Grieg NL and Provincial) as well as DFO will ensure quick responses to any identified emergencies.

The Grieg NL land-based RAS Hatchery will have redundant and backup systems for all major support systems to ensure the health and welfare of the fish is maintained. All efforts will be directed to restoring sufficient water quality for the fish including sufficient oxygen levels. In the event of life threatening compromised water quality events, the fish will be taken off feed to decrease the oxygen demand and stress. Should a fish health emergency related to a disease event occur, the objective will be to keep the pathogen "load" as low as possible and to prevent the spread of the pathogen. To prevent the spread of pathogens, it may be necessary to isolate or quarantine the (potentially) infected population from healthy populations.

Should a fish health emergency occur at the sea cage sites, Grieg NL will mobilize additional staff to assist with sample collections. Other measures that can be taken during this time is a reduction in feed as well as an increase in oxygen levels with the use of blowers. Feed reduction and oxygen level increases are mitigation measures that can assist reducing stress levels for the fish. A detailed Fish Health Management Plan is available in Appendix K of the EIS.

7.7 Mass Mortalities (RAS Hatchery)

In the event of mass mortality, Grieg NL will ensilage and transport the resulting slurry via truck or well boat depending on volume. Stringent biosecurity measures will be undertaken to eliminate any possible introduction or transfer of disease. Once removed from the land-based facility, Grieg NL will follow the procedures outlined in the Salmonid Aquaculture Waste Management Contingency Plan prepared by the Newfoundland Aquaculture Industry Association (NAIA) for sea farm mortalities.

7.8 Mass Mortality or Depopulation (Marine)

In the event of mass mortality at the marine sea cages, it is Grieg NL's obligation to act swiftly in a manner which reduces any further effect on its other sites while following all regulatory approvals. Grieg NL will use backup vessels supplied by OCI in combination with the well boat to collect all mass mortalities from the sea cages. Mitigation measures to reduce waste in the event of a mass mortality or depopulation order include, but are not limited to, ensilage, rendering, and processing. The plan is intended to ensure available capacity to manage farm mortalities in a biosecure manner, while at the same time reducing overall waste and minimizing loss of marketable product.

Grieg NL will adopt and follow the Salmonid Aquaculture Waste Management Contingency Plan prepared by the NAIA for mass mortality or depopulation events (Figure 5). The below information has been taken from the plan and adapted to fit the Placentia Bay Aquaculture Project. This plan is to maintain a strategy to effectively and efficiently manage potential waste due to sea farm mortality. Recovery and counting of the mortalities shall be governed by acceptable industry standards. Each Grieg NL site manager shall be responsible for following Standard Operating Procedures (SOPs) pertaining to recovery and counting during mass mortality events. In the case of an event due to disease, recovery shall be conducted within the guidelines specified by the Aquatic Animal Health Division (AAHD) of DFLR and the Canadian Food Inspection Agency (CFIA).

In the event of a mass mortality, the following general process shall be employed in accordance with Grieg NL standard operating procedures and all regulatory requirements:

> All mortalities shall be contained in an industry standard container and shall be transported in a biosecure manner to designated outflow wharves. Biosecure handling and transport is designed to circumvent spillage and entails. In the case of a confirmed presence of a reportable fish disease, if required, CFIA will give direction on how to proceed with disposal from affected sites. If the reportable disease does not require direction from CFIA, DFLR may provide direction along with approval from other federal and provincial agencies. The options will differ depending on the quantity of material to be disposed and whether there is a confirmed presence of an infectious disease. Grieg NL will adhere to governmental guidelines and regulations for the disposal of organic material and deadstock (refer to Grieg NL Waste Management Plan for details).

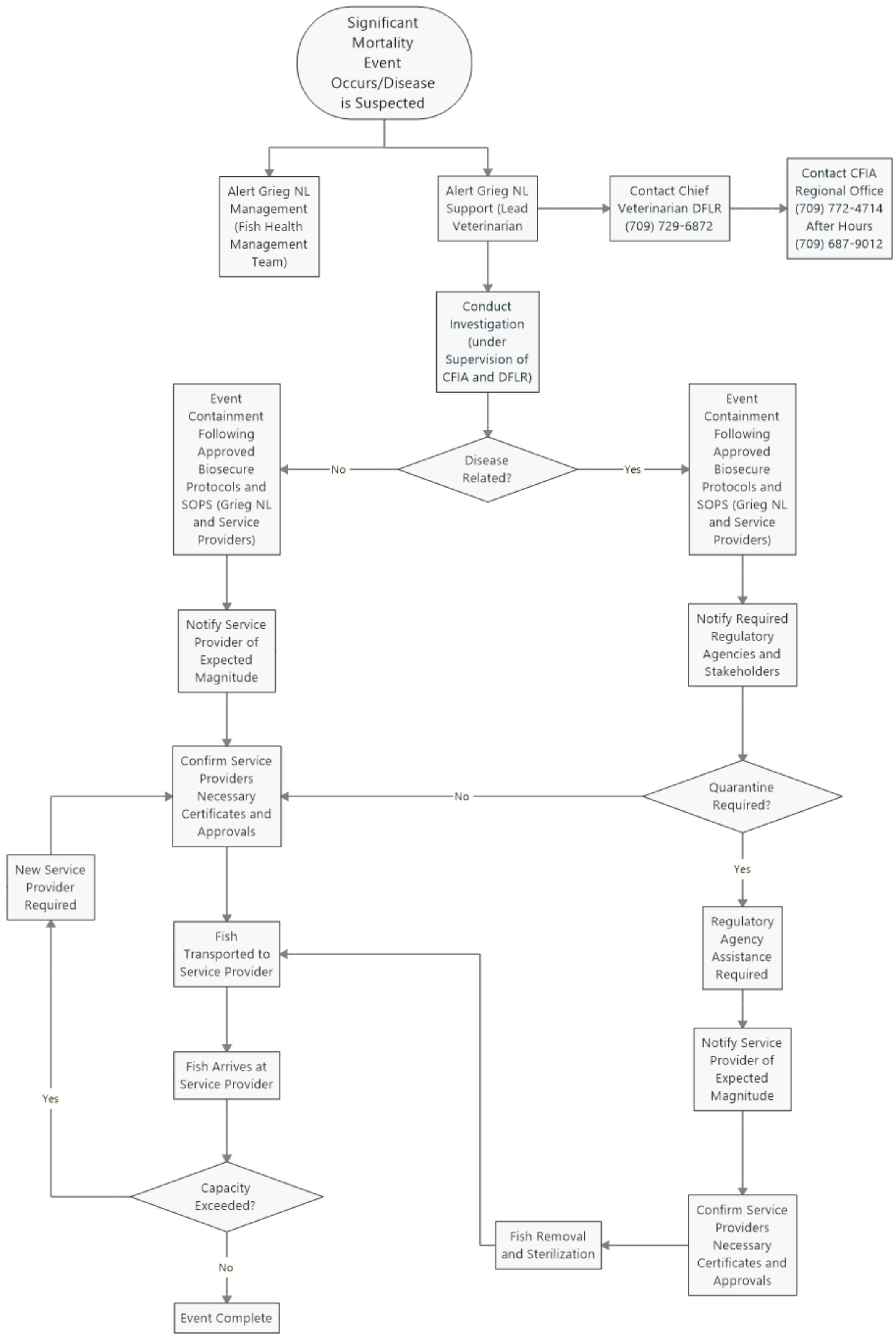

Figure 5. Fish mass mortality general procedure.

7.9 Spill Management (Land and Water)

Refer to Appendix M of EIS.

Appendix U

Bird Survey –

Bird Nest Search of the Marystown RAS Hatchery Site

LGL Limited, environmental research associates
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Bird Nest Search of the Marystown RAS Hatchery Site

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14 July 2017
LGL Project No. FA0135

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INTRODUCTION

LGL Limited (LGL) was contracted by Pennecon Heavy Civil Ltd. (Pennecon) to search for active bird nests at an area designated for clearing as part of the development of the RAS Hatchery at Marystown, Newfoundland and Labrador. Pennecon was required to conduct these breeding bird surveys under federal and/or provincial regulations.

METHODS

Tony Lang and Bruce Mactavish, biologists from LGL, visited the development area to be cleared of forest on 10–12 July 2017. The area consisted of three survey sites: GRIEG Site, Lot 5, and USM Deposit Area 1. The two biologists systematically walked through the survey sites searching for birds and looking for evidence of nesting. Most birds detected were likely nesting within the development area, but pinpointing the location of a nest was difficult (as typically is the case when conducting breeding bird surveys). The presence of an adult bird carrying food (which it does only to feed to the young in the nest or to courtship-feed its mate) is a confirming sign of active nesting. GPS waypoints were recorded of the locations where evidence of nesting was found.

RESULTS

Twenty-one species of birds were found within the development area (Table 1). Details on species encountered in each of the three survey areas (GRIEG Site, Lot 5, and USM Deposit) are provided in Appendix 1.

No bird nests were found. On three occasions, pairs of adult birds were observed feeding recently fledged young. The fledglings were very recently out of the nest and foraging on their own but also still being fed regularly by the parent birds. There were two pairs of Northern Waterthrush feeding fledged young and one pair of Savannah Sparrow feeding a fledged young. In addition, an adult Spotted Sandpiper was in close attendance of a recently fledged young. Young Spotted Sandpipers are mobile and can feed themselves as soon as they hatch from the eggs. The Spotted Sandpipers had probably nested near the shoreline of saltwater inlet <100 m away (but outside of the development area). Other birds (Blackpoll Warbler, Black-throated Green Warbler, and Fox Sparrow) were observed carrying food but a nest site or recently fledged young were not located. All of the birds listed in Table 1 were probably nesting or had recently finished nesting in the development area.

TABLE 1. Birds observed at three survey sites in the proposed RAS Hatchery, development area in Marystown, 10–12 July 2017.

Species	Scientific Name	GRIEG Site	Lot 5	USM Deposit Area 1
Spotted Sandpiper	*Actitis macularius*	X[1]	-	-
Wilson's Snipe	*Gallinago delicata*	X	-	X
Northern Flicker	*Colaptes auratus*			
Yellow-bellied Flycatcher	*Empidonax flaviventris*	-	X	X
Gray Jay	*Perisoreus canadensis*	-	X	-
Boreal Chickadee	*Poecile hudsonicus*	-	X	-
Ruby-crowned Kinglet	*Regulus calendula*	-	-	X

Species	Scientific Name	GRIEG Site	Lot 5	USM Deposit Area 1
Hermit Thrush	*Catharus guttatus*	X	-	X
American Robin	*Turdus migratorius*	X	X	-
Northern Waterthrush	*Parkesia noveboracensis*	X	X	X
Black-and-white Warbler	*Mniotilta varia*	-	-	X
Magnolia Warbler	*Setophaga magnolia*	-	-	X
Blackpoll Warbler	*Setophaga striata*	-	X	X
Yellow-rumped Warbler	*Setophaga coronata*	-	-	X
Black-throated Green Warbler	*Setophaga virens*	-	X	-
Wilson's Warbler	*Cardellina pusilla*	-	-	X
Fox Sparrow	*Passerella iliaca*			
Dark-eyed Junco	*Junco hyemalis*	-	X	X
White-throated Sparrow	*Zonotrichia albicollis*	X	-	X
Savannah Sparrow	*Passerculus sandwichensis*	X	-	-
Pine Grosbeak	*Pinicola enucleator*	-	-	X
American Goldfinch	*Spinus tristis*	-	X	-

[1] X indicates species was found.

Mitigation Measures

Based on a search of the three survey sites, there was only one occasion that required mitigative action. Savannah Sparrows had nested in an area of bog (at the GRIEG site) not yet cleared as evidenced by the presence of a fledgling. The area around the bog had been deforested in the previous year. The bog was relatively small and surrounded by deforested areas. LGL biologists determined that the fledgling Savannah Sparrow(s) in this bog 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. Pennecon Site Superintendent (Paul Smith) was informed that the young Savannah Sparrow would need at least another five days to give it a chance to leave the area. Pennecon agreed and indicated that the bog area was not slated to be cleared for another two weeks.

The two incidents of fledgling Northern Waterthrushes were treated differently than the Savannah Sparrows. It was thought that the fledgling waterthrushes would be able to move to adjacent woods with the parent birds before clearing commenced.

APPENDIX 1: BIRD OBSERVATIONS, 10–12 JULY 2017

GRIEG SITE

This area had been cleared of forest cover approximately one year earlier. A boggy wet area was still intact and mostly undisturbed by machinery.

Spotted Sandpiper

One alarmed adult and a recently fledged juvenile were sighted. The juvenile was fully feathered and capable of flight. It still had some down feathers on its head and back. It was in a wet area north east corner of cleared area about, 75 m from salt water.

American Robin

Individuals frequently were seen flying into cleared area to forage. They were not nesting in the cleared area but were likely nesting in woods outside of the GRIEG Site.

Savannah Sparrow

On 11 July, an agitated pair was seen carrying food in the wet boggy area that had not been cleared. A nest was not located but the area used by the pairs was identified. A return visit on 12 July to the area resulted in one recently fledged juvenile being found. The adults were still feeding it and possibly other fledglings hidden in the grass. The chick had a short tail and was a weak flier. A flag was placed near where the chick was found.

Other species of birds observed in the cleared area within 50 m of the forested perimeter were **Wilson's Snipe**, **Hermit Thrush**, **Yellow-bellied Flycatcher**, **Boreal Chickadee**, **Northern Waterthrush**, **Magnolia Warbler, White-throated Sparrow** and **Fox Sparrow (Table 1)**. These birds ventured into the cleared area to feed but were suspected of nesting in the forested area outside the construction zone.

LOT 5

This area comprised of second growth balsam fir crossed by several cut lines about 5 m in width.

Northern Flicker

One flew through the area.

Gray Jay

A pair of adults moved through the area.

Boreal Chickadee

One pair observed.

Yellow-bellied Flycatcher

One singing.

American Robin

Several observed feeding in the open areas. One was a juvenile (identified by breast spots) fully independent and feeding on its own.

Northern Waterthrush

At least three pairs were observed. One pair was observed feeding a recently fledged young. Down patches were still present on its back but the birds was mobile.

Black-throated Green Warbler

One female collecting food. Observed briefly then disappeared from area.

Blackpoll Warbler

Two singing males. One was seen carrying food but we did not pinpoint area of its nest.

Dark-eyed Junco

One pair present. The male was singing.

Fox Sparrow

One was seen feeding on the ground in clearing and later heard singing.

American Goldfinch

One was seen in flight flying over the area.

USM DEPOSIT AREA 1

This area comprised of second growth fir forest mixed with white spruce. Very dense in places with no undergrowth due to lowlight levels reaching the forest floor. There were small natural wet clearings with a rich growth of grasses and other plants. There was recent moose activity in the area.

Wilson's Snipe

Three separate snipe flushed out of damp clearings.

Yellow-bellied Flycatcher

One singing.

Hermit Thrush

One singing.

Ruby-crowned Kinglet

Two single birds agitated by our presence.

Magnolia Warbler

One male singing.

Blackpoll Warbler.

One male observed with carrying food in its bill. One lone female was observed in another part of the area.

Black-and-white Warbler

One male singing.

Yellow-rumped Warbler

One male investigating the presence of the observer.

Northern Waterthrush

One pair was bringing food to a recently fledged young. The young contained patches of down but it was old enough to feed on its own as well as being fed by both parent birds. Both parents were agitated by observer's presence. Another Northern Waterthrush was singing in another part of the area.

Wilson's Warbler

One agitated female investigating presence of observers.

Dark-eyed Junco

One male was singing.

White-throated Sparrow

One pair was agitated by presence of the observer.

Pine Grosbeak

One male was singing.

Appendix V

Metocean Conditions

for the Placentia Bay Aquaculture Sites

Oceans Ltd.

February 2018

Metocean Conditions
For the Placentia Bay
Aquaculture Sites

Submitted to
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by

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February 2018

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1.0 Introduction

The metocean conditions for the northern half of Placentia Bay were analyzed. The report is subdivided into two sections. Section 1 outlines the atmospheric environment, and includes wind speed and direction, air temperature, and precipitation while Section 2 outlines the aquatic environment, including ocean currents, waves, tidal and flood conditions, and sea ice and icebergs.

2.0 Atmospheric Environment

2.1 Data Sources

The data sources to describe the climatology of the northern half of Placentia Bay came from four main sources. The MSC50 Wind and Wave Reanalysis data set, the National Hurricane Centre's Tropical Storm data set, two SmartBay buoys and Environment and Climate Change Canada's (ECCC) Weather Stations located around Placentia Bay.

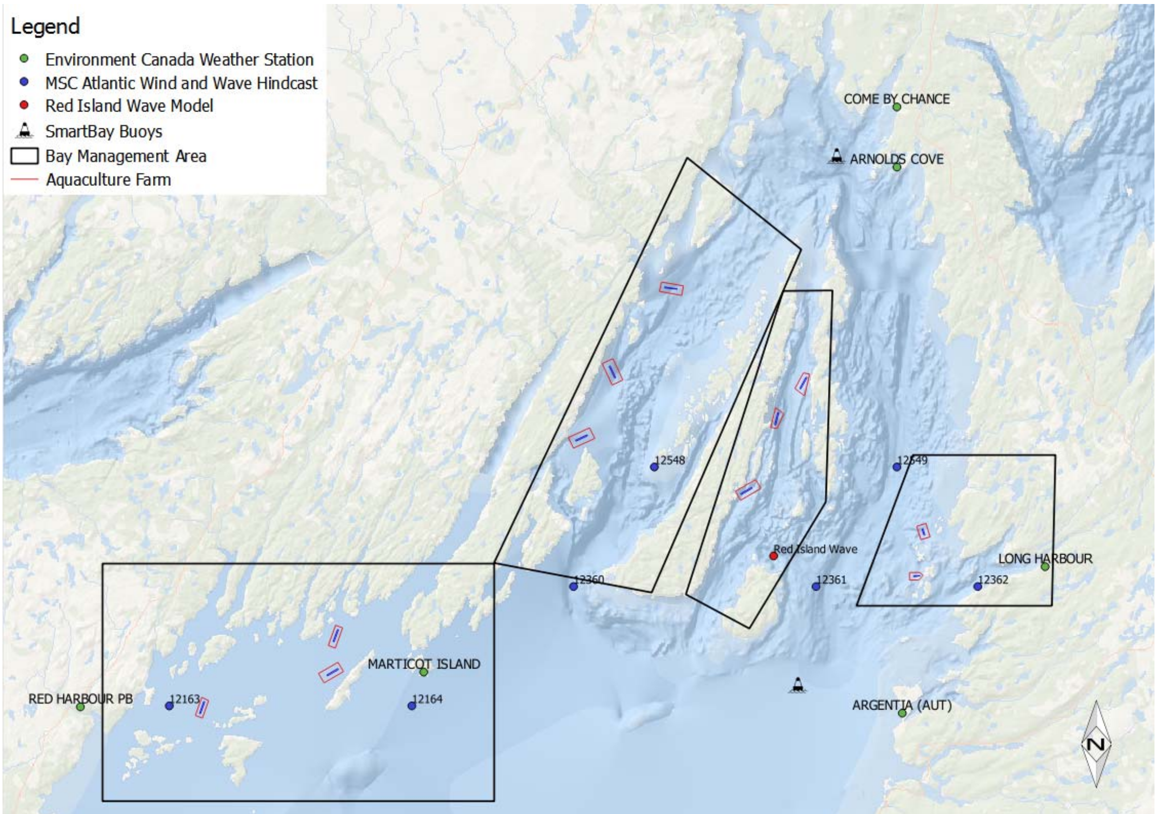


Figure 2.1 Location of Data Sources

2.1.1 MSC50 Wind and Wave Reanalysis

Wind climate statistics for the area were extracted from the MSC50 North Atlantic wind and wave climatology data base compiled by Oceanweather Inc. under contract to ECCC. The MSC50 data base covers the time period from January 1954 to December 2015. Winds from the MSC50 data set are 1-hour averages of the effective neutral wind at a height of 10 m above sea level, asl (Harris, 2007).

Grid Points 12163 and 12164 were chosen to represent conditions within the Rushoon Bay Management Area (BMA), 12360 and 12548 for the Merasheen BMA, and 12549, 12361 and 12362 for the Long Harbour BMA. There were no MSC50 Grid Points located within the Red Island BMA. Due to the proximity of the nearby islands, nearby grid points were of no use to provide a depiction of the climatology within the Red Island BMA. Location information for each grid point is presented in Table 2.1.

Table 2.1 MSC50 Grid Point Locations

Grid Point	Latitude	Longitude
12548	47.5	-54.3
12549	47.5	-54.0
12360	47.4	-54.4
12361	47.4	-54.1
12362	47.4	-53.9
12163	47.3	-54.9
12164	47.3	-54.6

2.1.2 Tropical Storms

Tropical cyclone climatology statistics were calculated from the National Hurricane Centre's best-track dataset (Neumann, Jarvinen, & McAdie, 1993); (Jarvinen, Neumann, & Davis, 1984). This dataset provides positions and intensities at 6-hour intervals for every Atlantic tropical cyclone since 1886. In this report, a subset of the NHC dataset consisting of all storms of tropical origin during the months of April to September from 1960 to 2015 was used. This subset was obtained from the National Oceanic and Atmospheric Administration's Coastal Services Center Historical Hurricane Tracks website. Due to the size of some storms, statistics were derived for all storms which have come within a buffer zone of 150 nm (278 km) of the four BMA's.

2.1.3 SmartBay Buoys

Data from two SmartBay Buoys were used in the analysis: the Red Island Shoal buoy and the Head of Placentia Bay buoy. These buoys measure wind speed and direction, wave height, sea surface temperature, ocean current and barometric pressure. The location of these buoys is provided in Table 2.2.

Table 2.2 SmartBay Buoy Locations

Buoy	Latitude	Longitude
Red Island Shoal	47.315	-54.123
Head of Placentia Bay	47.758	-54.074

2.1.4 Environment Canada Weather Stations

Wind speed, air temperature and visibility statistics were calculated from ECCC Stations near the BMAs. These stations, their location, as well as the available measured parameters are provided in Table 2.3. It should be noted that these measurements were all recorded over different time periods and statistics are not directly comparable to each other. Despite not being directly comparable, these data should give an indication of the conditions expected within the region.

Table 2.3 ECCC Station Locations and Available Data

Station	Latitude	Longitude	Start Date	End Date	Wind	Air Temperature	Precip.
Red Harbour	47.30	-55.01	1989-12-01	2006-02-28		X	X
Marticot Harbour	47.33	-54.58	2005-09-21	2018-02-07	X	X	
Arnold's Cove	47.75	-54.00	1971-07-01	1994-12-31		X	X
Long Harbour	47.42	-53.82	1969-11-06	1999-12-31		X	X
Argentia	47.29	-53.99	1951-01-01	2017-08-03	X	X	

2.2 General Description of Weather Systems

Placentia Bay, located along the south coast of Newfoundland experiences weather conditions typical of a marine environment with the surrounding waters having a moderating effect on temperature. In general, marine climates experience cooler summers and milder winters than continental climates and have a much smaller annual temperature range. Furthermore, a marine climate tends to be fairly humid, resulting in reduced visibilities, low cloud heights, and receives significant amounts of precipitation.

The climate of the study area is very dynamic, being largely governed by the passage of high and low-pressure circulation systems. These circulation systems are embedded in, and steered by, the prevailing westerly flow that typifies the upper levels of the atmosphere in the mid-latitudes, which arises because of the normal tropical to polar temperature gradient. The mean strength of the westerly flow is a function of the intensity of this gradient, and as a consequence is considerably stronger in the winter months than during the summer months, due to an increase in the south to north temperature gradient.

During the winter months, an upper level trough tends to lie over central Canada and an upper ridge over the North Atlantic resulting in three main storm tracks affecting the region: one from the Great Lakes Basin, one from Cape Hatteras, North Carolina and one from the Gulf of Mexico. These storm tracks, on average, bring eight low pressure systems per month over the area. The intensity of these systems ranges from relatively weak features to major winter storms. Recent studies (Archer & Caldeira, 2008) have shown that there exists a poleward shift of the jet stream, and consequently storm tracks, at a rate of 0.17 to 0.19 degrees/decade in the northern hemisphere. This shift has been related to an increase in the equator-to-pole temperature gradient. McCabe et al. (McCabe, Clark, & Serreze, 2001) obtained similar results, finding that there has been a decrease in mid-latitude cyclone frequency and an increase in high-latitude cyclone frequency. In addition, they found that storm intensity has increased in both the high and mid-latitudes.

In the case where the upper level long wave trough lies well west of the region, the main storm track will lie through the Gulf of St. Lawrence or Newfoundland. Under this regime, an east to southeast flow ahead of a warm front associated with a low will give way to winds from the south in the warm sector of the system. Typically, the periods of southerly winds and mild conditions will be of relatively long duration, and in general, the incidence of extended storm conditions is likely to be relatively infrequent. Strong frictional effects in the stable flow from the south results in a marked shear in the surface boundary layer and relatively lower winds at the sea surface. As a consequence, local wind wave development tends to be inhibited under such conditions. Precipitation types are more likely to be in the form of rain or drizzle, with relatively infrequent periods of continuous snow, although periods of snow showers prevail in the unstable air in the wake of cold fronts associated with the lows. Visibility will be reduced at times in frontal and advection fogs, in snow, and in snow shower activity.

At other times, with the upper long wave trough situated further to the east, the main storm track may lie through or to the east of the study area. With the lows passing closer to the study area and a higher potential for storm development, the incidence of strong gale and storm force conditions is greater. Longer bouts of cold, west to northwest winds behind cold fronts occur more frequently, and because the flow is colder than the surface water temperatures, the surface layer is unstable. The shear in the boundary layer is lower, resulting in relatively higher wind speeds near the surface, and consequently relatively higher sea state conditions. With cold air and sea surface temperatures coupled with high winds, the potential for freezing spray will occur quite frequently. In this synoptic situation, a greater incidence of precipitation in the form of snow is likely to occur. Freezing precipitation, either as rain or drizzle, occurs infrequently south of Newfoundland. Visibility will be reduced in frontal and advection fogs, and frequently by snow.

By summer, the main storm tracks have moved further north than in winter. Low-pressure systems are less frequent and much weaker. With increasing solar radiation during spring, there is a general warming of the atmosphere that is relatively greater at higher latitudes. This decreases the north-south temperature contrast, lowers the kinetic energy of the westerly flow aloft and decreases the potential energy available for storm development. Concurrently, there is a northward shift of the main band of westerly winds at upper levels and a marked development of the Bermuda-Azores sub-tropical high-pressure area to the south. This warm-core high-pressure cell extends from the surface through the entire troposphere. The main track of the weaker low-pressure systems typically lies through the Labrador region and tends to be oriented from the west-southwest to the east-northeast.

With low pressure systems normally passing to the north of the region in combination with the northwest sector of the sub-tropical high to the south, the prevailing flow across the Grand Banks is from the southwest during the summer season. Wind speed is lower during the summer and the incidence of gale or storm force winds are relatively infrequent. There is also a corresponding decrease in significant wave heights.

Frequently, intense low-pressure systems become ‘captured’ and slow down or stall off the coast of Newfoundland and Labrador. This may result in an extended period of little change in conditions that may range, depending on the position, overall intensity and size of the system, from the relatively benign to heavy weather conditions.

Rapidly deepening storms are a problem south of Newfoundland in the vicinity of the warm water of the Gulf Stream. Sometimes these rapidly deepening oceanic cyclones develop into a “weather bomb”; defined as a storm that undergoes central pressure falls greater than 24 mb over 24 hours. Hurricane force winds near the center, the outbreak of convective clouds to the north and east of the center during the explosive stage, and the presence of a clear area near the center in its mature stage (Rogers & Bosart, 1986) are typical of weather bombs. After development, these systems will either move across Newfoundland or near the southeast coast producing gale to storm force winds from the southwest to south over the study area.

In addition to extratropical cyclones, tropical cyclones often retain their tropical characteristics as they enter the study area. Tropical cyclones account for the strongest sustained surface winds observed anywhere on earth. The hurricane season in the North Atlantic basin normally extends from June through November, although tropical storm systems occasionally occur outside this period. Once formed, a tropical storm or hurricane will maintain its energy as long as a sufficient supply of warm, moist air is available. Tropical storms and hurricanes obtain their energy from the latent heat of vapourization that is released during the condensation process. These systems typically move east to west over the warm water of the tropics; however, some of these systems turn northward and make their way towards Newfoundland. Since the capacity of the air to hold water vapour is dependent on temperature, as the hurricanes move northward over the colder ocean waters, they begin to lose their tropical characteristics. By the time these weakening cyclones reach Newfoundland, they are usually embedded into a mid-latitude low and their tropical characteristics are usually lost.

2.3 Wind Speed

Placentia Bay experiences a predominately southwest to west flow throughout the year. There is a strong annual cycle in the wind direction. West to northwest winds which are prevalent during the winter months begin to shift counter-clockwise during March and April, resulting in a predominant southwest wind by the summer months. As autumn approaches, the tropical-to-polar temperature gradient strengthens and the winds shift slightly, becoming predominately westerly again by late fall and into winter.

In addition to mid-latitude low pressure systems crossing the route, tropical cyclones often move northward out of the influence of the warm waters of the Gulf Stream, passing near the Island of

Newfoundland. The tropical cyclone season typically extends from June to November, however may occur outside of this period given the right conditions. Once the cyclones move over colder waters they lose their source of latent heat energy and often begin to transform into a fast-moving and rapidly developing extratropical cyclone producing large waves and sometimes hurricane force winds.

Low pressure systems crossing the area tend to be weaker during the summer months. As a result, mean wind speeds tend to be at their lowest during this season.

2.3.1 Proposed Long Harbour BMA

Mean, minimum and maximum wind speed statistics for the Long Harbour BMA are presented in Table 2.4 and Table 2.6 respectively. An annual wind rose and percent frequency histogram for MSC50 Grid Point 12361 is presented in Figure 2.2.

No wind speed measurements are available within the Long Harbour BMA. Wind speeds from the Argentia weather station and the Red Island Shoal SmartBay buoy provide the closest observations. Mean monthly observed winds from these two stations are lower during than those presented with the MSC50 Grid Points. Maximum wind speeds recorded by the Argentia station are higher during the winter months than the buoys and the MSC50 grid points.

Table 2.4 Mean Wind Speeds (m/s) for the Long Harbour BMA

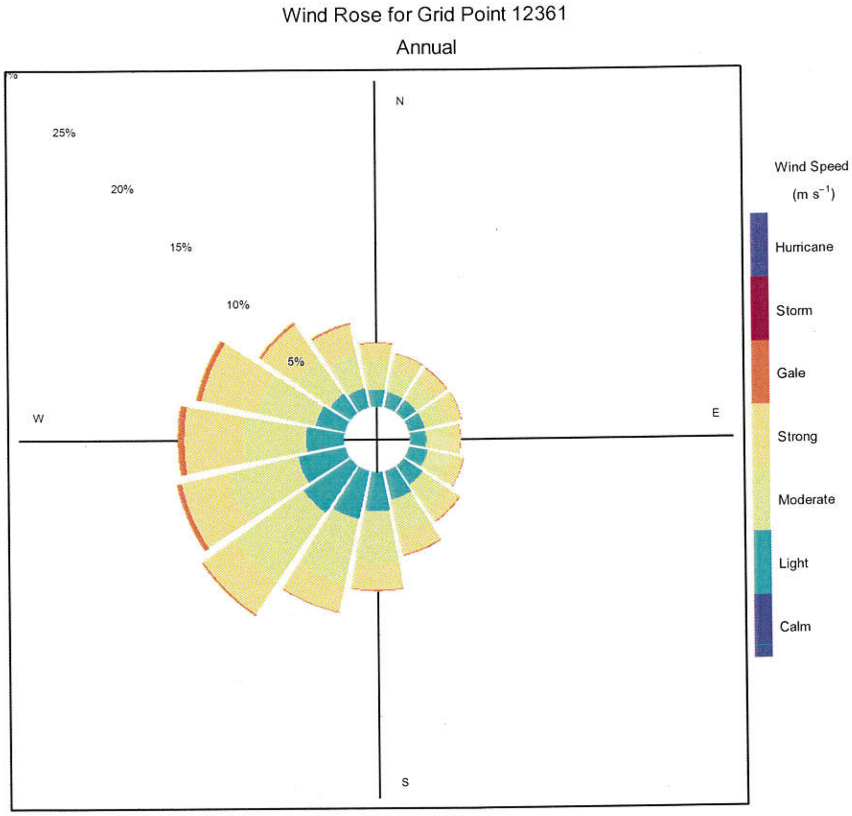
	Argentia	SmartBay Red Island Shoal	GP 12549	GP 12361	GP 12362
January	8.3	8.5	10.7	10.7	10.7
February	8.0	8.7	10.1	10.1	10.1
March	7.5	8.0	9.3	9.3	9.3
April	6.6	7.3	8.0	8.0	8.0
May	5.8	5.6	6.4	6.4	6.4
June	5.6	5.4	5.7	5.7	5.8
July	5.5	5.5	5.5	5.5	5.5
August	5.5	5.7	6.1	6.0	6.1
September	6.0	6.7	7.3	7.3	7.3
October	6.9	7.4	8.6	8.6	8.6
November	7.4	7.9	9.5	9.5	9.5
December	8.1	8.5	10.4	10.4	10.4

Table 2.5 Minimum Wind Speeds (m/s) for the Long Harbour BMA

	Argentia	SmartBay Red Island Shoal	GP 12549	GP 12361	GP 12362
January	0.2	0.2	1.9	1.8	1.9
February	0.1	0.2	0.7	0.7	0.6
March	0.1	0.1	1.0	1.0	1.0
April	0.1	0.1	0.6	0.6	0.6
May	0.1	0.0	0.4	0.4	0.4
June	0.0	0.1	0.2	0.2	0.2
July	0.1	0.2	0.4	0.4	0.4
August	0.1	0.1	0.4	0.4	0.4
September	0.1	0.2	0.5	0.5	0.5
October	0.1	0.1	0.9	0.9	0.8
November	0.1	0.0	0.9	0.9	0.9
December	0.1	0.1	1.4	1.4	1.3

Table 2.6 Maximum Wind Speeds (m/s) for the Long Harbour BMA

	Argentia	SmartBay Red Island Shoal	GP 12549	GP 12361	GP 12362
January	30.3	21.70	25.1	25.2	25.3
February	30.8	22.00	27.0	27.0	27.1
March	24.2	26.60	26.5	26.7	26.4
April	25.8	22.00	20.5	20.6	20.8
May	23.4	19.00	19.3	19.2	19.5
June	20.6	16.00	19.6	19.6	19.8
July	21.7	17.20	22.2	22.2	21.3
August	20.6	20.00	24.7	24.7	25.6
September	26.4	25.20	28.1	28.5	29.9
October	28.6	20.80	26.7	27.0	26.2
November	28.0	21.00	23.7	23.6	23.8
December	30.0	23.90	24.5	24.6	24.6



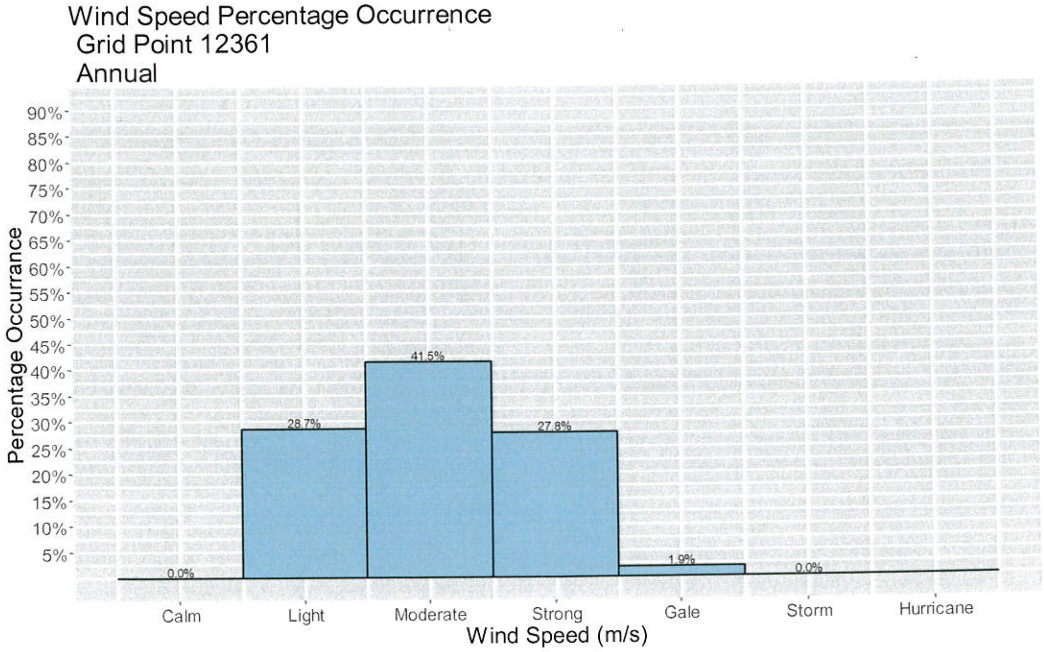


Figure 2.2 Wind Rose and Percentage Frequency Histogram for MSC50 Grid Point 12361 located at 47.4°N; 54.1W near Red Island

2.3.2 Proposed Red Island BMA

Wind speed and direction statistics are unavailable for the Red Island BMA due to lack of both observations and modelled data. Local effects due to the proximity of the islands to the east and west would result in winds being channeled into a north-northeast to south-southwest direction and in some situations the island would act as shelter.

All three aquaculture sites should see lighter winds from the south-southwest to north-northwest than presented with the other grid points. Winds from the north to northeast would get channeled into a north-northeast direction. Similarly, winds from the south to southeast will get channeled into a southeasterly direction. Some strengthening of the winds could occur during this process. Easterly winds at Butler Island and Red Island lease sites will be lighter than those from Grid Point 12361 due to sheltering from the island, while Darby Harbour Farms should see similar winds from the east to southeast as presented with Grid Point 12361.

2.3.3 Proposed Merasheen BMA

Mean, minimum and maximum wind speed statistics for the Merasheen BMA are presented in Table 2.7 and Table 2.9 respectively. An annual wind rose and percent frequency histogram for MSC50 Grid Point 12548 is presented in Figure 2.3.

No wind speed measurements are available within or near the Merasheen BMA. Mean monthly winds from two MSC50 grid points are presented.

Table 2.7 Mean Wind Speeds (m/s) for the Merasheen BMA

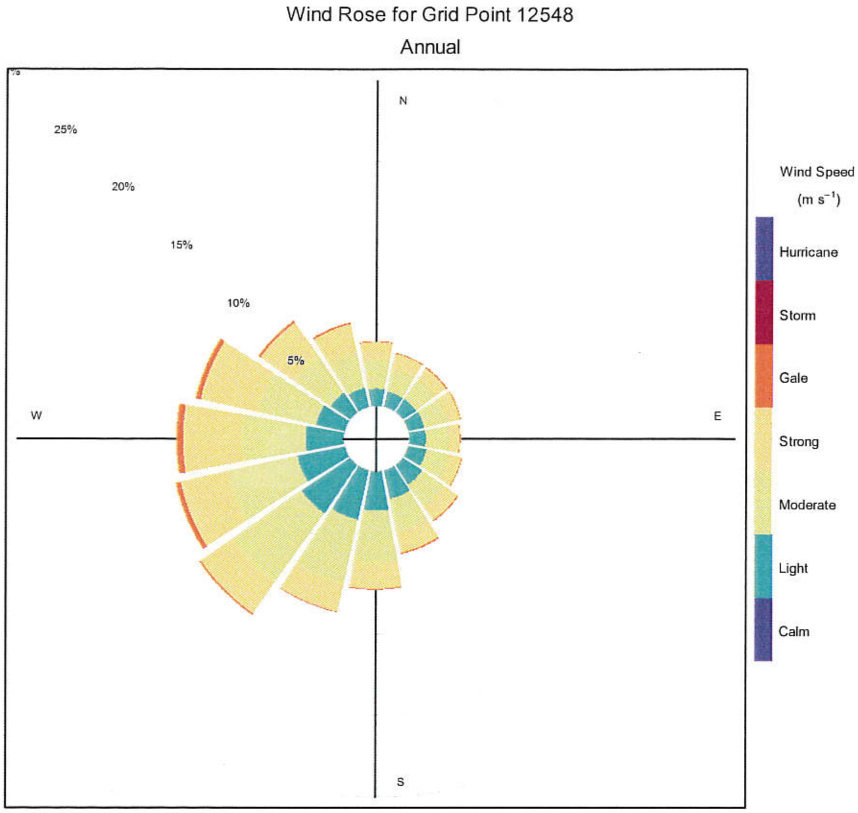
	GP 12548	GP 12360
January	10.6	10.6
February	10.0	10.1
March	9.2	9.3
April	8.0	8.0
May	6.4	6.4
June	5.7	5.7
July	5.4	5.4
August	6.0	6.0
September	7.3	7.3
October	8.6	8.6
November	9.5	9.5
December	10.4	10.4

Table 2.8 Minimum Wind Speeds (m/s) for the Merasheen BMA

	GP 12548	GP 12360
January	1.8	1.7
February	0.7	0.7
March	0.1	1.0
April	0.6	0.6
May	0.4	0.4
June	0.2	0.2
July	0.3	0.3
August	0.4	0.4
September	0.6	0.6
October	0.9	0.9
November	0.9	0.8
December	1.5	1.5

Table 2.9 Maximum Wind Speeds (m/s) for the Merasheen BMA

	GP 12548	GP 12360
January	24.9	25.1
February	26.8	26.9
March	26.8	26.9
April	20.3	20.3
May	18.9	19.1
June	19.3	19.4
July	22.8	22.8
August	22.4	22.8
September	26.9	26.8
October	28.0	28.3
November	23.4	23.3
December	24.4	24.6



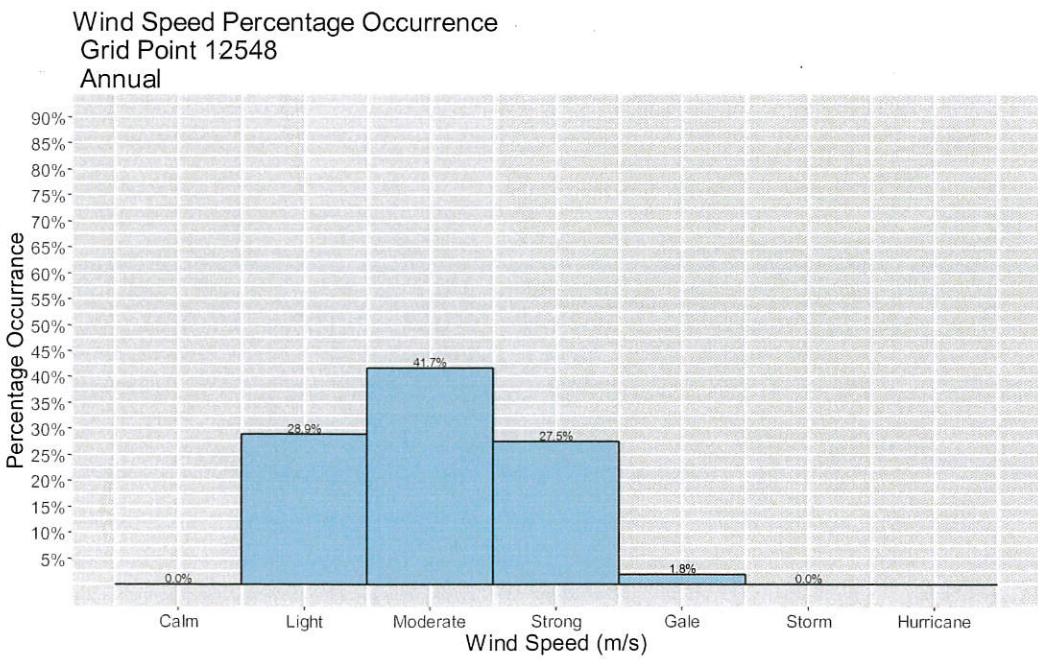


Figure 2.3 Wind Rose and Percentage Frequency Histogram for MSC50 Grid Point 12548 located at 47.5°N; 54.3W within the Merasheen BMA

2.3.4 Proposed Rushoon BMA

Mean and maximum wind speed statistics for the Rushoon BMA are presented in Table 2.10 and Table 2.12 respectively. An annual wind rose and percent frequency histogram for MSC50 Grid Point 12163 is presented in Figure 2.4.

No wind speed measurements are available within or near the Merasheen BMA. Mean monthly winds from two MSC50 grid points are presented.

Table 2.10 Mean Wind Speeds (m/s) for the Rushoon BMA

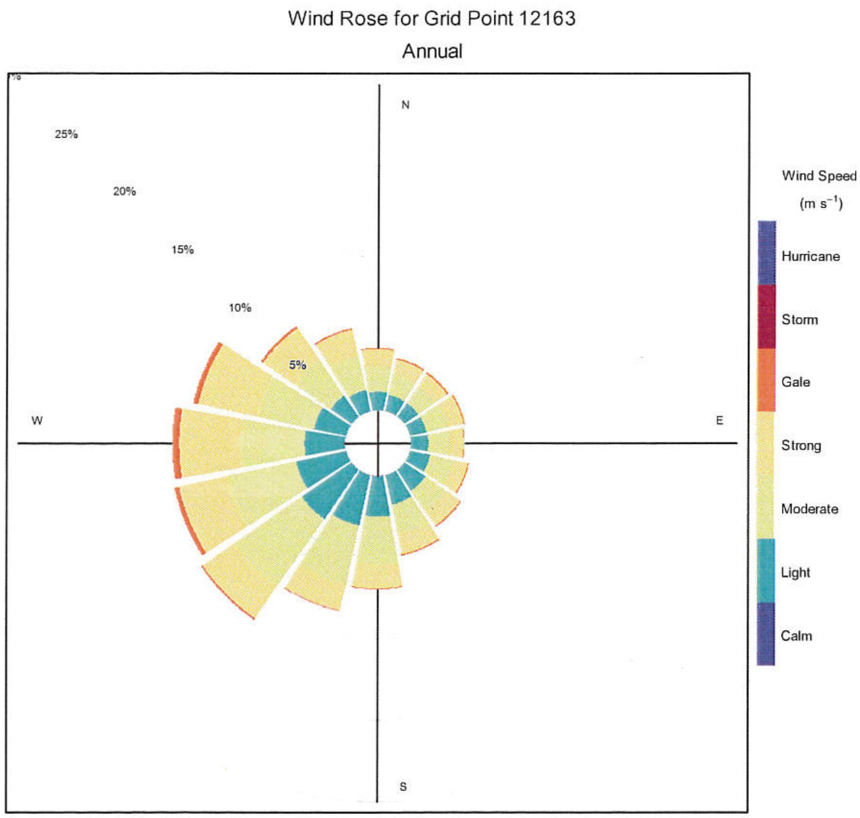
	GP 12163	GP 12164
January	10.6	10.6
February	10.0	10.1
March	9.3	9.3
April	7.9	8.0
May	6.3	6.3
June	5.6	5.7
July	5.3	5.4
August	6.0	6.0
September	7.2	7.2
October	8.5	8.6
November	9.4	9.4
December	10.3	10.4

Table 2.11 Minimum Wind Speeds (m/s) for the Rushoon BMA

	GP 12163	GP 12164
January	1.0	1.4
February	0.5	0.5
March	0.6	0.9
April	0.4	0.5
May	0.3	0.4
June	0.1	0.2
July	0.2	0.3
August	0.3	0.3
September	0.4	0.5
October	0.9	0.9
November	0.5	0.7
December	1.1	1.3

Table 2.12 Maximum Wind Speeds (m/s) for the Rushoon BMA

	GP 12163	GP 12164
January	25.3	25.3
February	26.2	26.3
March	26.9	26.9
April	20.5	20.3
May	21.3	20.3
June	19.4	19.5
July	21.9	22.2
August	24.4	24.1
September	25.8	26.5
October	30.0	28.9
November	23.8	23.2
December	25.4	25.0



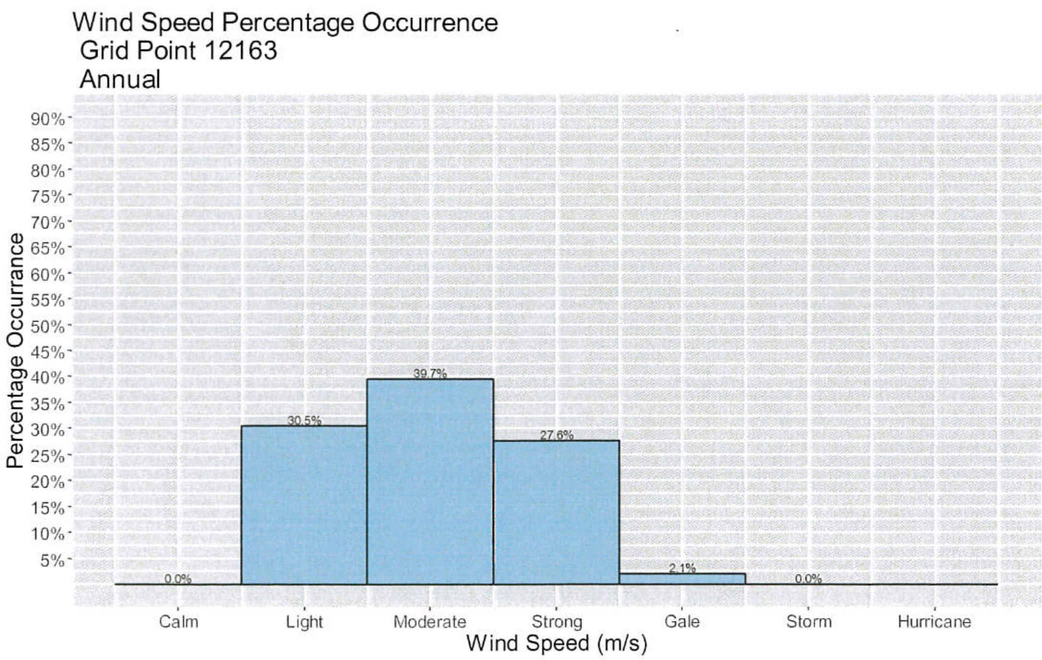


Figure 2.4 Wind Rose and Percentage Frequency Histogram for MSC50 Grid Point 12163 located at 47.3°N; 54.3W within the Rushoon BMA near Oderin Island Farm.

2.3.5 Extreme Wind Speed

Extreme winds were calculated for the northern half of Placentia Bay using the seven MSC50 grid points mentioned above. This data set was determined to be the most representative of the available data sets, as it provides a continuous 60-year period of hourly data for the site. All extremes are specified for return periods of 1-yr, 10-yr, 25-yr, 50-yr and 100-yr. All wind speeds are referenced to the 10 m height asl.

The extreme value analysis for wind speeds was carried out using the peak-over-threshold method. The Gumbel distribution was chosen to be the most representative for the peak-over-threshold method as it provided the best fit to the data. Since extreme values can vary depending on how well the data fits the distribution, a sensitivity analysis was carried out to determine the number storms to use, whereby the number of storms, the 100-year extreme value, the correlation coefficient and storm threshold were all compared on an annual basis.

The extreme value estimates for wind were calculated using Oceanweather's Osmosis software program. The analysis used hourly wind values for the reference height of 10 m asl. These values were converted to 10-minute values using a constant ratio of 1.06 (United States Geological Survey, Conservation Division, 1979).

The annual 1-hour, 10-minutes and 1-minute extreme wind speed estimates are presented in Table 2.13 through Table 2.15 for the Long Harbour, Rushoon and Merasheen BMAs. Since there were no grid points within the Red Island BMA, an extreme wind speed analysis was not possible within this BMA.

There is little variation in the extreme wind speeds for the different locations around Placentia Bay. The annual 1-hour wind speed was found to range from 28.3 m/s at Grid Point 12548 to 28.7m/s at Grid Point 12362 and 12364.

Table 2.13 One-hour Extreme Wind Speed Estimates (m/s) for Return Periods of 1, 10, 25, 50 and 100 Years

BMA	**Grid Point**	**1-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**
Long Harbour	**12361**	22.2	25.4	26.7	27.7	28.6
	12362	22.2	25.5	26.8	27.7	28.7
	12549	22.1	25.3	26.5	27.5	28.4
Merasheen	**12548**	22.0	25.2	26.5	27.4	28.3
	12360	22.1	25.4	26.6	27.6	28.5
Rushoon	**12163**	22.6	25.6	26.8	27.7	28.5
	12164	22.3	25.5	26.8	27.8	28.7

Table 2.14 Ten-minute Extreme Wind Speed Estimates (m/s) for Return Periods of 1, 10, 25, 50 and 100 Years

BMA	Grid Point	1-yr	10-yr	25-yr	50-yr	100-yr
Long Harbour	**12361**	23.5	26.9	28.3	29.3	30.3
	12362	23.5	27.0	28.4	29.4	30.4
	12549	23.4	26.8	28.1	29.1	30.1
Merasheen	**12548**	23.3	26.7	28.0	29.0	30.0
	12360	23.5	26.9	28.2	29.2	30.2
Rushoon	**12163**	24.0	27.2	28.4	29.3	30.3
	12164	23.7	27.1	28.4	29.4	30.4

Table 2.15 One-minute Extreme Wind Speed Estimates (m/s) for Return Periods of 1, 10, 25, 50 and 100 Years

BMA	Grid Point	1-yr	10-yr	25-yr	50-yr	100-yr
Long Harbour	**12361**	27.0	31.0	32.6	33.7	34.9
	12362	27.1	31.1	32.6	33.8	35.0
	12549	26.9	30.9	32.4	33.5	34.7
Merasheen	**12548**	26.9	30.8	32.3	33.4	34.6
	12360	27.0	30.9	32.5	33.6	34.8
Rushoon	**12163**	27.6	31.3	32.7	33.7	34.8
	12164	27.2	31.2	32.7	33.9	35.0

2.4 Tropical Storms

There has been an increase in the number of tropical storms that have developed within the Atlantic Basin during the last 19 years. Figure 2.5 shows the 5-year average of tropical storms which have developed within the Atlantic Basin since 1961. This increase in activity has been attributed to naturally occurring cycles in tropical climate patterns near the equator called the tropical multi-decadal signal (Bell & Chelliah, 2006). Despite the increase in Atlantic Basin Storms, there has been no appreciable increase in the number of storms which have entered the Canadian Hurricane Response Zone, or the number of storms passing through the 150nm buffer zone surrounding the BMAs.

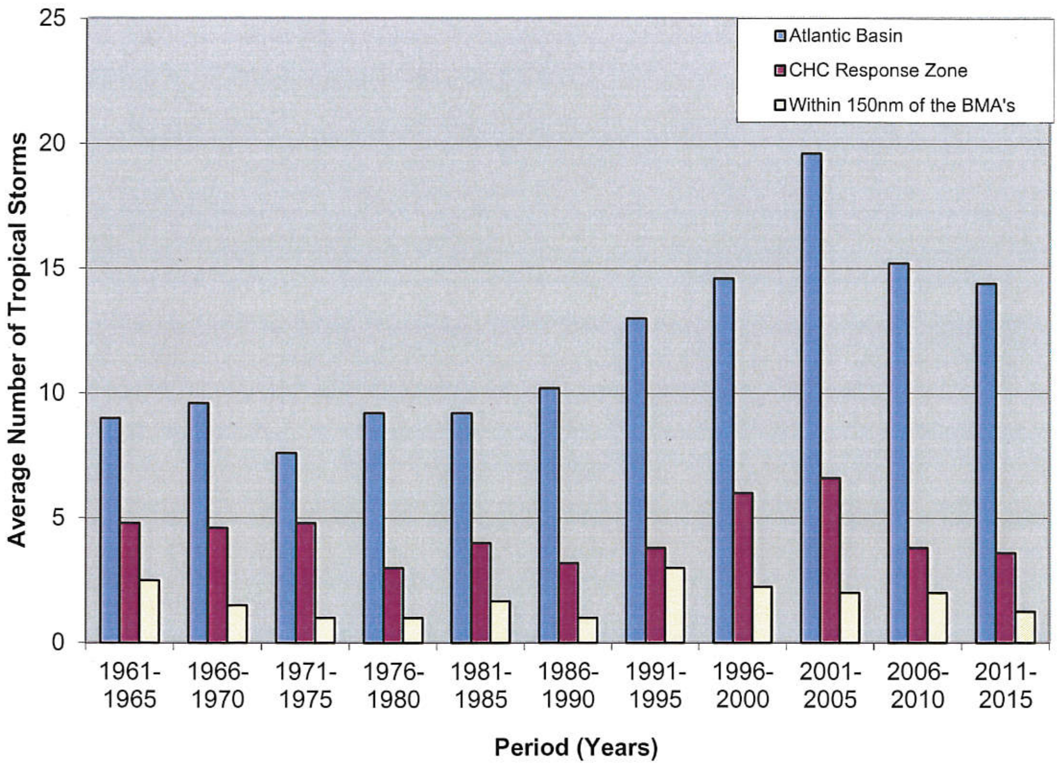


Figure 2.5 5-Year Average of the Number of Tropical Storms which formed in the Atlantic Basin since 1961

A significant number of tropical cyclones which move into the mid-latitudes transform into extratropical cyclones. On average, 46% of tropical cyclones which formed in the Atlantic transform into extratropical cyclones. During this transformation, the system loses tropical characteristics and becomes more extratropical in nature resulting in an increase in size which produces large waves, gale to hurricane force winds and intense rainfall. The likelihood that a tropical cyclone will undergo transition increases toward the second half of the tropical season; with October having the highest probability of transition. In the Atlantic, extratropical transition occurs at lower latitudes in the early and late hurricane season and at higher latitudes during the peak of the season (Hart & Evans, 2001).

Since 1960, 56 tropical systems have passed within 150 nm of the BMAs. The names are given in Table 2.16 and the storm tracks for the months of June - September are shown in Figure 2.6. Of the five months in which tropical storms affected the region, the month of September was the most active with a total of 24 named storms. There were no storms of tropical origin during the months of April and May. It should be noted that the values in Table 2.16 are the maximum 1-minute mean wind speeds occurring within the tropical system at the 10-m asl reference as it entered the area within 150nm of the BMAs.

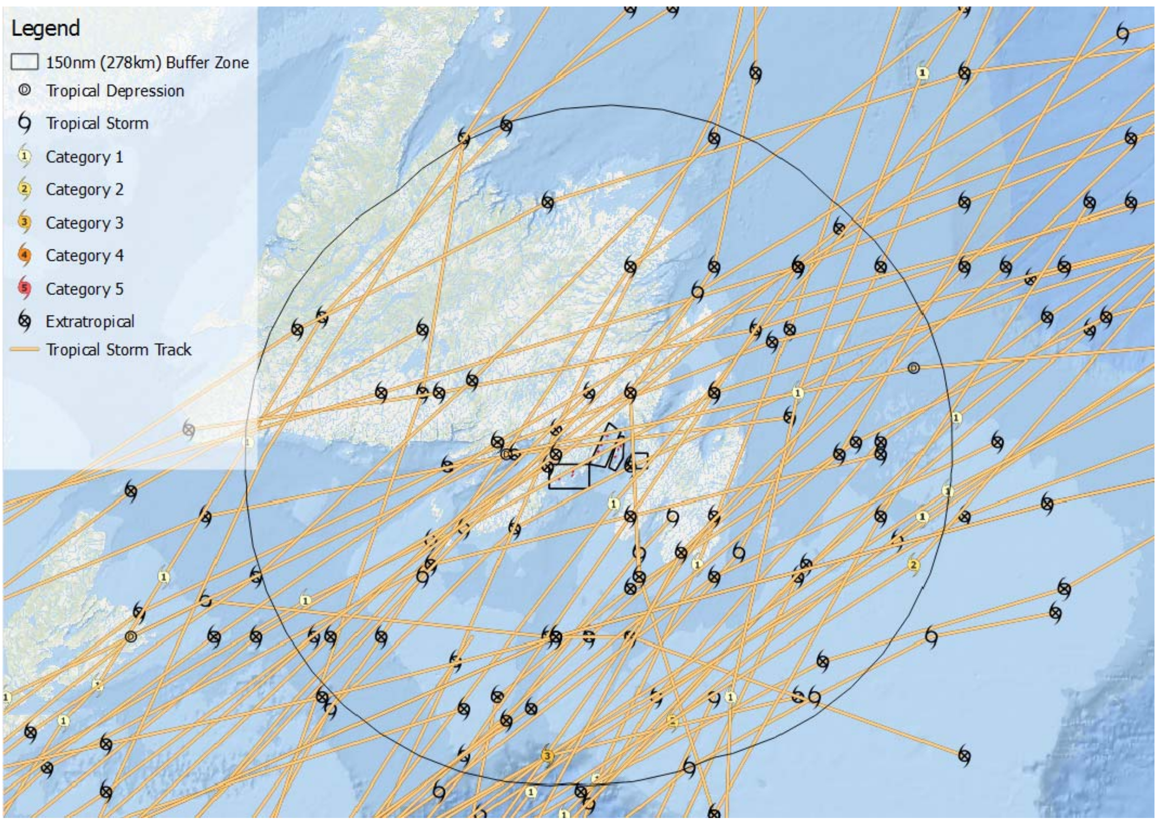


Figure 2.6 Storm Tracks of Tropical Systems Passing within 150 nm (278 km) of the Bay Management Areas (1960 to 2015)

On occasion, these systems still maintain hurricane strength as they enter the area within 150nm of the BMAs. Three Category 1, one Category 2 and one Category 3 hurricanes entered the study area during the period from 1960 to 2015. The most intense of these storms was Hurricane Ella which entered the area on September 5, 1978 with maximum sustained wind speeds of 54.0 m/s and a central pressure of 960 mb.

Table 2.16 Tropical Systems Passing within 150nm of the study area (1961 to 2015)

Year	Month	Day	Hour	Name	Latitude	Longitude	Wind (m/s)	Pressure	Category
1962	September	2	1800	Alma	45.3	-55.5	7.7	N/A	Extra-Tropical
1962	October	9	0600	Daisy	46.0	-54.9	25.7	N/A	Extra-Tropical
1962	October	22	1200	Ella	46.7	-53.4	30.9	N/A	Extra-Tropical
1964	September	15	1800	Dora	47.6	-55.6	28.3	N/A	Extra-Tropical
1964	September	25	0000	Gladys	47.5	-54.9	30.9	N/A	Extra-Tropical
1969	August	12	1800	Blanche	46.0	-54.9	30.9	N/A	Extra-Tropical
1969	August	24	0600	Debbie	45.5	-52.8	41.2	N/A	Category 1
1970	October	18	0000	Unnamed	47.0	-53.0	28.3	N/A	Extra-Tropical
1971	July	7	1800	Arlene	46.5	-53.0	23.1	N/A	Extra-Tropical
1973	October	28	0000	Gilda	45.4	-55.2	28.3	N/A	Extra-Tropical
1974	October	3	1200	Gladys	46.6	-50.6	43.7	960	Category 2
1977	September	30	0000	Dorothy	47.0	-51.0	25.7	995	Extra-Tropical
1978	September	5	0000	Ella	45.0	-55.0	54.0	960	Category 3
1979	August	6	0000	Unnamed	47.5	-55.5	12.9	N/A	Tropical Depression
1982	June	20	1800	Unnamed	45.4	-56.0	30.9	990	Extra-Tropical
1982	September	19	0000	Debby	45.3	-53.5	46.3	970	Category 2
1984	September	2	0600	Cesar	45.5	-51.8	23.1	997	Tropical Storm
1984	September	16	0600	Diana	46.0	-57.8	30.9	995	Extra-Tropical
1985	July	19	1200	Ana	48.0	-54.5	25.7	996	Extra-Tropical
1989	August	8	1200	Dean	46.5	-56.5	28.3	991	Tropical Storm
1990	October	15	0600	Lili	46.6	-56.4	20.6	994	Extra-Tropical
1995	June	9	0600	Allison	48.1	-55.9	20.6	996	Extra-Tropical
1995	August	22	1200	Felix	46.8	-50.8	25.7	985	Tropical Storm
1995	September	11	0600	Luis	47.1	-54.2	41.2	963	Category 1
1996	July	15	0000	Bertha	48.0	-57.0	25.7	995	Extra-Tropical
1996	September	15	1800	Hortense	46.0	-55.0	20.6	996	Extra-Tropical
1996	October	10	0600	Josephine	48.5	-58.0	23.1	985	Extra-Tropical
1998	September	6	0000	Earl	47.0	-54.0	25.7	979	Extra-Tropical
1999	September	19	0000	Floyd	48.0	-56.3	18.0	992	Extra-Tropical
1999	September	23	1200	Gert	46.6	-51.9	30.9	972	Extra-Tropical
2000	September	17	1800	Florence	45.5	-53.0	25.7	1002	Tropical Storm
2000	October	8	1200	Leslie	46.0	-57.0	20.6	1003	Extra-Tropical
2000	October	20	0000	Michael	48.0	-56.5	38.6	966	Extra-Tropical
2001	September	15	0000	Erin	46.7	-52.7	30.9	981	Tropical Storm
2001	September	19	1800	Gabrielle	46.5	-52.0	30.9	986	Extra-Tropical
2002	July	17	0600	Arthur	46.5	-53.9	23.1	999	Extra-Tropical

2002	September	12	0900	Gustav	47.6	-58.6	33.4	963	Category 1
2004	September	1	1800	Gaston	45.0	-55.0	23.1	998	Extra-Tropical
2005	July	30	1200	Franklin	45.8	-51.7	20.6	1005	Extra-Tropical
2005	September	18	1800	Ophelia	47.4	-56.2	23.1	999	Extra-Tropical
2005	October	26	1200	Ilma	45.0	-55.0	25.7	986	Extra-Tropical
2006	June	16	1200	Alberto	47.4	-55.0	23.1	985	Extra-Tropical
2006	July	18	1800	Unnamed	47.1	-55.8	12.9	1009	Tropical Low
2006	July	22	1200	Beryl	48.5	-56.5	15.4	1004	Extra-Tropical
2006	September	13	1200	Florence	45.5	-55.6	36.0	967	Extra-Tropical
2006	October	2	1800	Isaac	45.5	-53.7	28.3	995	Tropical Storm
2007	August	1	1200	Chantal	46.0	-54.5	28.3	990	Extra-Tropical
2008	September	8	0600	Hanna	47.5	-55.4	20.6	996	Extra-Tropical
2009	August	24	0300	Bill	46.9	-56.0	30.9	976	Tropical Storm
2010	September	21	1500	Igor	46.6	-53.2	38.6	950	Category 1
2011	September	16	1800	Maria	46.7	-53.9	30.9	983	Tropical Storm
2011	October	3	1000	Ophelia	46.9	-55.4	30.9	990	Extra-Tropical
2012	September	11	0900	Leslie	45.8	-56.1	33.4	968	Extra-Tropical
2014	October	19	0600	Gonzalo	44.5	-54.8	41.2	968	Category 1
2015	July	15	1200	Claudette	46.0	-55.9	15.4	1004	Tropical Low

2.5 Air Temperature

The moderating influence of the ocean serves to limit both the diurnal and the annual temperature variation along the coast of Placentia Bay as well as over the bay itself. Diurnal temperature variations expected at the aquaculture farms due to the day/night cycles are very small. Short-term, random temperature changes are due mainly to a change of air mass following a warm or cold frontal passage. In general, air mass temperature contrasts across frontal zones are greater during the winter than during the summer season.

Air temperature statistics were calculated for six ECCC climate stations located around the northern half of Placentia Bay. While only Marticot Harbour and Long Harbour are within the BMAs, temperatures are not expected to vary much throughout the region on any given day. Therefore, statistics from these stations can be considered representative of the Placentia Bay coast.

Monthly mean air temperature statistics are presented in Table 2.17. This table shows that temperatures are coldest in the month of February and warmest during the month of August. The moderating influence of the ocean can be seen within these statistics with mean temperatures only reaching the mid-teens during August. Similarly, mean temperatures only drop to around -5°C during the coldest month of the year.

Table 2.17 Monthly Mean Air Temperature (°C) in Placentia Bay

	Arnolds Cove	Come By Chance	Long Harbour	Red Harbour	Marticot Harbour	Argentia
January	-4.4	-4.7	-3.5	-4.7	-2.3	-2.0
February	-5.1	-5.5	-4.0	-5.1	-3.1	-2.4
March	-2.0	-2.3	-1.1	-2.1	-1.8	-0.8
April	2.3	2.2	2.9	2.3	1.8	2.2
May	5.9	6.1	6.8	6.7	5.2	5.6
June	9.5	9.9	10.7	11.0	9.3	9.3
July	13.8	14.1	15.0	15.0	13.5	13.8
August	15.3	15.4	15.9	16.5	15.9	15.7
September	12.6	12.3	12.8	12.9	13.2	13.2
October	7.8	7.5	8.3	8.1	8.9	8.9
November	3.4	3.0	4.1	3.1	5.1	5.0
December	-1.5	-1.9	-0.4	-1.1	-0.1	0.8

The maximum and minimum air temperature statistics in Table 2.18 and Table 2.19 represent the maximum and minimum temperature recorded with that month over the entire record set. Therefore, as can be seen from these tables, while the ocean does have a moderating effect on temperatures, temperatures as high as 30.6°C and as low as -28.9°C have been recorded within the region.

Table 2.18 Maximum Air Temperature (°C) in Placentia Bay

	Arnolds Cove	Come by Chance	Long Harbour	Red Harbour	Marticot Harbour	Argentia
January	11.0	10.5	15.0	12.0	8.4	15.1
February	11.0	14.5	16.0	9.0	5.8	13.7
March	13.9	15.0	17.2	12.5	10.1	14.4
April	19.5	20.0	21.0	17.0	13.8	20.9
May	20.0	20.0	20.5	25.5	15.6	20.6
June	25.0	24.5	25.0	26.0	21.3	23.9
July	26.0	27.5	26.1	28.5	23.3	26.0
August	28.0	29.0	30.6	29.5	23.8	26.1
September	26.0	26.5	27.0	30.0	24.3	24.2
October	19.5	23.0	22.5	21.5	17.5	21.1
November	15.5	16.1	19.5	17.5	14.3	21.1
December	14.0	14.4	16.1	13.0	11.3	15.7

Table 2.19 Minimum Air Temperature (°C) in Placentia Bay

	Arnolds Cove	Come by Chance	Long Harbour	Red Harbour	Marticot Harbour	Argentia
January	-21.7	-25.6	-24.0	-24.5	-17.5	-16.3
February	-25.6	-28.9	-25.0	-28.5	-15.8	-19.5
March	-21.0	-25.0	-22.5	-22.0	-15.9	-21.4
April	-18.0	-18.0	-14.0	-17.0	-11.3	-9.2
May	-6.7	-8.0	-6.7	-6.0	-2.0	-4.6
June	-1.1	-3.3	-5.0	-2.0	-0.1	0.6
July	1.0	2.0	-1.0	0.0	6.2	4.6
August	2.2	1.0	1.7	0.5	6.9	5.8
September	-1.7	-1.0	-2.5	-1.5	3.2	2.2
October	-8.0	-8.0	-6.0	-7.0	-1.9	-1.9
November	-13.5	-15.0	-12.0	-14.0	-6.8	-10.5
December	-20.0	-24.0	-20.0	-23.0	-14.5	-15.9

2.6 Precipitation

Monthly precipitation was recorded at four of the ECCC climate stations in Placentia Bay: Arnold’s Cove, Come by Chance, Long Harbour, and Red Harbour. Mean daily and maximum one day precipitation amounts for each month are provided in Table 2.20 and Table 2.21

respectively. Mean, minimum and maximum monthly precipitation amounts for the four climate stations are provided in Table 2.22 through Table 2.24.

Table 2.20 Mean Daily Precipitation Amounts (mm, on days with precipitation) for each month from the ECCC Climate Stations

	Arnolds Cove	Come by Chance	Long Harbour	Red Harbour
January	10.4	9.6	8.7	8.7
February	10.8	9.8	8.9	8.6
March	9.8	9.2	7.7	11.3
April	9.1	8.1	7.3	10.9
May	8.9	6.8	6.1	10.3
June	12.1	9.4	7.6	9.4
July	9.5	7.4	6.8	9.0
August	10.1	8.0	7.5	8.5
September	9.8	8.7	7.4	12.1
October	12.0	9.2	8.0	12.8
November	11.2	8.5	7.4	10.6
December	9.6	8.6	7.6	9.9

Table 2.21 Maximum One Day Precipitation Amounts (mm) for each month from the ECCC Climate Stations

	Arnolds Cove	Come by Chance	Long Harbour	Red Harbour
January	62.6	56.0	53.8	55.0
February	108.0	101.0	68.0	81.6
March	66.0	42.0	80.2	198.5
April	49.4	43.2	82.0	96.4
May	46.6	38.0	55.0	73.6
June	97.2	50.0	92.4	60.4
July	94.4	71.0	63.0	91.4
August	60.0	48.2	78.5	92.0
September	56.6	51.0	68.0	129.8
October	73.7	64.8	119.0	92.0
November	82.0	50.8	66.4	64.6
December	46.8	57.7	41.0	61.3

Mean daily precipitation amounts are the average daily precipitation amounts recorded on days with precipitation over all years. Maximum one day precipitation amounts refer to the maximum amount of precipitation recorded on one day within the month. Monthly mean precipitation amounts refer to the amount of precipitation recorded during the particular month averaged over the entire period.

Table 2.22 Mean Monthly Precipitation Amounts (mm) from the ECCC Climate Stations

	Arnolds Cove	Come by Chance	Long Harbour	Red Harbour
January	120.7	127.7	127.4	162.9
February	104.2	103.0	111.6	149.1
March	100.6	107.4	110.0	144.3
April	85.9	93.2	101.9	145.5
May	92.7	88.9	92.7	146.6
June	126.2	117.2	112.8	114.9
July	94.6	86.1	92.3	124.4
August	101.7	91.8	110.5	120.2
September	111.2	107.9	124.5	179.3
October	139.9	128.4	148.0	207.2
November	124.3	108.1	125.9	176.2
December	111.5	115.0	117.6	174.3

Table 2.23 Minimum Monthly Precipitation Amounts (mm) from the ECCC Climate Stations

	Arnolds Cove	Come by Chance	Long Harbour	Red Harbour
January	37.8	63.0	42.0	101.0
February	17.2	34.1	24.4	54.2
March	42.9	43.4	42.5	78.0
April	20.8	33.4	21.9	65.4
May	38.2	28.8	28.8	49.6
June	42.2	45.2	17.8	53.8
July	21.1	29.0	13.0	57.3
August	29.0	28.2	53.2	80.6
September	33.8	43.7	52.3	92.6
October	54.4	33.7	52.6	117.6
November	58.4	33.0	62.8	74.6
December	56.2	65.9	60.8	142.0

Table 2.24 Maximum Monthly Precipitation Amounts (mm) from the ECCC Climate Stations

	Arnolds Cove	Come by Chance	Long Harbour	Red Harbour
January	202.6	213.7	202.1	278.0
February	265.2	227.6	207.7	226.0
March	169.1	171.0	218.4	279.3
April	196.9	183.8	240.9	361.0
May	153.8	141.9	157.2	245.6
June	300.5	295.9	249.2	186.3
July	233.4	187.5	223.4	195.2
August	204.0	200.7	343.6	196.2
September	196.2	180.2	222.7	294.6
October	231.0	259.4	311.2	355.5
November	185.8	163.5	208.4	273.0
December	193.1	207.2	168.2	231.6

2.7 Climate Change

Climate is naturally variable and can change over a range of time scales from the very short term, to seasonally, and to longer time periods in response to small and large-scale changes of atmospheric circulation patterns. Short-term meteorological variations are largely a consequence of the passage of synoptic scale weather systems: low pressure systems, high pressure systems, troughs and ridges. The energetics of these features varies seasonally in accordance with the changes in the strength of the mean tropical - polar temperature gradient. Long-term changes occur in response to small and large-scale changes of atmospheric circulation patterns and in the past in the Northern Hemisphere were the mainly result of changes in the North Atlantic Oscillation (NAO). While the NAO still has an effect on climate patterns, there is a general consensus amongst the scientific community that Greenhouse Gas emissions have played a significant role in the climate during the last 60 years.

The dominate features of the mean sea level pressure pattern in the North Atlantic Ocean are the semi-permanent area of relatively low pressure in the vicinity of Iceland and the sub-tropical high-pressure region near the Azores. The relative strengths of these two systems control the strength and direction of westerly winds and storm tracks in the North Atlantic and therefore, play a significant role in the climate of the North Atlantic. The fluctuating pressure difference between these two features is known as the NAO.

A measure of the NAO is the NAO Index, which is the normalized difference in pressure between the Icelandic low and the Azores high. A large difference in pressure results in a positive NAO Index and can be the result of a stronger than normal subtropical high, a deeper than normal sub-polar low, or a combination of both. The positive phase of the NAO index results in more and stronger winter storms crossing the North Atlantic on a more northerly track, and cold dry winters in Northern Canada and Greenland, while the negative phase results in fewer and weaker storms crossing on a more west-east track. A time-series of the Winter (DJF) North Atlantic Oscillation Index during the period of 1950 – 2017 is presented in Figure 2.7.

The negative phase of the NAO dominated from the mid to late 1950’s until the early 1970’s. There was a 5-year period of positive phase in the 1970’s, then another shift back to a negative phase for three years from 1977 – 1979. From 1979/80 until the late 2000’s the NAO index remained in a generally positive mode, with only six deviations into the negative mode during this 29-year period. Since 2012, the NAO has been in a positive phase with 2015 being the strongest positive phase since 1950. It is uncertain how long this recent trend will persist.

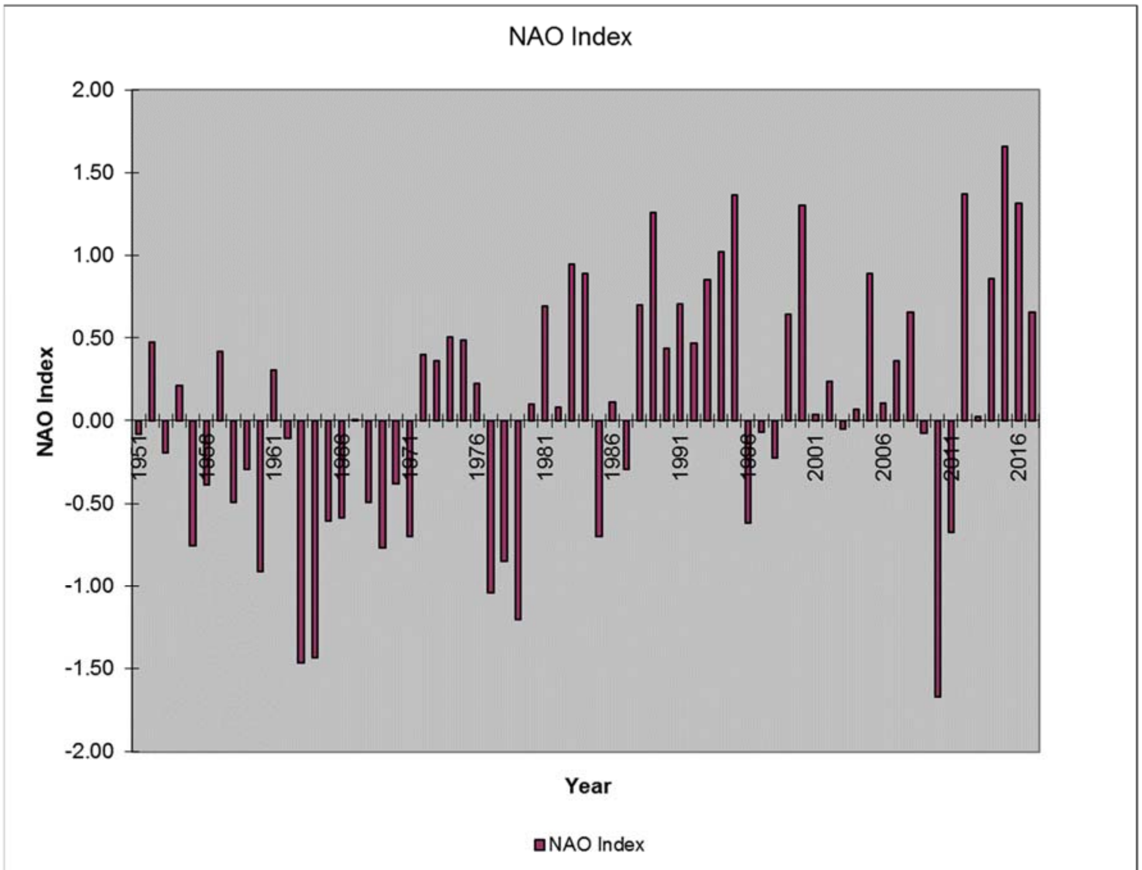


Figure 2.7 The Winter North Atlantic Oscillation Index

2.7.1 Storm Frequency and Intensity

The mean location of extratropical cyclones is referred to as the storm track, the location of which is determined by troughs and ridges in the upper atmosphere. Low pressure systems tend to form in the regions of maximum jet stream located downstream of the upper troughs and follow the jet axes. As a result, areas immediately downstream of an upper trough typically experience more cyclones. A study by Reitan (1974) found that the highest frequency of storms occurs between 40° to 50°N, with one of the most active areas being over the Gulf Stream off the United States Eastern Seaboard. Changes in the location of the jet stream, and intensity of altitude can result in changes in the frequency and intensities of storm systems.

A number of studies have been done recently to assess whether climate change and global warming would have an effect on storm tracks, frequency and intensity. Archer and Caldeira (2008) found that during the period of 1979 to 2001, there was a poleward shift in the jet stream of 0.17 to 0.19 degrees/decade and a significant pressure decrease which would imply an increase in jet stream altitude in the Northern Hemisphere. These results were consistent with an increase in mean temperature from equator to pole. Changes in jet-stream latitude, altitude and strength, have the potential to affect the formation and evolution of storms in the mid-latitudes and of hurricanes in the sub-tropical regions. These results are consistent with a study by McCabe (2001) which showed that from the period of 1959 to 1997, there has been a significant decrease in mid-latitude cyclone frequency and a significant increase in high-latitude cyclone frequency consistent with increases in winter Northern Hemisphere temperatures.

During the summer months, the NAO index has a less direct effect on the climate of Eastern Canada; however, studies have shown that the NAO has an effect on the track of hurricanes in the North Atlantic. During seasons with a negative NAO index, hurricanes tend to follow a track that parallels lines of latitude often ending up in the Gulf of Mexico and the Caribbean (Elsner, 2003), while during seasons with a positive NAO index, hurricanes tend to curve northward (Elsner & Bossak, 2004) along the United States Eastern Seaboard. An analysis of the number of tropical storms entering the Canadian Hurricane Centre Response Zone, however, shows no correlation between tropical cyclone frequency and NAO Index.

2.7.2 Temperature and Precipitation Changes

In the last 60 years, most parts of Canada have experienced warmer temperatures and increased precipitation. It should not be inferred, however, that temperature and precipitation over the whole earth, or even all of Canada is increasing at the same rate. In fact, some areas will experience increasing trends, while other areas may experience a decreasing trend. Over the past century, the earth's temperature has increased by 0.85°C (IPCC, 2013) over the period of 1880-2012. However, between 1895-1995 Canada's temperature increased by 1.1°C (Environment Canada, 1997) with most of this increase occurring during the last decade.

Future climate trends are difficult to predict and the Intergovernmental Panel on Climate Change (IPCC) has developed a number of plausible future climate scenarios. The most commonly used of these scenarios are the Representative Concentration Pathway (RCP) scenarios. RCP scenarios are new scenarios that specify concentrations and corresponding emissions but are not directly based on socio-economic storylines like the SRES scenarios. The RCP scenarios are based on a different approach and include more consistent short-lived gases and land use changes (IPCC, 2013). Four possible scenarios have been chosen by the IPCC to represent future conditions. These four scenarios are the RCP 2.6, RCP 4.5, RCP 6 and RCP 8.5.

According to the IPCC, the projected change in global mean surface air temperature for all four RCP's will likely be in the range of 0.3 to 0.7°C (IPCC, 2013). A regional map showing the 50th and 75th percentile December-February and June-August temperature change in Eastern North America is shown in Figure 2.8.

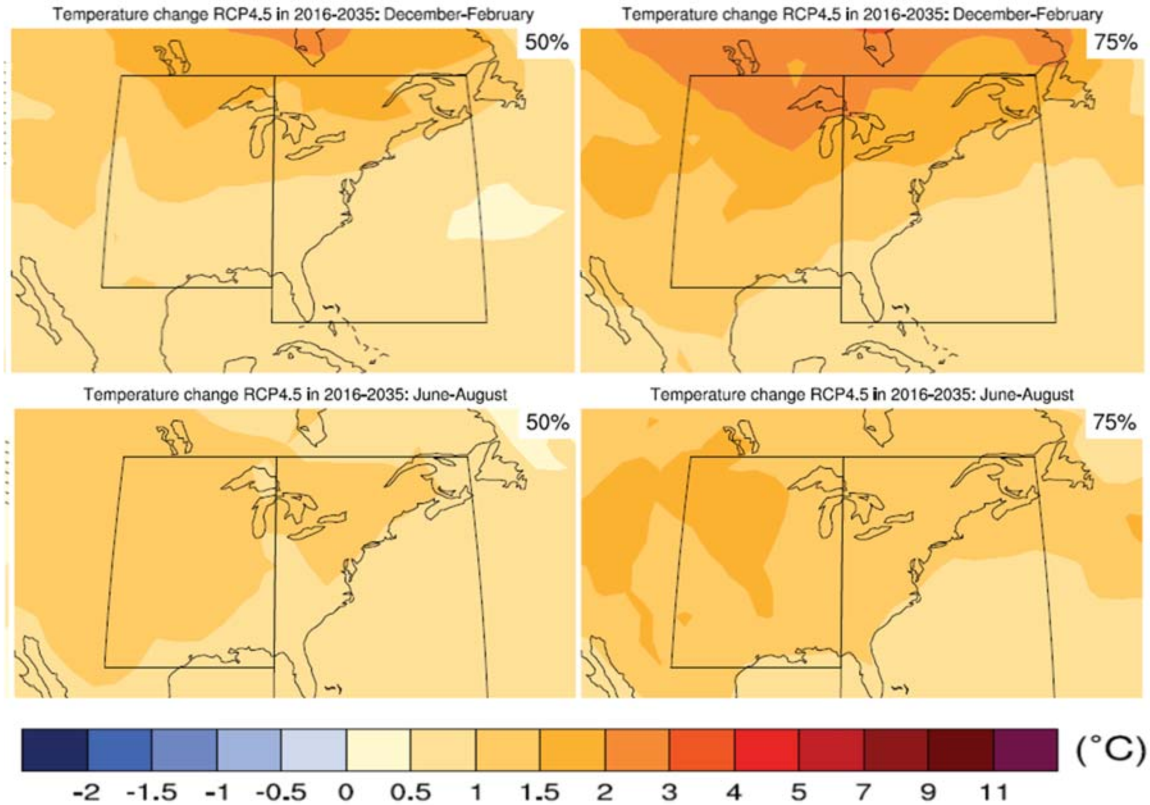


Figure 2.8 Possible future temperature change from the CMIP5 ensemble model running the RCP4.5 scenario for Eastern North America

Changes in precipitation are more difficult to predict than temperature, however ensemble models show some consistency on larger scales, but larger uncertainty on regional scales. The IPCC reports that zonal mean precipitation will very likely increase in high and some of the mid latitudes.

A regional map showing the 50th and 75th percentile December-February and June-August precipitation change in Eastern North America is shown in Figure 2.9. The hatched area denotes areas where the 20-year mean differences of the percentiles are less than the standard deviation of model-estimated present-day natural variability of 20-year mean differences.

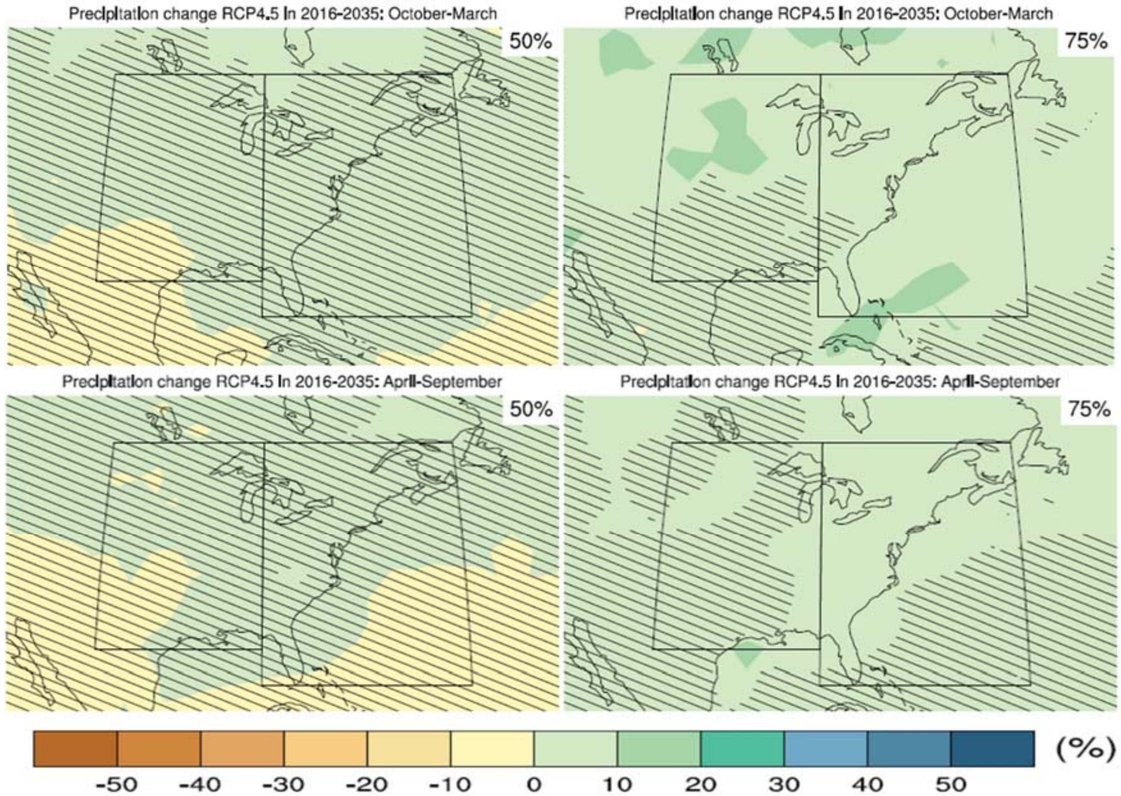


Figure 2.9 Possible future precipitation change from the CMIP5 ensemble model running the RCP4.5 scenario for Eastern North America

2.7.3 Sea Ice and Icebergs

The thickness and extent of ice in the Arctic has long been considered to be a sensitive indicator of climate change. Studies in the past (McLaren, The Under-Ice Thickness Distribution of the Arctic Basin as Recorded in 1958 and 1970, 1989); (McLaren, Walsh, Bourke, Weaver, & Wittmann, 1992); (Wadhams, Evidence for Thinning of the Arctic Ocean Cover North of Greenland, 1990) have shown that sea ice thickness has been decreasing and it was surmised that sea ice thickness would continue to decrease throughout the 1990s. Several recent studies however (Winsor, 2001); (Laxon, Peacock, & Smith, 2003), have shown that this is not the case and that sea ice thickness has remained relatively constant during the 1990s. Winsor (2001) further surmised that the thickness of sea ice cover has remained on a near constant level during the period of 1986 to 1997. This is supported by Wadhams and Davis (2000) who concluded that a substantial part of the thinning in the previous studies took place during the late 1970s and early 1980s.

Inter-annual Arctic winter sea ice variability has been linked to large scale sea level pressure and surface air temperature changes associated with the North Atlantic Oscillation (Deser, Walsh, & Timlin, 2000). The study by Deser et al. examined sea ice concentrations anomalies in the Arctic during 1958 to 1997 and its association with surface air temperature and sea level pressure. The study found that when wintertime sea level pressure (SLP) is lower than normal over the North

Atlantic (positive phase of the NAO), the Labrador Sea ice boundary extends further south in the spring.

A concern that often arises with global warming is whether or not there would be an increase in the number of icebergs off Newfoundland and Labrador due to an increase in calving at tidal glaciers. A study by Marko et al (1994) observed the inter-annual and seasonal variations in the numbers of icebergs passing south of 48°N off eastern North America. This study showed that the number of icebergs off Newfoundland and Labrador is relatively insensitive to iceberg production rates and highly dependent on the Labrador spring ice extent, with higher numbers of icebergs occurring when the sea ice extent is greatest. The spring sea ice ensures iceberg survival by preventing them from grounding and subsequently melting on shallow continental shelves, suppressing sea surface temperatures and suppressing wave heights. A decrease in sea ice extent due to climate variability should result in a decrease in the number of icebergs near the aquaculture sites.

2.7.4 Sea Level Rise

Sea levels are expected have been on the increase and are expected to continue to rise over the next 80 years as a result of climate change. Observations since 1971 indicate that thermal expansion and glacier melting explains 75% of the observed rise. The contribution of the Greenland and Antarctic ice sheets has increased since the early 1990s, partly from the increased outflow induced by warming of the immediately adjacent ocean (IPCC, 2013). There is a high confidence in the future projections of sea level rise due to ocean thermal expansion and a medium confidence in the projections due to glacier melting.

The rate of sea level rise is projected to vary on a regional basis, with some regions experiencing a rise in sea level and others experiencing a decrease in sea level. The global mean is 0.48 m with a total range of -1.76 m to 0.71 m (IPCC, 2013). Decreases in sea levels are expected to occur in regions located near glaciers and ice sheets. Figure 2.11 shows the regional projected sea level rise based on the RCP 4.5 scenario. This indicates a sea level rise of approximately 0.6 m for the waters south of Newfoundland, including Placentia Bay, by the 2081 – 2100 period.

Sea level predictions were also computed for several cities globally. The closest projection to Newfoundland was for the city of New York. A graph of the observed and projected sea level rise for New York is presented in Figure 2.12. This graph indicates a sea level rise of about 0.06 m per year.

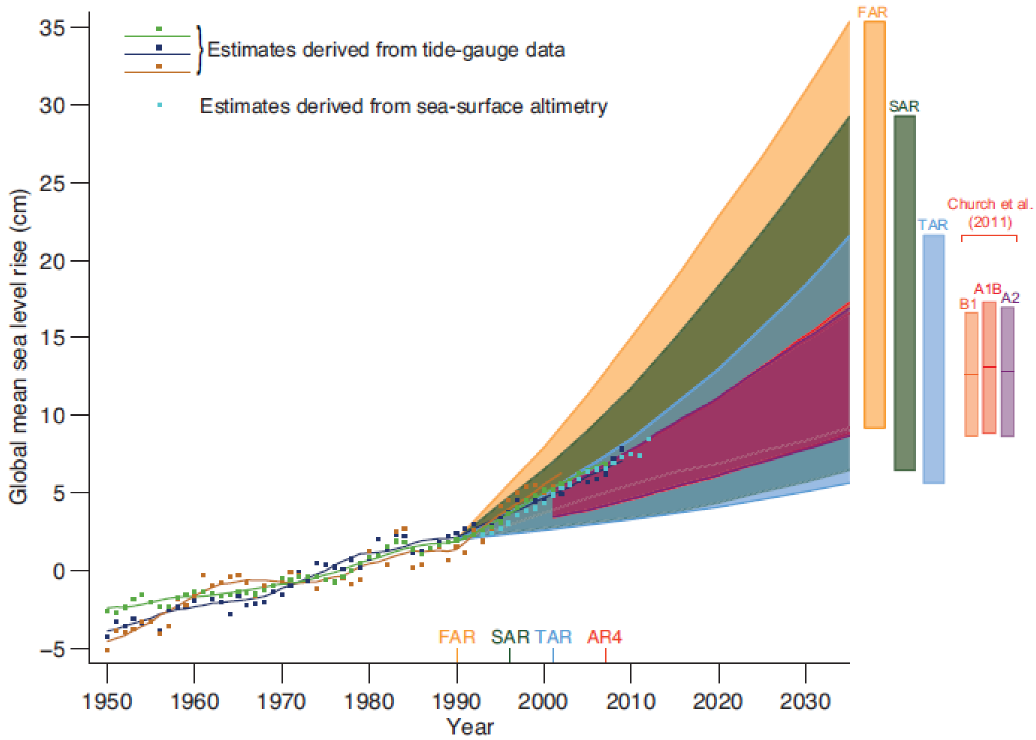


Figure 2.10 Past and future likely ranges of global mean sea-level rise (IPCC, 2013)

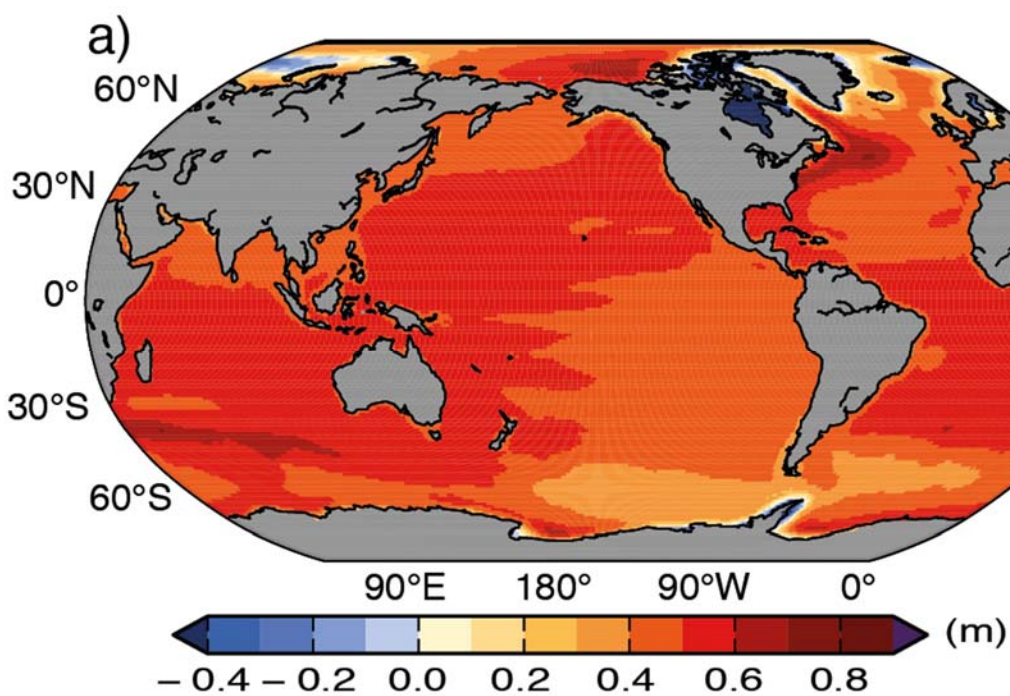


Figure 2.11 Ensemble mean regional relative sea level change (m) evaluated from 21 models of the CMIP5 scenario RCP 4.5 between 1986 - 2005 and 2081 - 2100

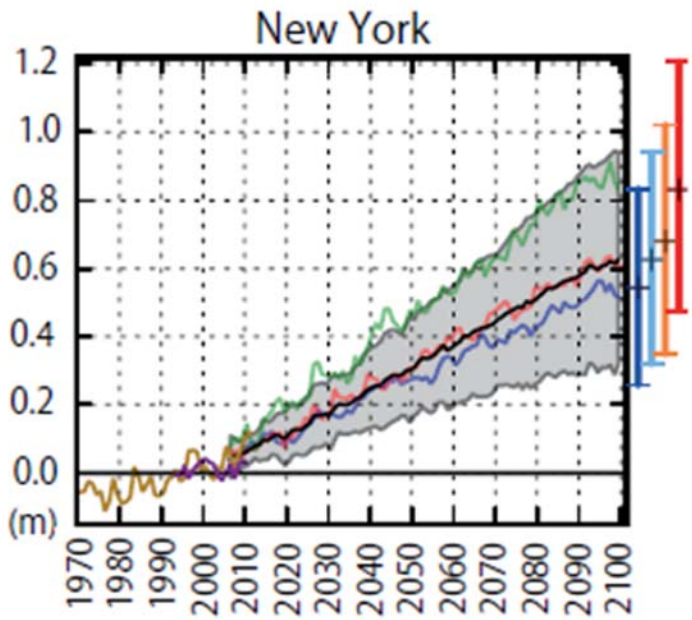


Figure 2.12 Observed and Projected Sea Level Change near New York.

3.0 Aquatic Environment

3.1 Ocean Currents

The bathymetry of Placentia Bay is very irregular with many banks and troughs. There are several islands in the Bay; the largest is Merasheen Island situated in the inner portion of the bay. A deep channel on the eastern side of Placentia Bay has water depths extending to approximately 300 m in some locations. In general, the water is shallower on the western side of the Bay than on the eastern side with the exception of many deep troughs.

In general, the near-surface currents in Placentia Bay have been observed to flow counter clockwise around the Bay. This circulation pattern is not consistent at deeper levels. The flow in Placentia Bay is expected to be the result of tides, winds, and the Labrador Current. Since the variability due to tides account for approximately only 15% of the total variability, other factors are more important. Winds in the area are predominately from the southwest during all seasons and this would contribute to a counter clockwise pattern in the near surface waters. The inshore branch of the Labrador Current follows the bathymetric contours around the Avalon Peninsula. North of Green Bank the direction of the bathymetric contours shift from an east/west direction to a north/south direction. The Labrador Current probably divides at this location with a portion of the Labrador Current contributing to the flow into Placentia Bay and becoming the major contributor to the overall current variability.

3.1.1 Data Sources

Current data in Placentia Bay was collected by the Department of Physics and Physical Oceanography at Memorial University during the spring (April to June) of 1998 and 1999, and by the Bedford Institute of Oceanography (BIO) during winter 1988 (February 16 to March 29) and fall 1998 (September 27 to October 29). The Memorial University data consisted of data from two sites in 1998 and seven sites in 1999. In 1999, there were four moorings deployed in the outer section of the Bay with two instruments on each mooring, and three ADCPs deployed around the islands in the inner section of the Bay in the location shown in Figure 1. Two of the moorings in the outer section of the Bay in 1999 were in the same locations as the moorings in 1998. The BIO moorings consisted of three moorings (Figure 3.1) with two instruments on each mooring; one instrument moored near the surface between 15 m and 25 m and the other moored between 49 m and 63 m.

The Marine Institute School of Ocean Technology has had a Smart Bay Buoy moored in the channel east of Red Island collecting near surface current data at a depth of 0.5 m since 2010. The location corresponds with the current data collected by the Memorial mooring in 1999.

Grieg NL collected current data in each of the 11 proposed aquaculture sites during January to March 2016 (DHI, 2016) to support a dispersion modelling study. The total current monitoring time was limited and varied by site ranging from 20 hours to 7 days in duration.

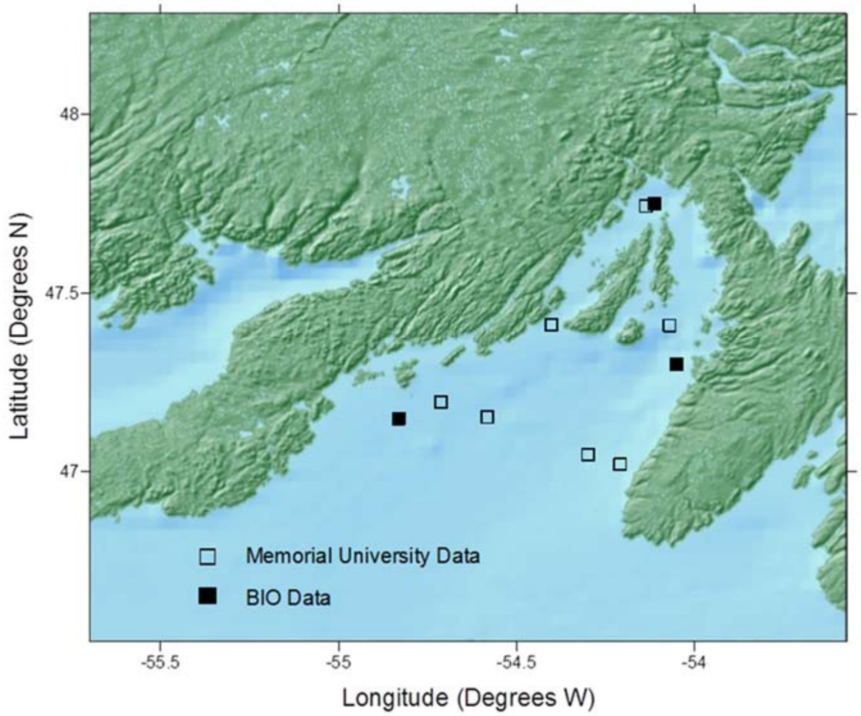


Figure 3.1 Location of Current Meter Moorings in Placentia Bay

3.1.2 Proposed Long Harbour BMA

The proposed aquaculture sites outside Long Harbour are shown in Figure 3.2.

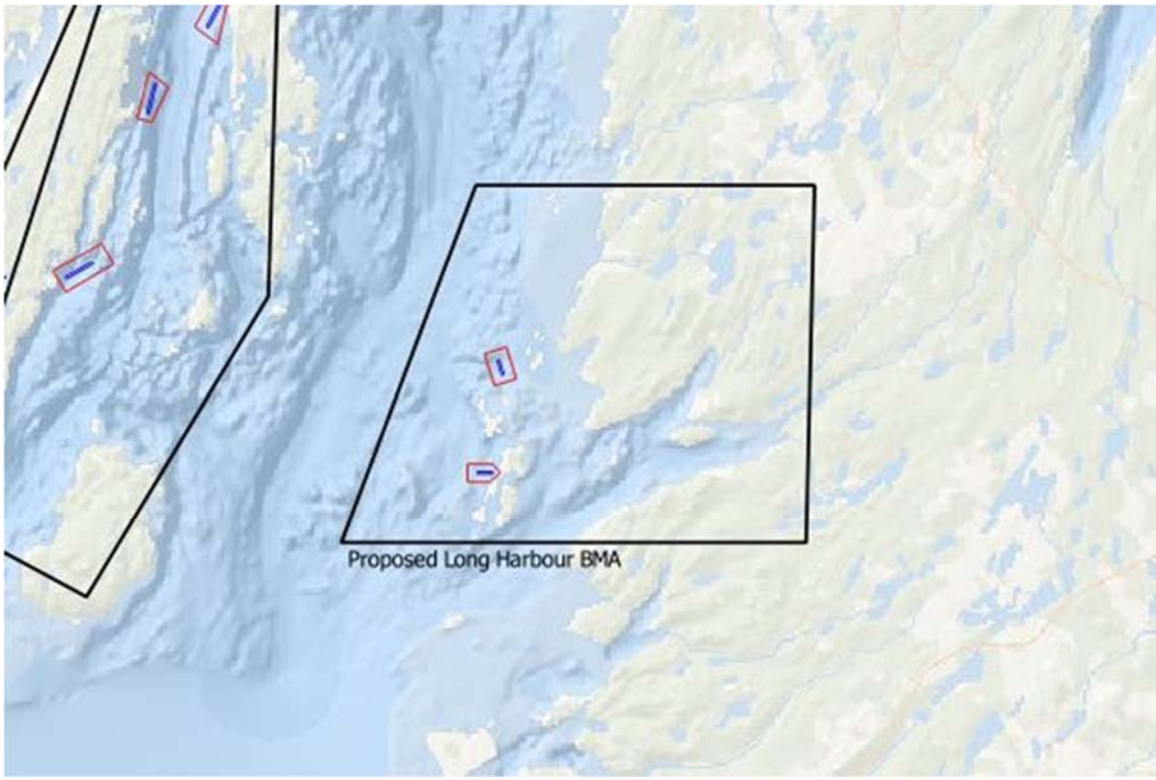


Figure 3.2 Proposed Long Harbour Aquaculture Sites

At the head of Placentia Bay on the eastern side, the Memorial data showed that the current is consistently flowing into the bay with mean speeds between 11 cm/s and 18 cm/s at a depth of 20 m. The maximum current speed reached 75 cm/s during the sampling period in 1999. During the same year the near surface current at 16 m in the middle of the channel between Red Island and the aquaculture site had a mean speed of 16 cm/s and a maximum speed of 79 cm/s. The BIO data collected outside Long Harbour during winter and fall of 1988 showed similar current speeds. The mean current speed at approximately 23 m was between 12 cm/s and 13 cm/s and reached a maximum speed of 75 cm/s. At this location the current is still flowing predominately into the Bay, but at times the current is flowing in the opposite direction, presumably due to tidal influence. The semi-diurnal tidal constituents M_2 and S_2 had values of 6.0 cm/s and 3.7 cm/s, respectively. The tidal current during spring tides is approximately 10 cm/s. A rose plot of the near-surface current is shown in Figure 3.3.

DHI collected current data for GREIG Seafarms between March 2 and March 7, 2016 at two locations in the study area. The currents were measured near the Brine Islands for a duration of

2.8 days and near the IONA Islands for a duration of two days. The current direction was variable at both locations, sometimes showing a tidal influence. At a depth of 30m, the current speed reached a maximum of 25 cm/s near the Brine Islands location and a maximum of 22 cm/s near the IONA Islands

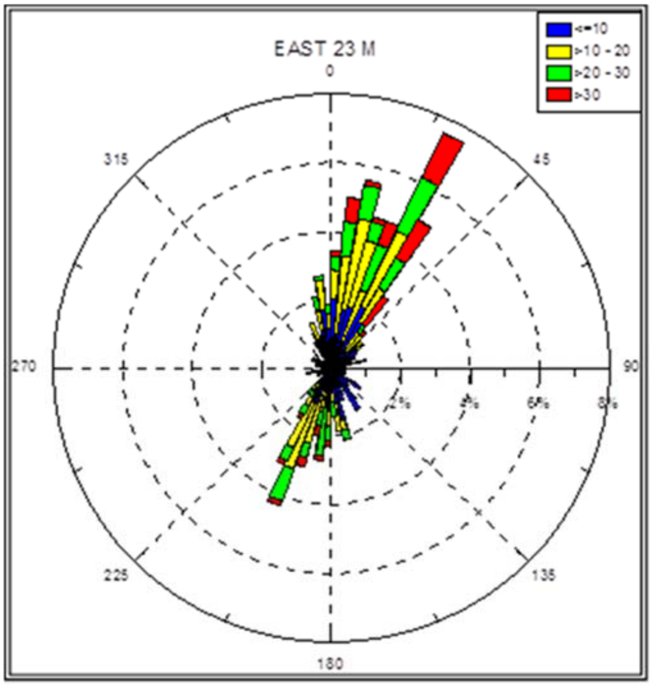


Figure 3.3 Rose Plot of the Near-Surface Current Speeds and Directions Outside Long Harbour in 1988

3.1.3 Proposed Red Island BMA

The location of the proposed aquaculture sites east of Merasheen Island is shown in Figure 3.4. With the exception of current data collected by Grieg NL at each of the aquaculture (lease) sites, there is no current information for the stretch of water between Merasheen Island and Red Island.

Data was collected by DHI for Greig NL between February 20 and March 2, 2016. The sampling periods for the location varied between 0.8 days and six days. The current direction was predominately into the Bay at a depth of 30m and the maximum current speed was 15 cm/s.

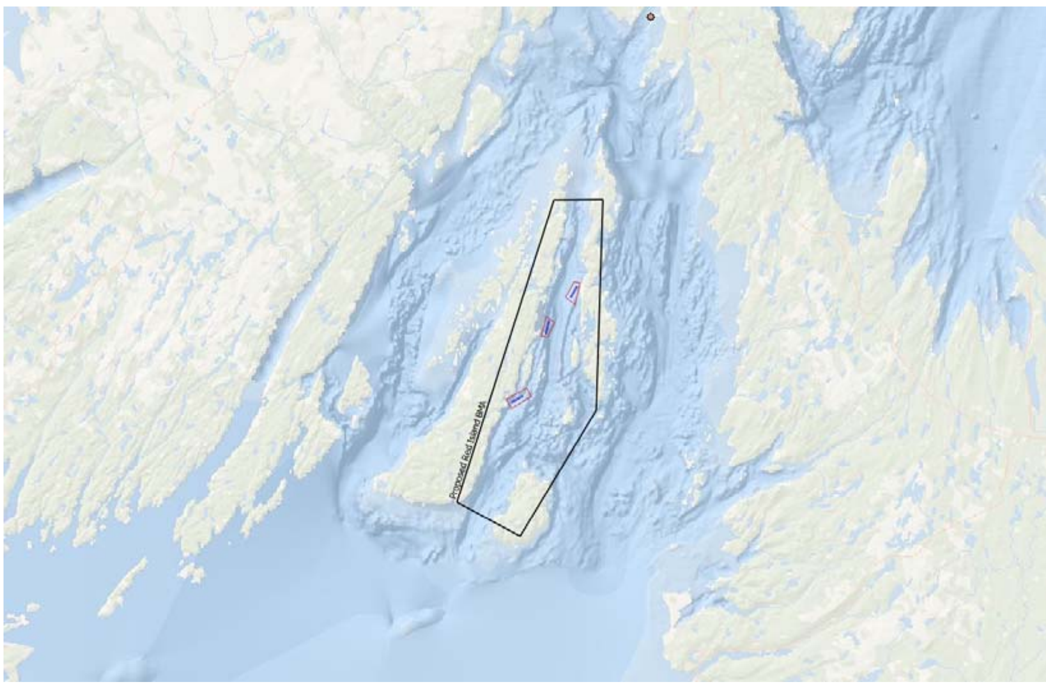


Figure 3.4 Proposed Red Island Aquaculture Sites

3.1.4 Proposed Merasheen BMA

The locations of the proposed aquaculture sites for the proposed Merasheen location are situated west of Merasheen Island. These locations are shown in Figure 3.5.

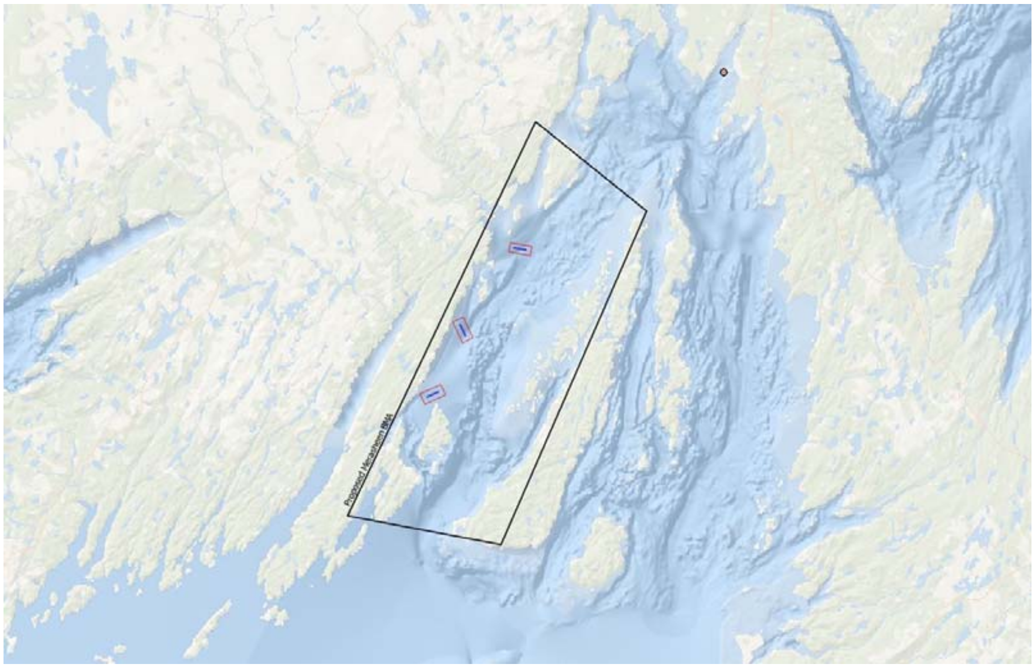


Figure 3.5 Proposed Merasheen Aquaculture Sites

The current speeds on the Western side of Placentia Bay are less than on the eastern side. In 1999, the Memorial data showed that the mean current speed at a depth of 36 m was 7.9 cm/s and reached a maximum speed of 36.5 cm/s during the sampling period. The rose plot in Figure 3.6 shows that the flow was mainly towards the southwest, or out of the Bay. There is also a significant northeast component. The semi-diurnal constituents M_2 and S_2 were 4.0 cm/s and 1.3 cm/s, respectively. During spring tide, the tidal current is expected to be approximately 5-6 cm/s.

DHI measured the currents for Greig NL at three locations in the study area between February 1 to February 20, 2016, for durations of approximately two days, one day and 8 days respectively. The current directions were variable. At a depth of 30m, the maximum current speeds were 10 cm/s for the Valen Island location, 14 cm/s for the Chambers Island location, and 30 cm/s for the Ship Island location.

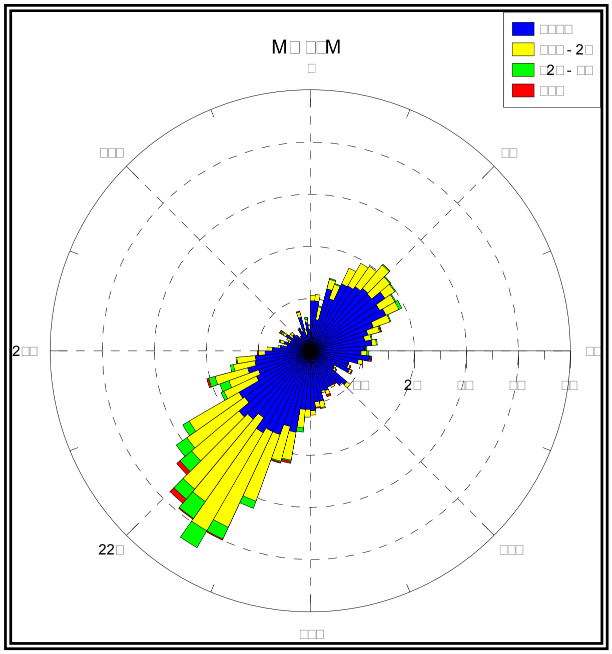


Figure 3.6 Rose Plot of Current Speed and Directions at 36 m west of Merasheen Island

3.1.5 Proposed Rushoon BMA

The location of the proposed aquaculture sites in the Rushoon area is shown in Figure 3.7.

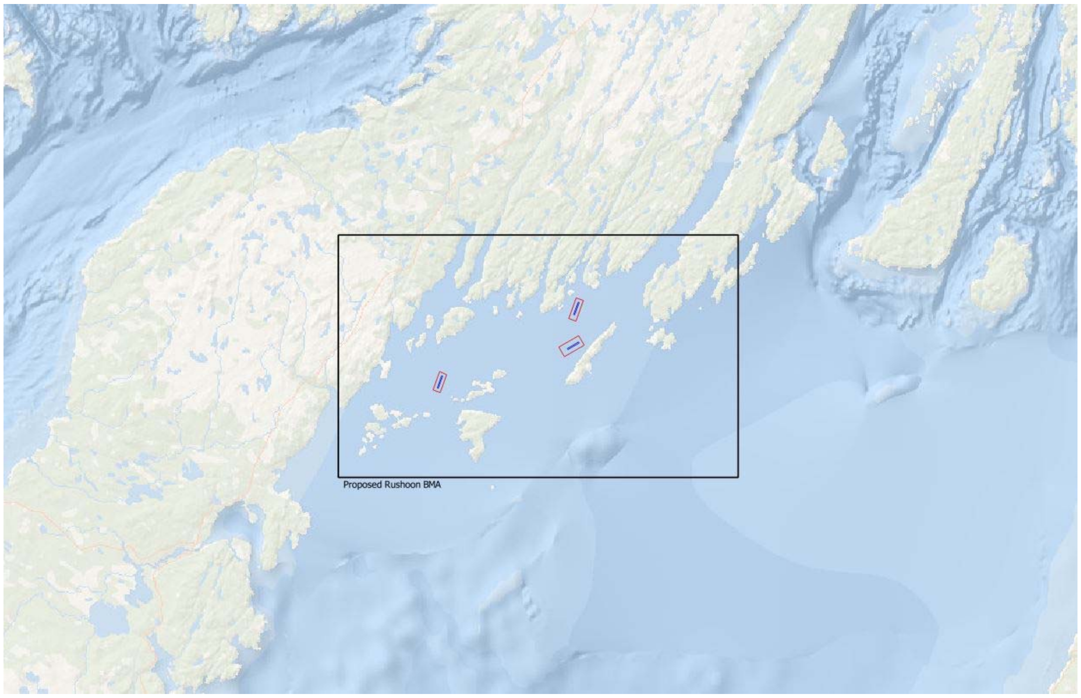


Figure 3.7 Proposed Rushoon Aquaculture Sites

With the exception of current data collected by Grieg NL at each of the aquaculture (lease) sites, there are no current data. The currents are expected to be weak due to the presence of the islands east of the sites. Outside the islands, currents were measured by Memorial University in 1999 and BIO in 1988. The Memorial data showed mean near surface currents (20 m) of 10.3 cm/s and a maximum current of 49.7 cm/s.

The current flowed consistently out of the Bay (Figure 3.8). The semi-diurnal tidal constituents M_2 and S_2 had values of 5.9 cm/s and 1.4 cm/s, respectively. The tidal current at spring tides is expected to be approximately 8 cm/s. BIO data measured during the fall of 1988 showed a similar pattern in the currents. The current flowed consistently out of the Bay with a mean speed of 9.1 cm/s and a maximum speed of 37.3 cm/s. Figure 3.9 presents a rose plot of the current speeds and directions.

The currents were measured at three locations in this study area by DHI for Grieg NL between January 28 and February 1, 2016. The sampling period was less than one day at Gallows Harbour and Oderin Island and for approximately two days at Long Island. The current directions are variable. At a depth of 30m, the maximum current speed was 5 cm/s at the Gallows Harbour location, 15 cm/s at the Long Island location and 5 cm/s at the Oderin Island location.

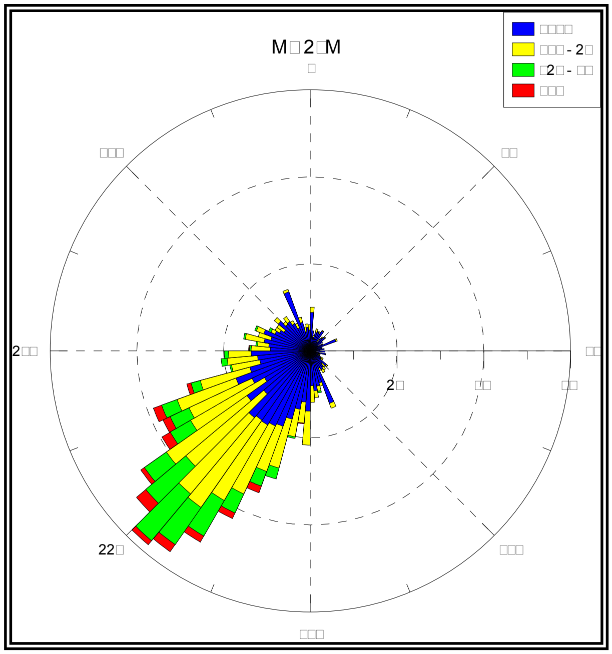


Figure 3.8 Rose Plot of the Near-Surface Current Speeds and Directions from the Memorial University Data Set

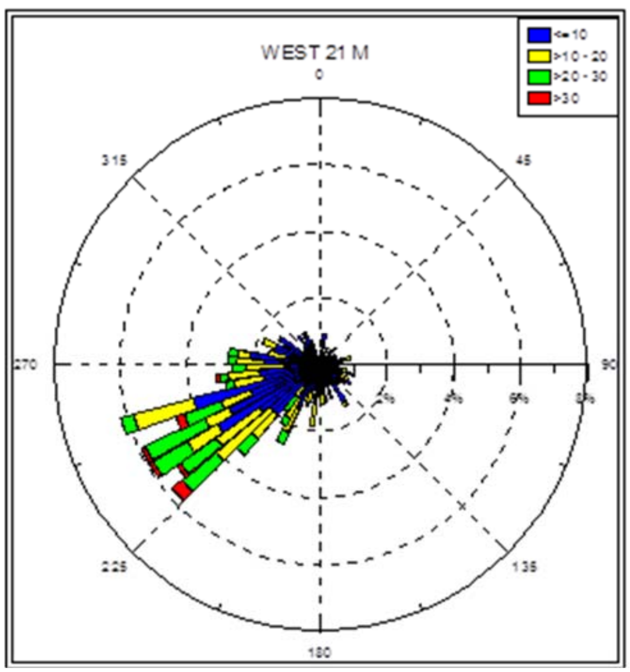


Figure 3.9 Rose Plot of the Near-Surface Current Speeds and Directions Corresponding to the BIO Fall Data Set

3.2 Waves

The main parameters for describing wave conditions are the significant wave height, the maximum wave height, the peak spectral period, and the characteristic period. The significant wave height is defined as the average height of the 1/3 highest waves, and its value roughly approximates the characteristic height observed visually. The maximum height is the greatest vertical distance between a wave crest and adjacent trough. The spectral peak period is the period of the waves with the largest energy levels, and the characteristic period is the period of the 1/3 highest waves. The characteristic period is the wave period reported in ship observations, and the spectral peak period is reported in the MSC50 data set.

A sea state may be composed of the wind wave alone, swell alone, or the wind wave in combination with one or more swell groups. A swell is a wave system not produced by the local wind blowing at the time of observation and may have been generated within the local weather system, or from within distant weather systems. The former situation typically arises when a front, trough, or ridge crosses the point of concern, resulting in a marked shift in wind direction. Swells generated in this manner are usually of low period. Swells generated by distant weather systems may propagate in the direction of the winds that originally produced the waves to the vicinity of the observation area. These swells may travel for thousands of miles before dying away. As the swell advances, its crest becomes rounded and its surface smooth. As a result of the latter process, swell energy may propagate through a point from more than one direction at a particular time.

The wave climate of Placentia Bay is dominated by extra-tropical storms, primarily during October through March. Severe storms may, on occasion, occur outside these months. Storms of tropical origin may occur during the early summer and early winter, but most often from late August through October. Hurricanes are usually reduced to tropical storm strength or evolve into extra-tropical storms by the time they reach the area but they are still capable of producing storm force winds and high waves.

3.2.1 Proposed Long Harbour BMA

The annual wave rose from the MSC50 grid point 12361 is presented in Figure 3.10. The wave rose depicts the direction the waves are travelling to (oceanographic convention) and shows that the majority of wave energy comes from the southwest, travelling to the northeast. This wave direction is mainly due to local topography.

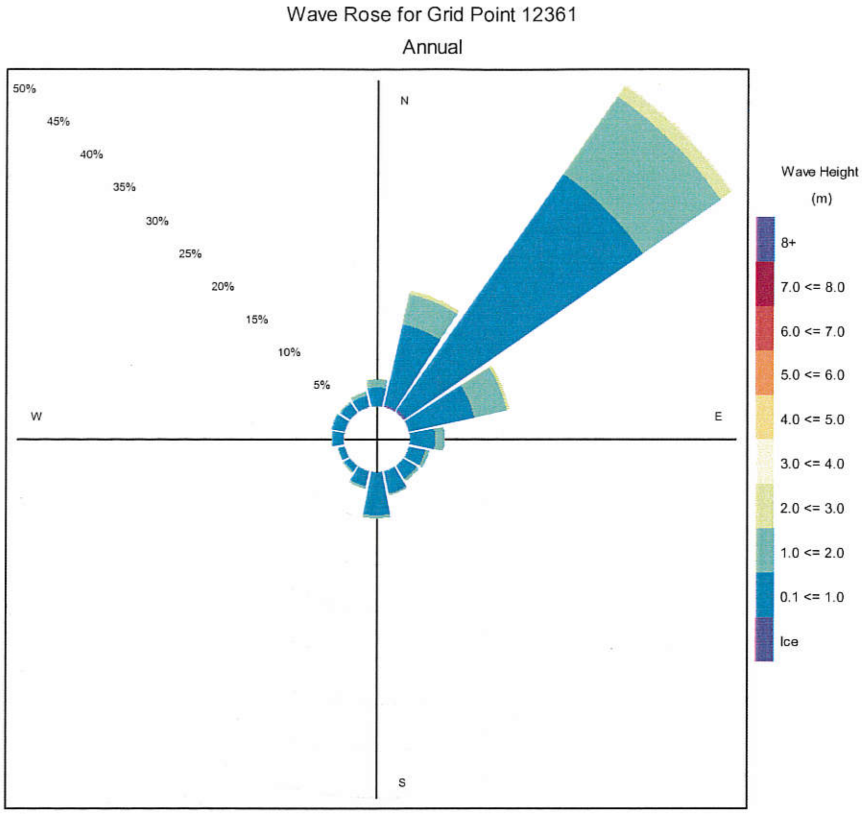
Wave heights were higher at grid point 12361, than the other two grid points. The SmartBay buoy recorded mean wave heights of 1.9 m during the months of January and February and a maximum wave height of 7.9 m in January. Maximum wave heights recorded at the MSC50 sites ranged from 1.3-5.4 m. It seems likely the higher mean heights recorded at the SmartBay buoy are due to a more exposed location than the MSC50 data. The location was covered in ice 4.4% of the time at grid point 12361.

Table 3.1 Mean Wave Height (m) for the Long Harbour BMA

	SmartBay Red Island Shoal	GP 12549	GP 12361	GP 12362
January	1.9	0.7	1.1	0.7
February	1.9	0.6	1.0	0.7
March	1.5	0.6	0.9	0.6
April	1.4	0.5	0.8	0.5
May	0.9	0.3	0.6	0.3
June	0.9	0.3	0.6	0.3
July	0.9	0.2	0.6	0.2
August	0.8	0.3	0.6	0.3
September	1.0	0.4	0.7	0.4
October	1.3	0.5	0.8	0.5
November	1.5	0.6	0.9	0.6
December	1.6	0.7	1.1	0.7

Table 3.2 Maximum Wave Height (m) for the Long Harbour BMA

	SmartBay Red Island Shoal	GP 12549	GP 12361	GP 12362
January	7.9	2.2	4.8	2.3
February	7.5	2.3	5.0	2.1
March	7.0	2.6	5.4	2.2
April	7.0	1.6	3.2	1.9
May	3.9	1.6	3.0	1.9
June	4.0	1.5	2.9	1.8
July	3.3	1.3	3.4	1.3
August	4.0	1.7	4.0	1.7
September	5.0	2.1	3.9	1.9
October	5.8	2.2	4.9	2.1
November	6.9	2.0	4.0	1.9
December	7.8	2.2	4.8	2.3



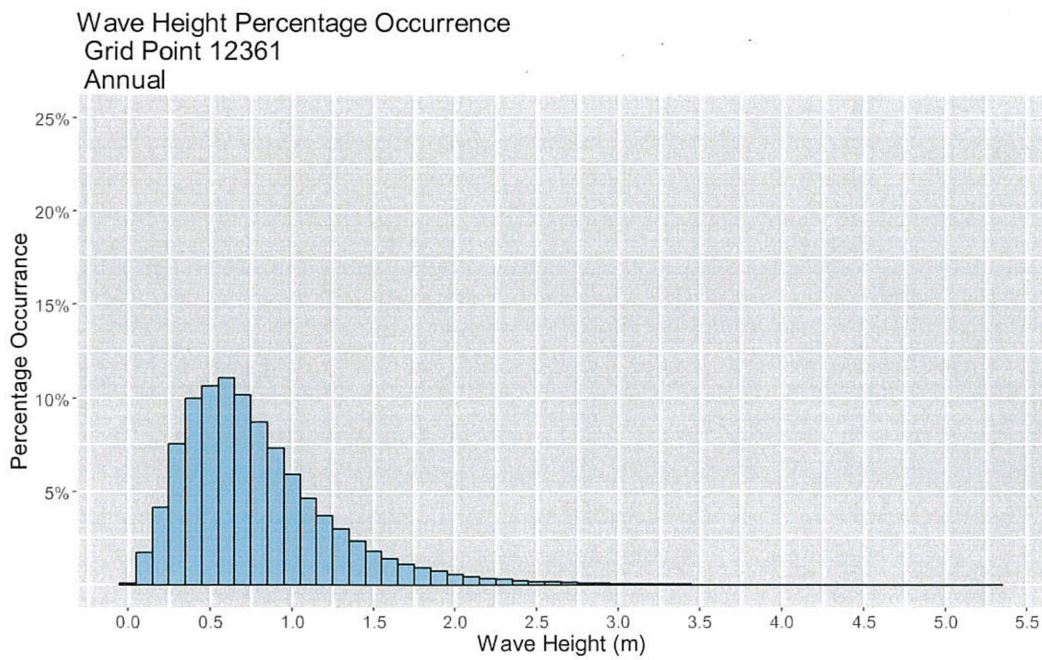


Figure 3.10 Wave Rose and Percentage Frequency Histogram for MSC50 Grid Point 12361 located at 47.4°N; 54.1W near Red Island

3.2.2 Proposed Red Island BMA

Wave heights were previously modelled by Oceans Ltd. for a location north of Red Island. Statistics from this analysis are presented in the absence of any other modelled or measured data near the aquaculture sites. While not completely representative of conditions near the aquaculture sites, these results should give a better idea of conditions than in the open bay.

Surrounded by islands and the mainland, the waters within the Red Island BMA are generally well sheltered from high seas. Red Island lies about 1.5 km to the south around to the southwest; Goat Island is about 2 km to the west; Merasheen Island extends from about 5 km to the west-northwest to 25 km to the north, while Long Island stretches from about 25 km to the north to 7 km to the northeast. Between Long Island and the study site, to the north-northeast, Barren Island lies 9 km distant, while a bit further eastward Little Seal and Great Seal Islands lie 3 and 4 km away, respectively, with Iron Island about 6.5 km to the northeast. From the northeast to the south-southeast, the study site is open to incoming seas from the Eastern Channel off Placentia Bay.

The MSC50 wind and wave reanalysis database (Swail, et al., 2006) provided a historical time series of winds and waves for the study. The closest MSC50 grid point at 47° 24' north latitude and 54° 06' west longitude was only 5 km to southeast of the site in the Eastern Channel.

The following tables and figures present the wave climate at the study site. Table 3.3 lists the mean and maximum significant wave heights for each month, with the maximum wave being the absolute highest value found for each month over the period of the study. Maximum wave heights were not predicted to exceed 3.2 m.

Table 3.3 Monthly Mean and Maximum Waves

Month	Mean Significant Wave Height [m]	Max Significant Wave Height [m]
January	0.7	2.8
February	0.7	2.6
March	0.6	2.7
April	0.6	2.1
May	0.4	2.3
June	0.4	1.8
July	0.4	2.0
August	0.4	2.3
September	0.5	2.4
October	0.5	3.2
November	0.6	2.9
December	0.7	3.2

Figure 3.11 presents the wave height frequency distribution for the entire period. For each wave height category depicted along the bottom of the charts, the height of the bar indicates the expected frequency of occurrence.

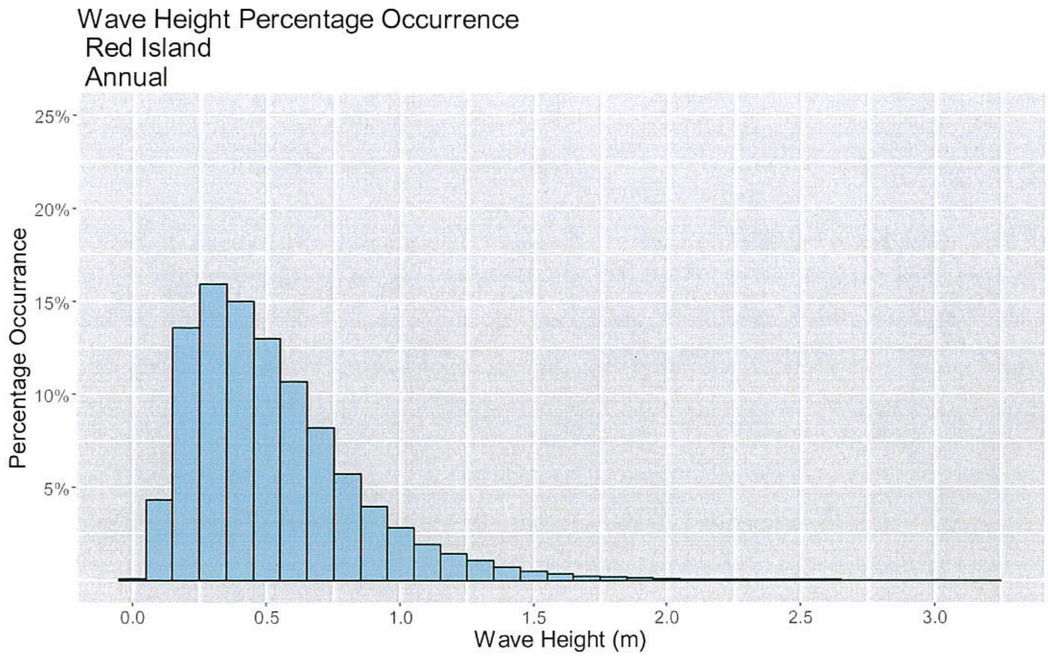


Figure 3.11 Red Island Shoal Percentage Frequency Histogram of Wave Heights.

3.2.3 Proposed Merasheen BMA

The annual wave rose from the MSC50 grid point 12548 is presented in Figure 3.12. The wave rose depicts the direction the waves are travelling to (oceanographic convention) and shows that the majority of wave energy comes from the southwest, travelling to the northeast. Wave heights were higher at grid point 12360, than the other grid point due to its more exposed location (see Figure 2.1). Maximum wave heights at grid point 12360 peaked in October with a wave height of 7.2 m. Maximum wave heights of 6 m or higher were recorded in six months of the year. Maximum wave heights were much lower at grid point 12548, ranging from 1.3 to 2.3 m. It is anticipated that wave heights at the three aquaculture sites in this BMA would be even lower given their proximity to the coast. The location was covered in ice 3.7% of the time at grid point 12548.

Table 3.4 Mean Wave Heights (m) for the Merasheen BMA

	GP 12548	GP 12360
January	0.6	1.4
February	0.6	1.3
March	0.5	1.2
April	0.4	1.0
May	0.3	0.8
June	0.2	0.8
July	0.2	0.8
August	0.3	0.8
September	0.4	0.9
October	0.5	1.0
November	0.5	1.2
December	0.6	1.3

Table 3.5 Maximum Wave Heights (m) for the Merasheen BMA

	GP 12548	GP 12360
January	2.1	6.1
February	2.2	6.4
March	2.3	6.5
April	1.4	4.3
May	1.3	4.2
June	1.3	3.7
July	1.4	4.3
August	1.5	5.2
September	1.8	6.2
October	2.2	7.2
November	1.8	5.5
December	2.1	6.2

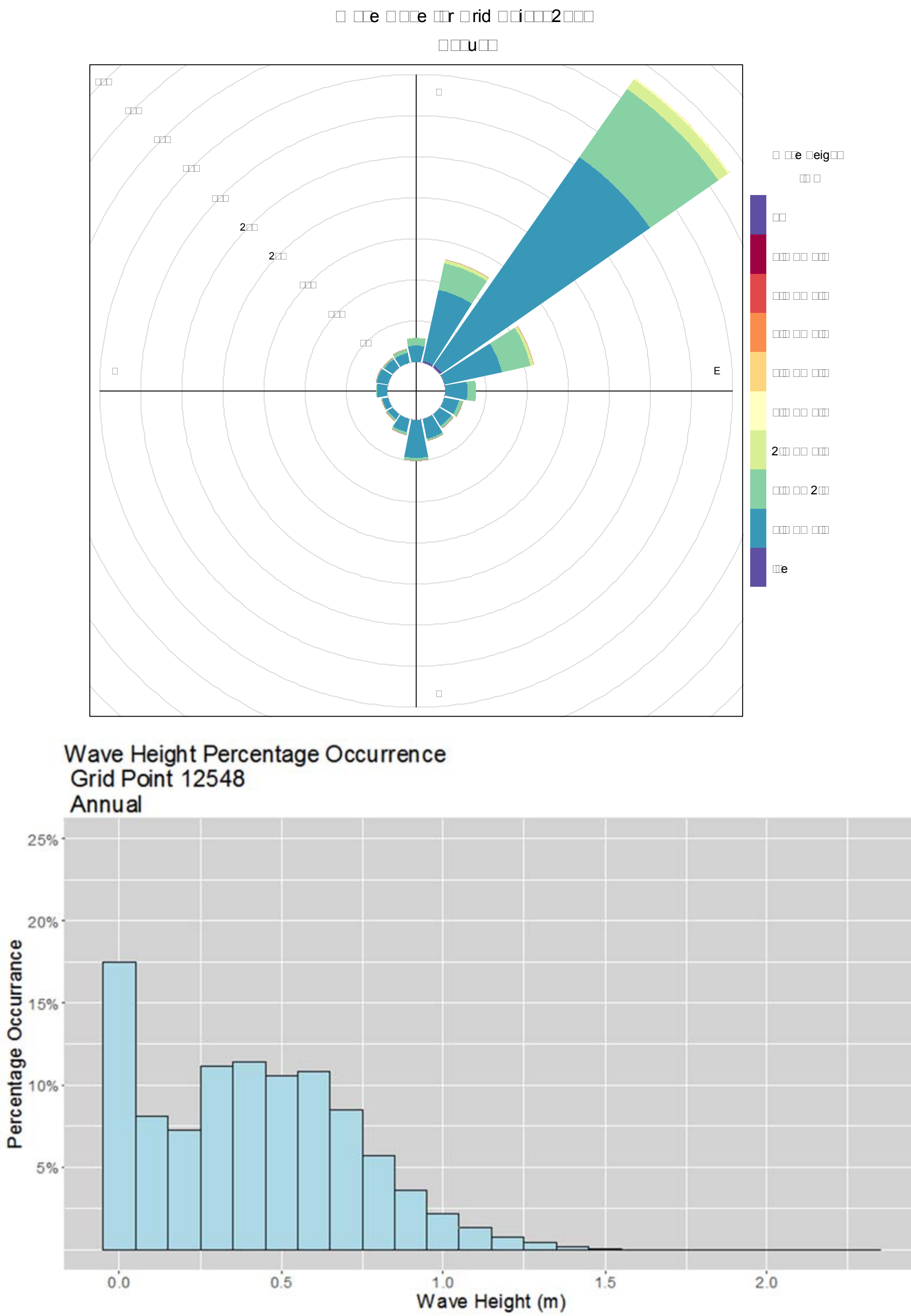


Figure 3.12 Wave Rose and Percentage Frequency Histogram for MSC50 Grid Point 12548 located at 47.5°N; 54.3W within the Merasheen BMA

3.2.4 Proposed Rushoon BMA

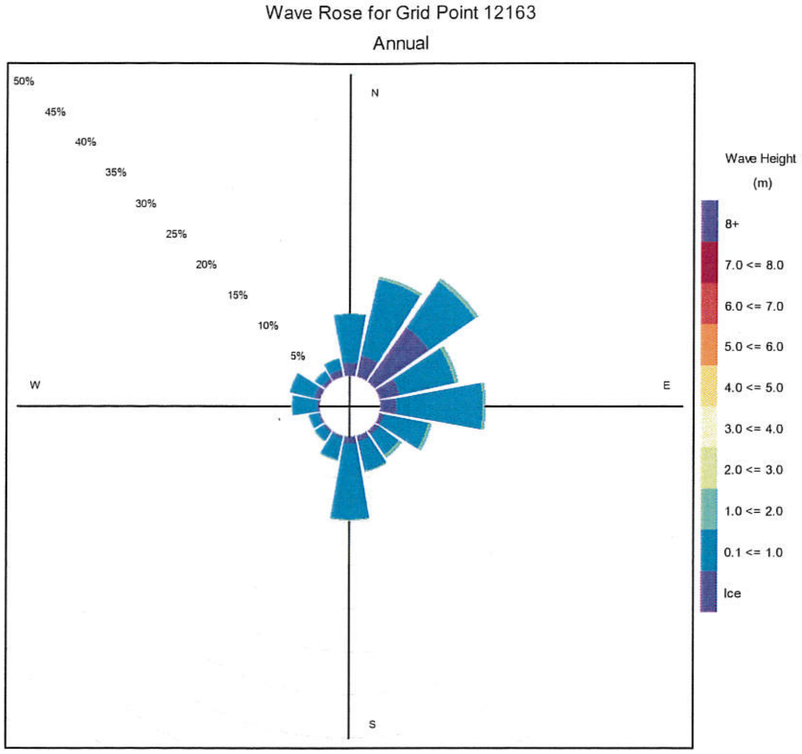
The annual wave rose from the MSC50 grid point 12163 is presented in Figure 3.13. The wave rose depicts the direction the waves are travelling to (oceanographic convention) and shows that the majority of wave energy comes from the west to south-southwest, travelling to the east to east-northeast. Wave heights were higher at grid point 12164, that the other grid point due to its more exposed location. Maximum wave heights at grid point 12164 peaked in October with a wave height of 7.8 m. Maximum wave heights of 6 m or higher were recorded in 8 months of the year at Grid Point 12164, but only in October at Grid Point 12163. Maximum wave heights at grid point 12163 which is relatively close to one of the aquaculture (lease) sites (Figure 2.1), ranged from 3.7 to 6.8 m and on average ranged from 0.8 to 1.3 m. The location was covered with ice 3.7% of the time at grid point 12163.

Table 3.6 Mean Wave Heights for the Rushoon BMA

	GP 12163	GP 12164
January	1.3	1.6
February	1.2	1.5
March	1.1	1.4
April	1.0	1.2
May	0.8	0.9
June	0.7	0.9
July	0.7	0.9
August	0.7	0.9
September	0.9	1.0
October	1.0	1.2
November	1.1	1.3
December	1.2	1.5

Table 3.7 Maximum Wave Heights for the Rushoon BMA

	GP 12163	GP 12164
January	5.2	6.2
February	5.7	6.7
March	5.6	6.7
April	3.7	4.6
May	4.2	5.0
June	3.7	4.1
July	4.0	4.6
August	4.8	6.0
September	5.3	6.9
October	6.8	7.8
November	5.1	6.2
December	5.8	6.9



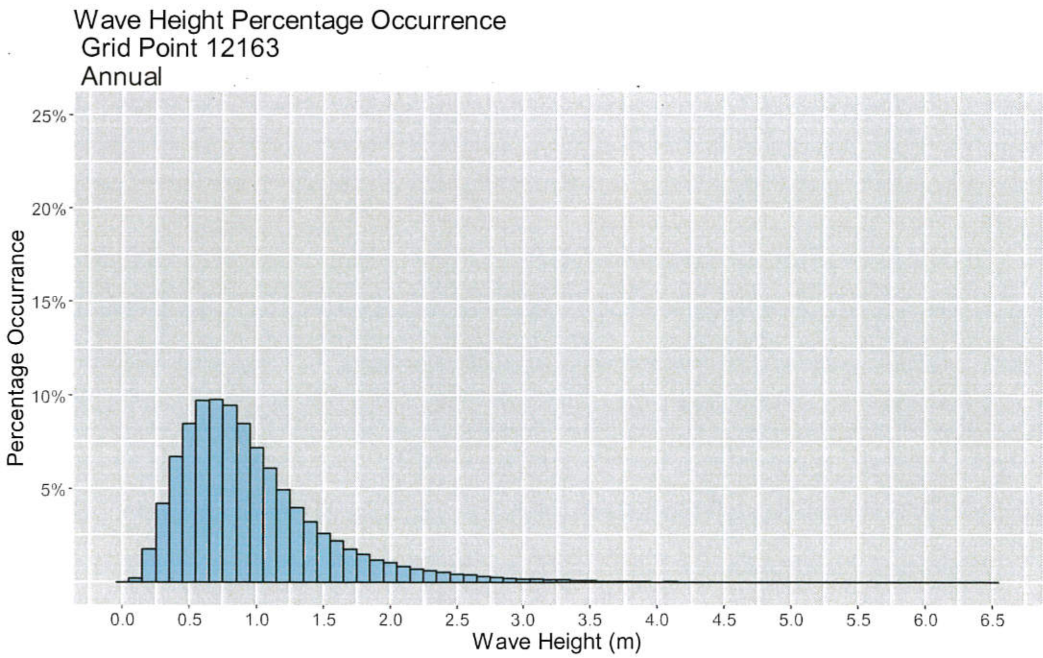


Figure 3.13 Wave Rose and Percentage Frequency Histogram for MSC50 Grid Point 12163 located at 47.3°N; 54.3W within the Rushoon BMA near Oderin Island Farm.

3.2.5 Extreme Wave Heights

Extreme waves were calculated for the northern half of Placentia Bay using three MSC50 grid points: 12163, 12361 and 12548. This data set was determined to be the most representative of the available data sets, as it provides a continuous 60-year period of 1 hourly data for the site. However, only grid point 12163 is adjacent to an aquaculture (lease) site. All extremes are specified for return periods of 1-yr, 10-yr, 25-yr, 50-yr and 100-yr.

The extreme value analysis was carried out using the peak-over-threshold method. The Gumbel distribution was chosen to be the most representative for the peak-over-threshold method as it provided the best fit to the data. Since extreme values can vary depending on how well the data fits the distribution, a sensitivity analysis was carried out to determine the number storms to use, whereby the number of storms, the 100-year extreme value, the correlation coefficient and storm threshold were all compared on an annual basis.

The maximum individual wave heights were calculated within Oceanweather's OSMOSIS software by evaluating the Borgman integral (Borgman, 1973), which was derived from a Raleigh distribution function. The variant of this equation used in the software has the following form (Forristall, 1978):

$$\Pr\{H > h\} = \exp\left[-1.08311\left(\frac{h^2}{8M_0}\right)^{1.063}\right]; \; T = \frac{M_0}{M_1}$$

where h is the significant wave height, T is the wave period, and M_0 and M_1 are the first and second spectral moments of the total spectrum.

The annual extreme value estimates for significant wave height for return periods of 1-year, 10-years, 25-years, 50-years and 100-years are given in Table 3.8 for the Long Harbour, Rushoon and Merasheen BMAs. Since there were no grid points within the Red Island BMA, an extreme wave height analysis was not possible.

The annual 100-year extreme significant wave height is estimated to range from 2.2 m at Grid Point 12548 within the Merasheen BMA to 7.7 m at Grid Point 12164 within the Rushoon BMA. Extreme maximum wave heights are estimated to range from 4.2 m at Grid Point 12548 to 13.8 m at Grid Point 12164.

The Iona Islands aquaculture site should expect extreme waves consistent with Grid Point 12361. Sheltered behind an island to the southwest, the Brine Island site should expect waves lower than that of Grid Point 12361.

The three sites within the Merasheen BMA are sheltered from most directions. Extreme significant and maximum wave heights at these three sites would be most represented by Grid Point 12548.

Since wave heights at Grid Point 12164 are predominately to the northeast (from the southwest), both the Gallows Harbour and Long Island aquaculture sites, which are exposed to the southwest, could see these extreme significant wave heights.

It should be noted that the 100-year extreme significant and maximum wave heights are the highest waves expected over a period of 100 years based on probability. The maximum wave height of 6.8 m at Grid Point 12163 in Table 3.7 is higher than the 100-year estimate in Table 3.8. Further analysis shows that the 6.8 m maximum wave height corresponds with the 250-year extreme wave height.

Table 3.8 Extreme Significant Wave Height Estimates (m) for Return Periods of 1, 10, 25, 50 and 100 Years

BMA	Grid Point	1-yr	10-yr	25-yr	50-yr	100-yr
Long Harbour	**12361**	3.4	4.4	4.7	5.0	5.3
	12362	1.8	2.1	2.2	2.3	2.4
	12549	1.7	2.0	2.1	2.2	2.3
Merasheen	**12548**	1.6	1.9	2.0	2.1	2.2
	12360	4.6	5.9	6.4	6.8	7.2
Rushoon	**12163**	4.3	5.4	5.8	6.1	6.4
	12164	5.2	6.5	7.0	7.3	7.7

Table 3.9 Extreme Maximum Wave Height Estimates (m) for Return Periods of 1, 10, 25, 50 and 100 Years

BMA	Grid Point	1-yr	10-yr	25-yr	50-yr	100-yr
Long Harbour	**12361**	6.6	8.2	8.8	9.0	9.4
	12362	3.5	4.1	4.3	4.5	4.6
	12549	3.3	3.8	4.0	4.2	4.4
Merasheen	**12548**	3.1	3.6	3.8	4.0	4.2
	12360	8.6	10.7	11.6	12.2	12.9
Rushoon	**12163**	8.0	9.8	10.5	11.0	11.5
	12164	9.5	11.7	12.5	13.2	13.8

3.3 Sea Ice and Icebergs

3.3.1 Sea Ice

In comparison to other bays surrounding Newfoundland, Placentia Bay is a relatively ice-free bay due to its location along the south coast of Newfoundland. A weekly analysis of the Canadian Ice Service's 30-year median of ice in Placentia Bay reveals that ice is only present in Placentia Bay from mid-February until mid-April.

Figure 3.14 shows the weekly analysis of 30-year median of ice concentration when ice is present in Placentia Bay. The likelihood of ice present in Placentia Bay is highest during the week beginning March 5th. During this week, the median of ice concentration in Placentia Bay is 9-9+/10.

A detailed map with the weekly analysis of 30-year median of ice concentration in the four Bay Management Areas in Placentia Bay is shown in Figure 3.15. Figure 3.16 indicates that the frequency of sea ice presence in the four aquaculture farm areas is 1-15%.

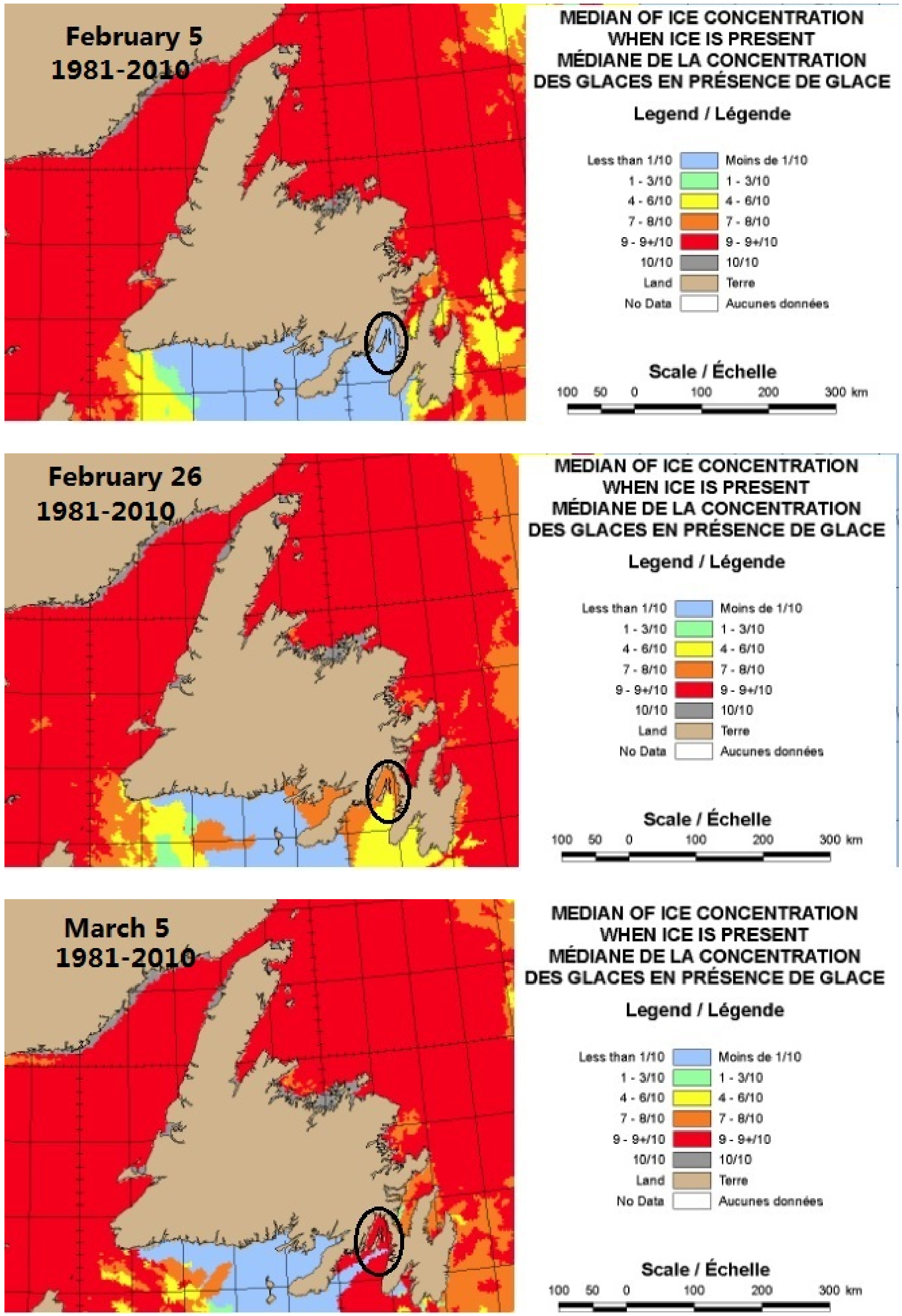


Figure 3.14 Weekly analysis of 30-year median of ice concentration when ice is present in Placentia Bay (black oval) from 1981 to 2010 (Canadian Ice Service).

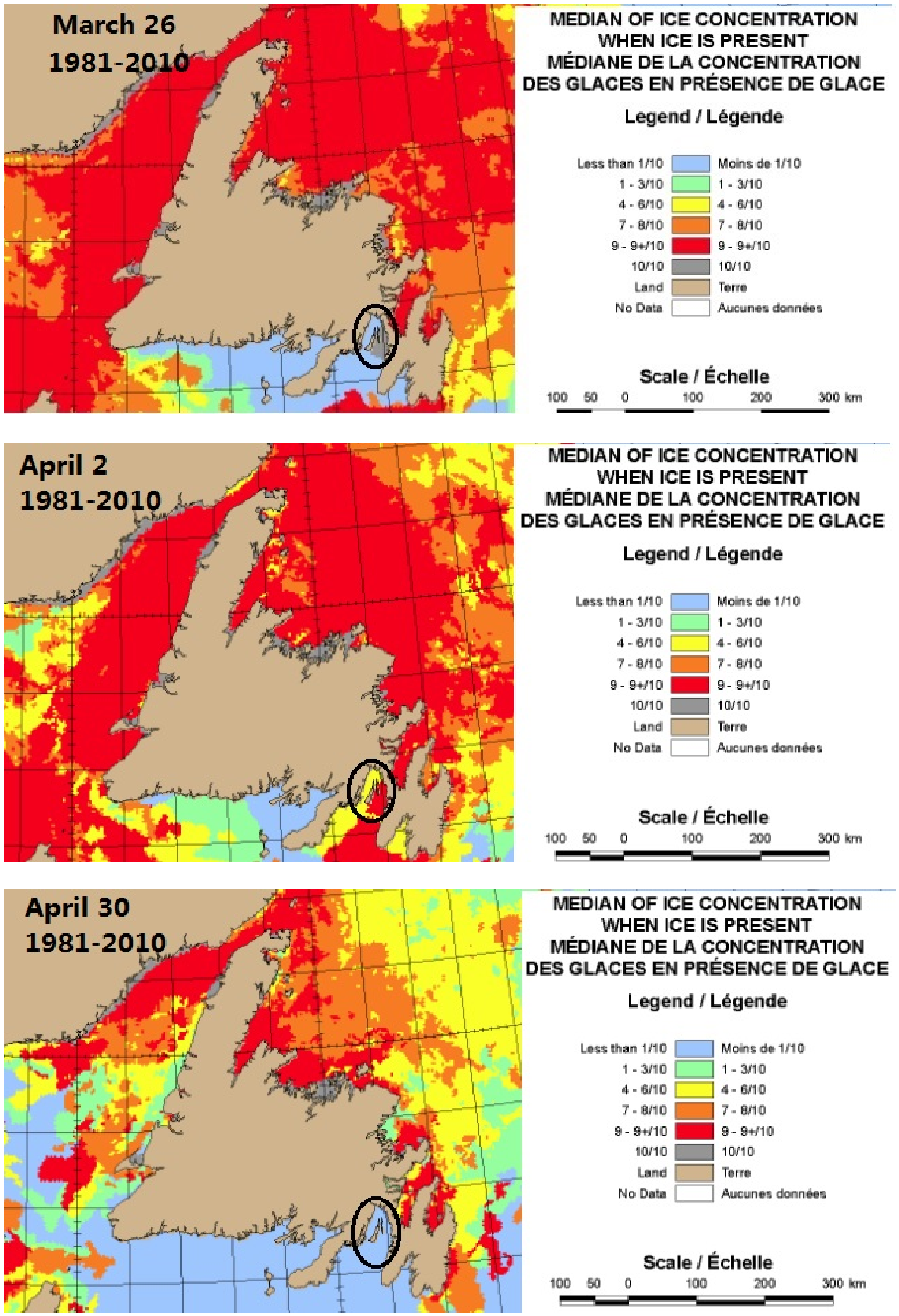


Figure 3.14 Weekly analysis of 30-year median of ice concentration when ice is present in Placentia Bay (black oval) from 1981 to 2010 (Canadian Ice Service) (Cont.).

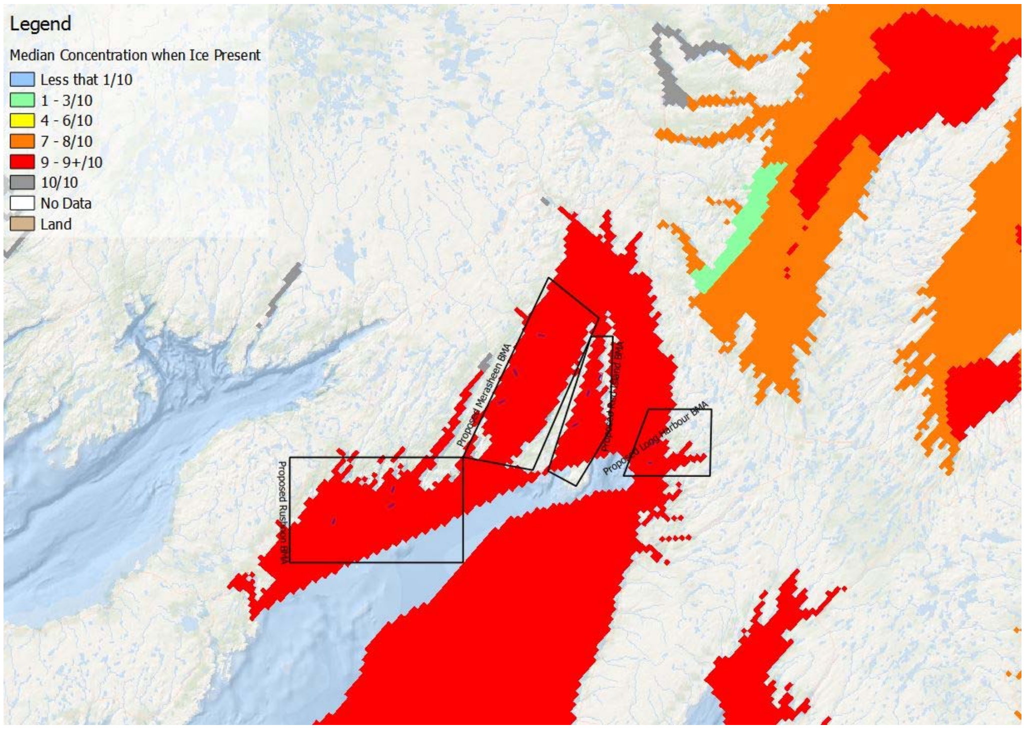


Figure 3.15 Weekly analysis of 30-year median of ice concentration when ice is present for the four BMA's in the week starting March 5, 1981-2010 (Canadian Ice Service).

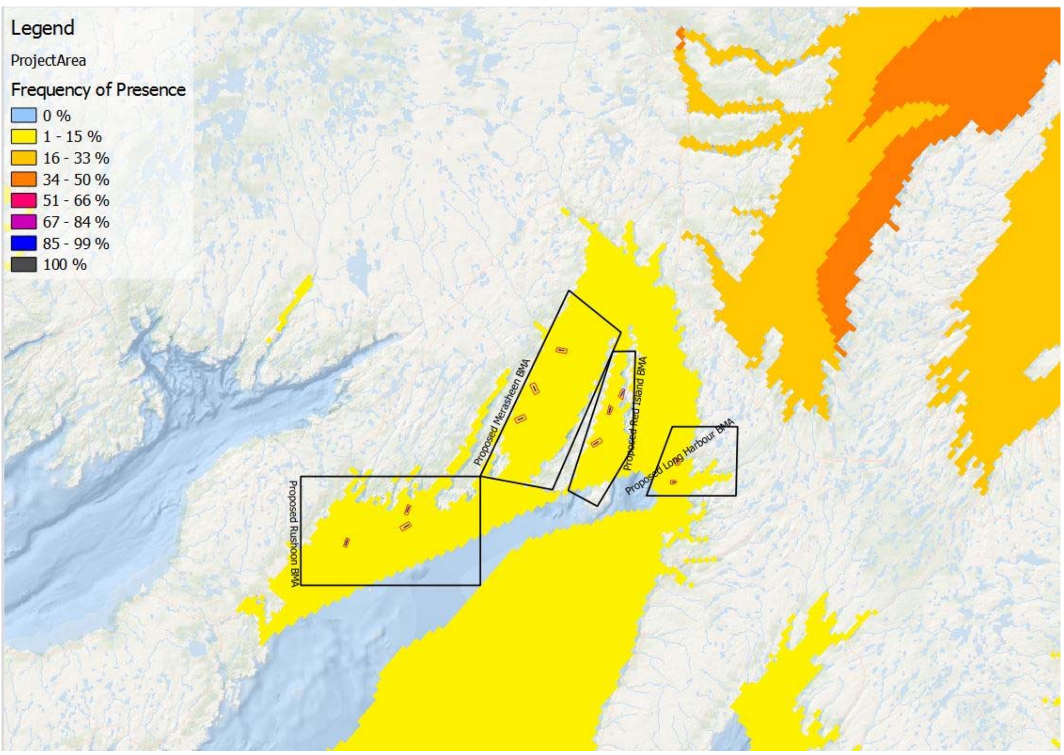


Figure 3.16 Weekly analysis of 30-year frequency of presence for the four BMA's in the week starting March 5, 1981-2010 (Canadian Ice Service).

In an effort to provide more up-to-date sea ice information, weekly sea ice charts for Placentia Bay were analysed over the past 10 years for the presence of sea ice within the northern half of Placentia Bay. A table containing the percent frequency of ice conditions within the region is provided below in Table 3.10. The information provided in this table gives an indication of the worst conditions which occurred within the region. For example, if half of the region was covered in 1/10th ice, and half classified ice free, the information was recorded as 1/10th for the whole area. The concentration of the majority of sea ice present over the last 10 years was less than one tenth. There was one year in which the week beginning February 05 contained 5/10ths coverage of sea ice.

Table 3.10 Percent Frequency of Weekly Sea Ice Concentration for northern Placentia Bay (2008 - 2017)

	Ice Free	Open Water	Bergy Water	Fast Ice	Tenths									
					1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**9+**
Feb-05	70	20	0	0	0	0	0	0	10	0	0	0	0	0
Feb-12	40	50	0	0	0	10	0	0	0	0	0	0	0	0
Feb-19	20	80	0	0	0	0	0	0	0	0	0	0	0	0
Feb-26	30	70	0	0	0	0	0	0	0	0	0	0	0	0
Mar-05	40	60	0	0	0	0	0	0	0	0	0	0	0	0
Mar-12	40	40	10	10	0	0	0	0	0	0	0	0	0	0
Mar-19	50	20	0	20	0	10	0	0	0	0	0	0	0	0
Mar-26	60	20	10	10	0	0	0	0	0	0	0	0	0	0
Apr-02	40	30	20	10	0	0	0	0	0	0	0	0	0	0
Apr-09	40	40	10	10	0	0	0	0	0	0	0	0	0	0
Apr-16	60	10	20	10	0	0	0	0	0	0	0	0	0	0
Apr-23	60	10	10	10	0	10	0	0	0	0	0	0	0	0
Apr-30	70	0	30	0	0	0	0	0	0	0	0	0	0	0

Definitions for the terms “Ice Free”, “Open Water”, “Bergy Water” and “Fast Ice” as defined in the ECCC Ice Glossary (Environment and Climate Change Canada, 2018) are provided below.

Ice Free

No ice present. If ice of any kind is present, this term shall not be used.

Open Water

A large area of freely navigable water in which ice is present in concentrations less than 1/10. No ice of land origin is present.

Bergy Water

An 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 less than 1/10.

Fast Ice

Ice which forms and remains fast along the coast. It may be attached to the shore, to an ice wall, to an ice front, between shoals or grounded icebergs. Vertical fluctuations may be observed during changes of sea level. It may be formed “in-situ” from water or by freezing of floating ice of any age to shore and can extend a few metres or several hundred kilometres from the coast. It may be more than one year old in which case it may be prefixed with the appropriate age category (old, second-year or multi-year). If higher than 2 m above sea level, it is called an ice shelf.

3.3.2 Icebergs

Figure 3.17 shows the positions of all recorded icebergs within Placentia Bay from 1960 to 2015. Over the 55 years studied, only six icebergs have been sighted inside the four Bay Management Areas. Since the icebergs are moving into the bay from south of the Avalon Peninsula this is not surprising. Environmental factors such as iceberg concentration, ocean currents and wind determine if icebergs will move into the bay.

Table 3.11 summarizes the available information for recorded icebergs in the four Bay Management Areas in Placentia Bay. The Long Harbour, Merasheen and Red Island BMAs had only one iceberg each within the 55 years assessed. In the Rushoon BMA, which is close to the outer bay in comparison to the other three areas, three icebergs were sighted over the 55 years (i.e., 1961, 1995, and 2001). These icebergs range in size from growlers to medium. There was one of unknown size in the Rushoon BMA.

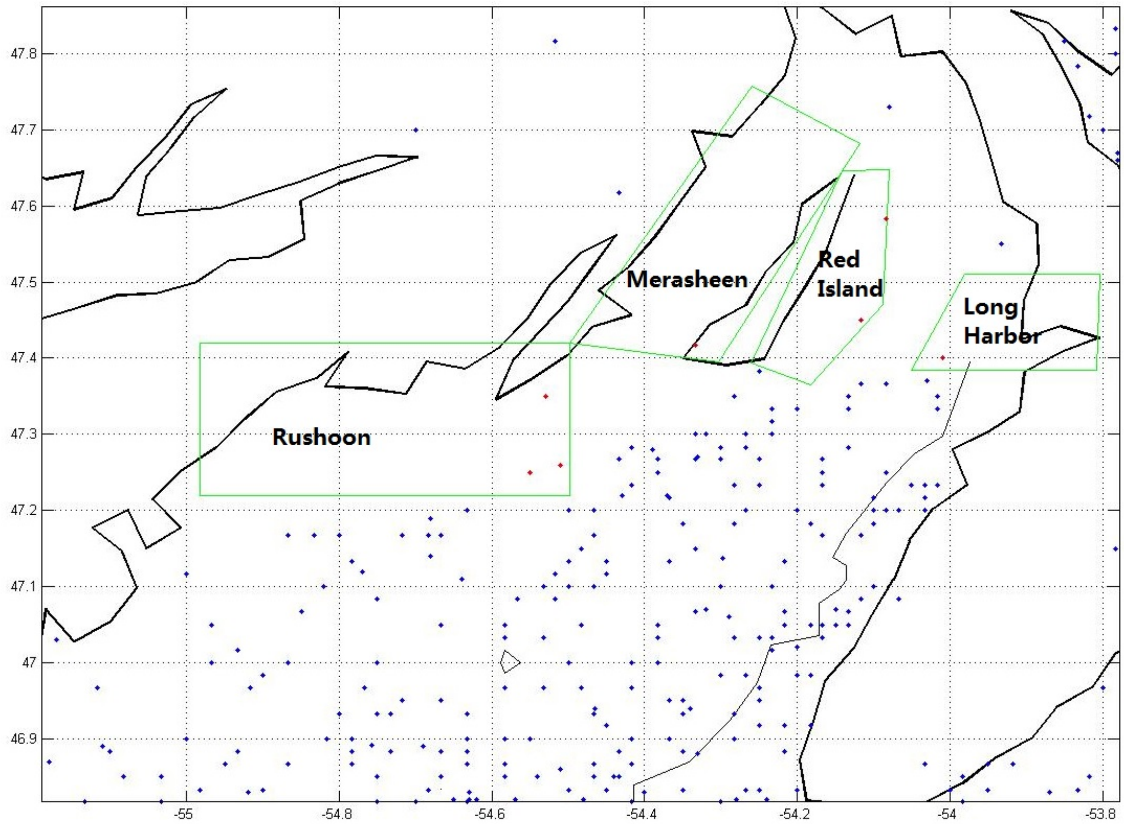


Figure 3.17 Iceberg sightings from 1960 to 2015. The green polygons are the four Bay Management Areas in Placentia Bay. The blue dots are icebergs sighted over 55 years within the farm fields. Some icebergs which were recorded at different coordinates due to drifting are shown.

Table 3.11 Recorded iceberg information in the four Bay Management Areas in Placentia Bay from 1960 to 2015.

BMA	Iceberg Count	Year	Latitude	Longitude	Size
Long Harbor	1	1996	47.40	-54.01	Medium
Merasheen	1	1961	47.42	-54.33	Growler
Red Island	1	1961	47.45	-54.12	Medium
Rushoon	3	1961	47.25	-54.55	Growler
		1995	47.35	-54.53	Small
		2001	47.26	-54.51	Unknown

3.4 Flood and Tidal Conditions

Tidal Heights

The tidal heights for various stations in Placentia Bay are presented in Table 3.12 and have been taken from the Canadian Tide and Current Tables (DFO, 2018). The tidal heights are in reference to chart datum. Recorded extremes from the Great St. Lawrence tidal station were not included in the above report however, were obtained from the Canadian Tides and Water Levels Data Archive (Government of Canada, 2018).

Table 3.12 Placentia Bay Tidal Data

	Mean Water Level	Range (m)		High Water (m)		Low Water (m)		Recorded Extremes(m)	
Port		**Mean Tide**	**Large Tide**	**Mean Tide**	**Large Tide**	**Mean Tide**	**Large Tide**	**Highest High Water**	**Lowest Low Water**
Argentia	1.4	1.6	2.4	2.3	2.6	0.7	0.2	3.4	-0.4
Burin	1.2	1.5	2.2	2.4	2.7	0.6	0.0		
South East Bight	1.2	1.3	2.1	2.5	3.0	0.5	0.2		
Tacks Beach	1.1	1.6	2.4	2.5	2.8	0.8	0.4		
Woody Island	1.2	1.6	2.5	2.4	2.7	0.7	0.3		
North Harbour	1.4	1.7	2.5	2.1	2.5	0.6	0.1		
Come by Chance	1.4	1.6	2.5	2.2	2.5	0.5	0.1		
Arnold's Cove	1.4	1.7	2.5	2.1	2.5	0.6	0.1		
Long Harbour	1.5	1.7	2.7	2.0	2.3	0.5	0.1		
St. Bride's	1.2	1.6	2.5	2.4	2.7	0.8	0.4		
Great St. Lawrence								3.1	-0.2

Water level recorders have been installed at both Argentia and Great St. Lawrence. Measurements from these stations These stations were analyzed for events in which the recorded water levels exceeded 3.0 metres. There were eleven individual events (Table 3.13) recorded at Argentia between the period of February 12, 1971 to March 29, 2018 and five individual events (Table 3.14) at Great St. Lawrence between the period of October 23, 2005 and March 29, 2018. Plots of the highest events at both stations are provided in Figure 3.18 and Figure 3.19.

Table 3.13 Events where the Maximum Water Level recorded at the Argentia Tidal Station exceeded 3.0 metres (Feb 12, 1971 to March 29, 2018)

Date	Tidal Heights
Dec 22, 1983 1100	3.2
Dec 25, 1983 1200	3.2
Jan 10, 1982 1000	3.15
Dec 15, 2016 2200	3.14
Jan 05, 1989 0600	3.13
Dec 04, 2013 0900	3.11
Dec 25, 1991 1200	3.08
Jan 03, 2010 1100	3.05
Dec 13, 2016 0700	3.04
Jan 10, 1974 0900	3.03
Jan 30, 1975 1000	3.01

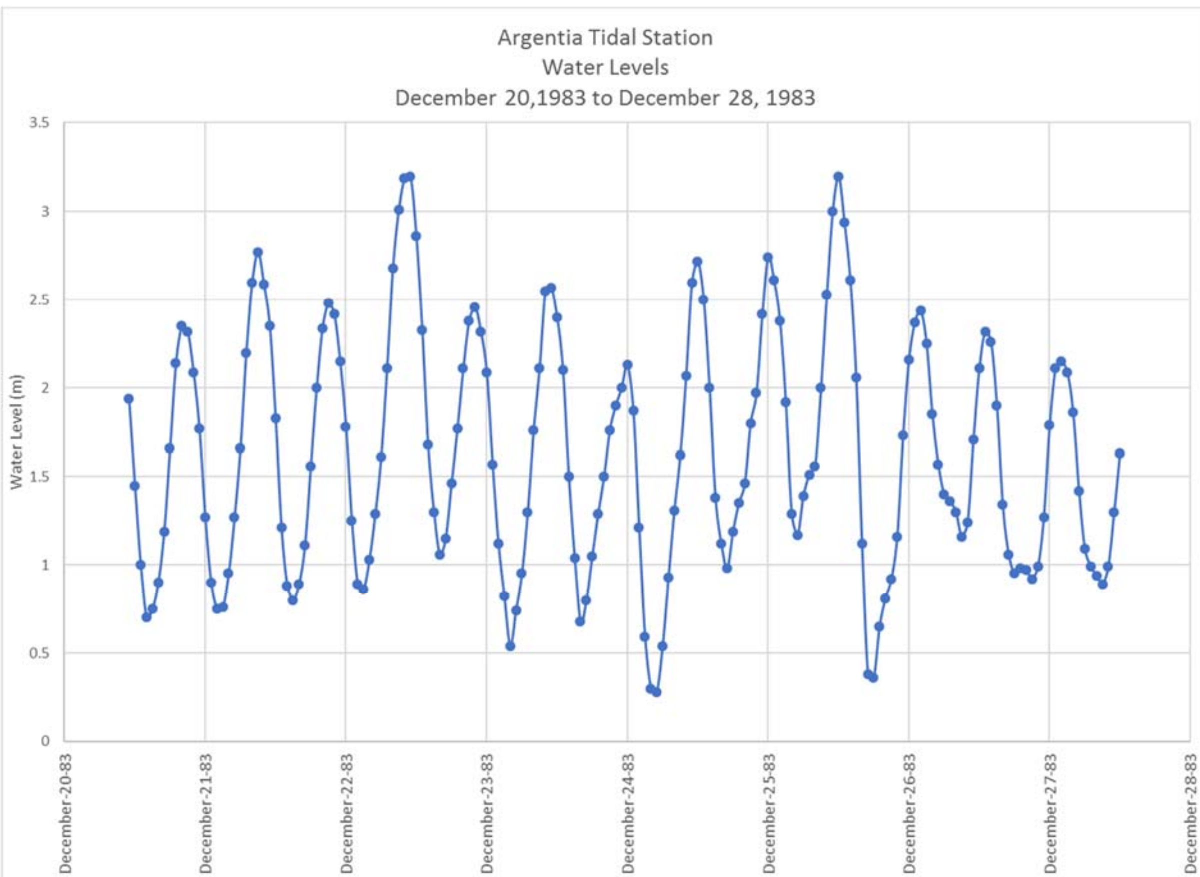


Figure 3.18 Argentia Tidal Station Water Levels (December 20, 1983 to December 28, 1983)

Table 3.14 Events where the Maximum Water Level recorded at the Great St. Lawrence Tidal Station exceeded 3.0 metres (Oct 23, 2005 to March 29, 2018)

Date	Tidal Heights
Feb 01, 2006 1100	3.1
Dec 13, 2016 0800	3.07
Nov 06, 2009 1200	3.05
Oct 26, 2011 0700	3.01
Feb 09, 2016 0900	3.01

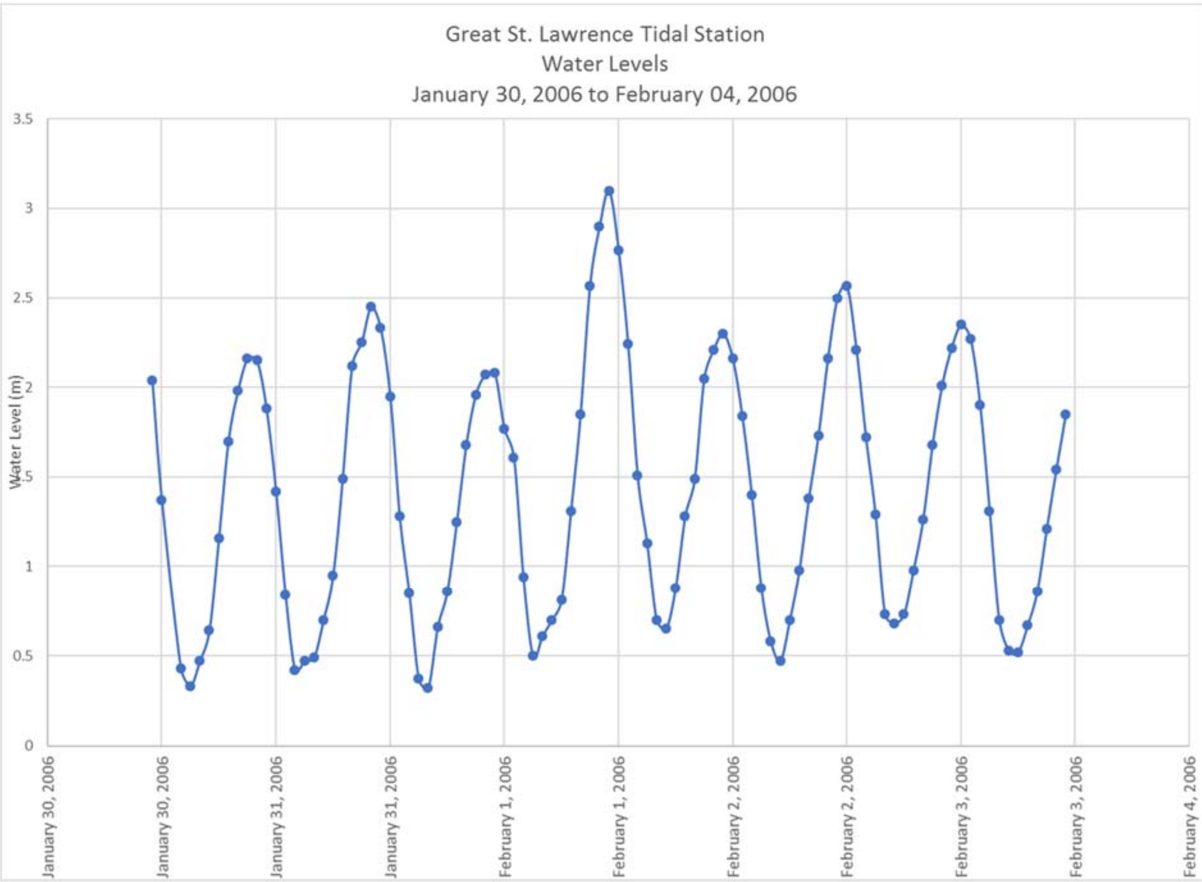


Figure 3.19 Great St. Lawrence Tidal Station Water Levels (January 30, 2006 to February 04, 2006)

Storm Surge

A storm surge is a pronounced increase in sea level associated with the passage of storm systems and defined as the difference between the observed water level and the predicted astronomical tide. This increase in sea level is typically the result of the combined forces of wind stress acting on the ocean and the inverted barometer effect due to the low atmospheric pressure associated with the storm.

Bernier and Thompson (2006) did a study of extreme storm surges in the Northwest Atlantic using a 40-year hindcast of storm surges. In their study, they showed a 40-year return period storm surge between 0.7 metres for the south coast of Newfoundland (Figure 3.20). Near the shoreline of Placentia Bay, the height of a storm surge could exceed 0.7 metres due to the shoaling and funneling effects of a movement of water into more shallow or restricted areas.

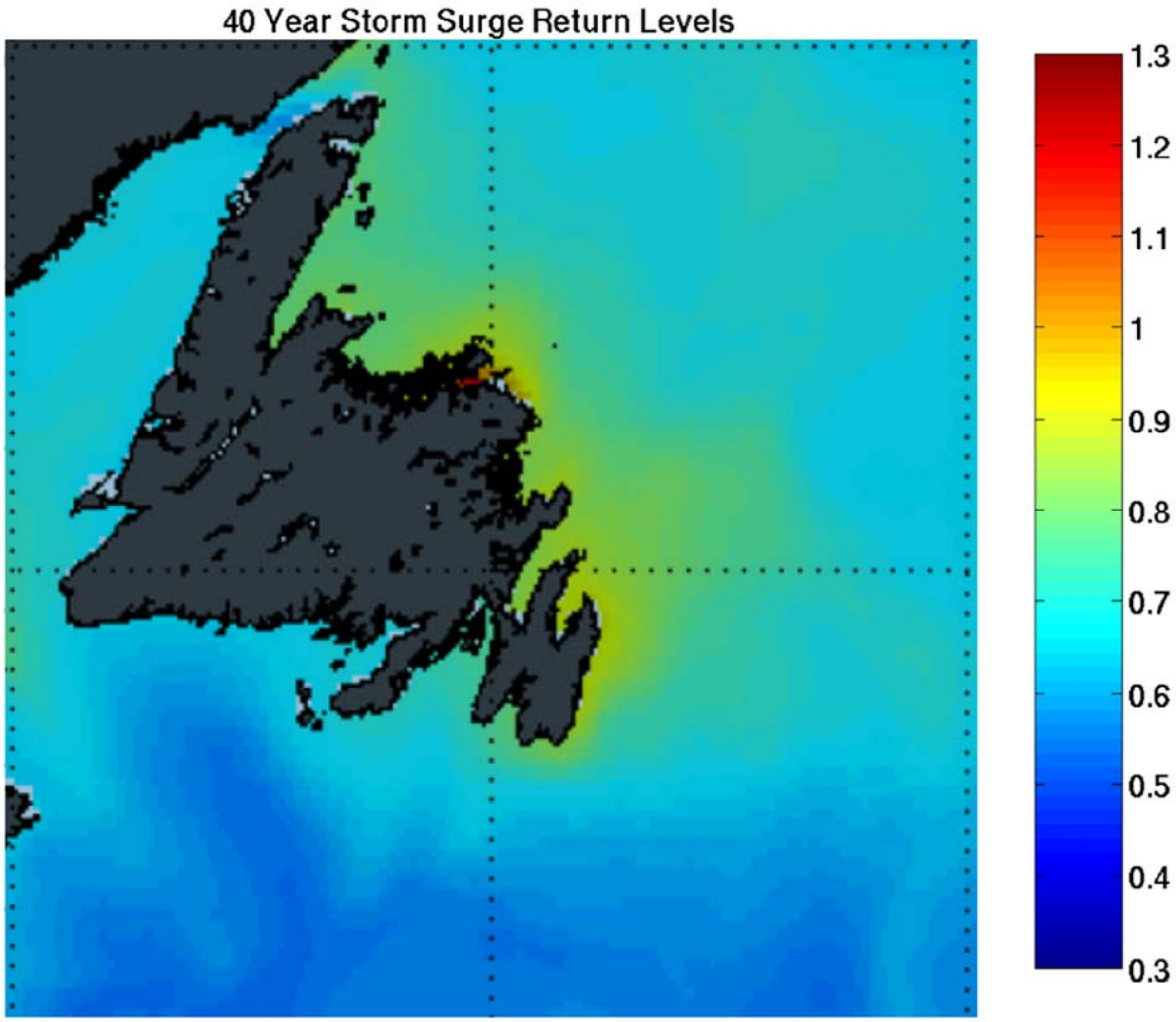


Figure 3.20 40-year return level of extreme storm surges based on the surge hindcast. Colorbar indicates the 40 return levels in metres. (Modified from (Bernier & Thompson, 2006))

During an event on January 16, 2004 a low pressure deepened to 951 mb along the south coast of Newfoundland, then moved inland to lie over central Newfoundland by afternoon. This low pressure became slow moving over Newfoundland resulting in a prolonged period of strong to gale force winds from the south to southwest over Placentia Bay. Using tidal height predictions for Argentia from the Bedford Institute of Oceanography WebTide model (V0.7.1) and calculating the difference between the measured water level records and the WebTide model it was determined that a storm surge near 0.93 m in height was observed at Argentia. This resulted in the sea level at Argentia rising to 2.6 m as a result of the combined tidal and storm surge heights.

Similarly, during the passage of Hurricane Igor on September 21, 2010, a maximum storm surge of near 0.92 metres was observed at Argentia at 1130 the following day. At the same time, the Great St. Lawrence water level recorder measured a maximum surge of near 0.86 m.

Negative storm surges associated with offshore winds can result in a pronounced decrease in water level below the astronomical tide level. These events are usually not as pronounced as onshore storm surges but may be of concern to mariners since they can create unusually shallow water if they occur near the low tide. In December 2006 a negative storm surge of -0.7 metres was recorded at Argentia. This negative surge was the result of an intense low-pressure system passing west of Placentia Bay. As the system passed, strong to gale force northerly winds were generated over Placentia Bay resulting in offshore winds forcing water out of the bay.

In the fall of 1999 and 2000, unusual events were observed in coastal areas of eastern Newfoundland, believed to be associated with the passage of tropical storms Jose in 1999 and Helene in 2000 as they moved across the Grand Banks. The waves had a period of tens of minutes and lasted between one and three hours, depending on location. The waves were large enough to cause local flooding and damage to docks and other structures. At Port Rexton in Trinity Bay the peak-to-trough displacement was 2 to 3 m, destroying the local wharf (Mercer, Sheng, Greatbach, & Bobanovic, 2002). Mercer et al. (2002) attributed the events to be a barotropic wake created by the tropical storms as they moved over the Grand Banks.

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Appendix W
Letters of Support

Appendix W-1
Stofnfiskur Letter -
Procedures to minimize genetic interactions of farmed and wild Atlantic salmon

February 22, 2018

Grieg NL Seafarms Ltd.
P.O. Box 457
205 McGettigan Blvd.
A0E 2M0

Attn: Mr. Knut Skeidsvoll, General Manager

Information on procedures that will be undertaken to minimize the genetic consequences of wild Atlantic and farmed salmon interactions, such as the use of all-female triploid salmon.

A sterile/triploid salmon can escape from a farm the same way as its diploid counterparts. The triploid male may if matured, migrate up rivers, but if they do spawn there is no reproduction. Any gametes produced by the male are not viable and will not fertilize an egg. Several studies also show that farm salmon does not handle the competition of the wild salmon at the spawning grounds but they might disturb the other parties at the spawning area. In order to eliminate all negative effect regarding genetic consequences of wild Atlantic and farmed salmon interaction as well as potential migration of farmed salmon up into the freshwater /river system we recommend the use of all female sterile/triploid salmon. The use of all female sterile/triploid salmon remove the maturation problems, efficiently eliminate any possibility for genetic pollution as well as migration into the freshwater/river system.

Best regards,

……………………………………

Rudi Ripman Seim
R&D and Technical Manager
Benchmark Genetics Ltd.

Appendix W-2

Stofnfiskur Letter –

Procedures undertaken to increase confidence in the triploidy of eggs

Benchmark Breeding & Genetics

February 22th, 2018

Grieg NL Seafarms Ltd.
P.O. Box 457
205 McGettigan Blvd.
A0E 2M0

Attn: Mr. Knut Skeidsvoll, General Manager

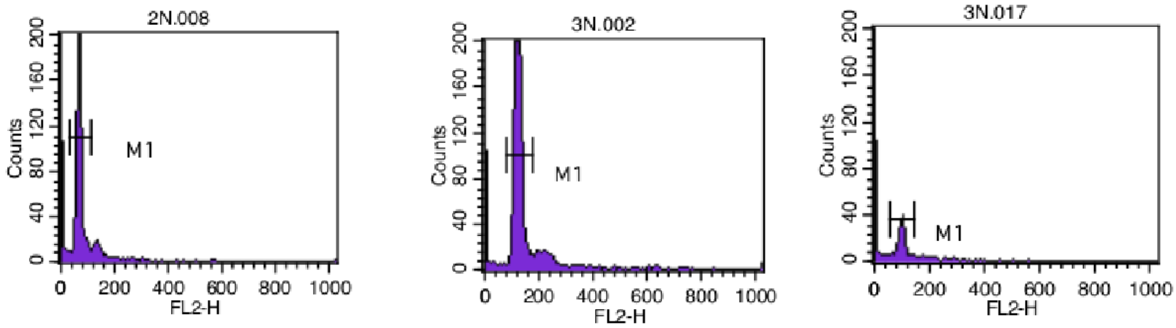
Information on procedures that will be undertaken to increase confidence in the triploidy of eggs. An alternative sampling protocol with appropriate sample sizes and levels of significance needs to be established to confirm the acceptable triploid induction level

Induction of triploidy occurs after the eggs are fertilized. Triploid fish have been produced by preventing the second polar body to pass out of the egg. In triploid fish two sets of chromosome are contributed by female and one set by male (2 N egg + 1N sperm = 3N). This procedure is most commonly accomplished through pressure shock on fertilized eggs. Triploidy induction in fish is commonly verified by taking a blood sample and analyzing DNA content by flow cytometry.

The use of flow cytometry for measurement of cellular DNA content with high degree of resolution has in recent years been considered as a reliable and constant method. Individual ploidy investigations, eyed eggs or larvae is collected and stored deep-frozen (-80°C). For analysis, the larva is thawed and smashed by re-suspending up and down in 0.4 mL propidium iodide (PI) solution until the tissues is completely dissolved. PI binds to the cell's DNA that at the correct wavelength it will fluoresce. The samples are then passed through a 0.45µm filter. The DNA content of approximately 30 larvae per treatment and the same amount of larvae as a control group was measured using a Becton Dickinson FACSCalibur TM (BD Biosciences, San Jose, CA, USA) flow cytometer.

The analysis takes in account the cell population and the amount of fluorescence inside a single cell, we must measure single cells in order to estimate the amount of DNA in diploid (2N) cells and compare it with the amount of DNA in the triploids (3N). We use the average value of the 20 – 30 control samples and we compare it with the values for the 3N samples.

Benchmark
Breeding & Genetics



File: 2N.008	Sample ID:	
Mean	Geo Mean	CV
34.99	6.92	133.01
69.26	68.48	15.44

File: 3N.002	Sample ID:	
Mean	Geo Mean	CV
113.48	58.11	65.90
123.30	122.67	10.40

File: 3N.017	Sample ID:	
Mean	Geo Mean	CV
9.31	1.50	364.46
98.89	97.67	15.40

Control Diploid (2N) — Triploid sample (3) — Ambiguous sample

Figure 1. The fluorescence is proportional to the amount of DNA in a cell. Since diploid cells contain 2 sets of chromosomes (2N) and triploids contain three sets of chromosomes (3N), triploid cells have 1.5 times the DNA of diploid cells, and therefore more counts.

For each group of all female triploid that we make, a certified international approved health certificate for export as well as a triploid certificate will be issued.

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Best regards,

Rudi Ripman Seim
R&D and Technical Manager
Benchmark Genetics Ltd.

Appendix W-3

Stofnfiskur Letter –

Use of triploid specific nutrition in commercial feed

February 22th, 2018

Grieg NL Seafarms Ltd.
P.O. Box 457
205 McGettigan Blvd.
A0E 2M0

Attn: Mr. Knut Skeidsvoll, General Manager

The application of commercial rations of triploid specific nutrition and improvements in husbandry and genetics to improve triploid growth rates and decrease incidences of cataracts and skeletal deformities in post-smolts

It is well established in the production of triploids that triploids have a special nutritional requirement that is now provided by all of the main feed companies. With the development of a commercial line of "triploid" feed, the deformities previously observed are now reduced to the levels of diploids. We have conducted an internal study where a total of 400 individuals where selected randomly from a group of triploids. They were pit tagged and reared among the diploid family fish. Evaluation in the family fish is for quality parameters in each year class. The triploid received no special treatment at any stage, except the pressure put on the ova at fertilization. The triploid fish received the same feed, rearing temperature, light regime and handling as the diploids. These 400 individuals where divided randomly between the two breeding stations of Stofnfiskur. When the quality parameters where assessed in the families in one of the two breeding stations, the triploids where slaughtered, filleted and the fat and pigment assessed in the fillets. The results in table 1 are showing growth, deformities and maturation in breeding station 1.

	Diploid	Triploid	Total Group
Number of individuals	4659	163	4822
Mean of weight, Kg	3,4	3,4	3,4
Std.dev	1,1	0,9	1,1
External signs of maturation	395 (8.8%)	0%	398 (8.8%)
Deformity	77 (1.7%)	7 (3.4%)	84 (1.7%)

Table 1 Growth parameters in breeding station 1

In breeding station 1, there was minor additional deformity and no maturation in the triploid group. The growth was the same on diploids and triploids. The results displayed in table 2 are the results for the same traits measured in breeding station 2 as in breeding station 1.

	Diploid	Triploid	Total Group
Number of individuals	4928	146	5074
Mean of weight, Kg	3,3	2,9	3,3
Std.dev	0,97	0,79	0,96
External signs of maturation	229 (4.6%)	3 (2%)	232 (4.7%)
Deformity	56 (1.2%)	6 (4%)	62 (1.2%)

Table 2 Growth parameters in station 2

The quality parameters where measured in breeding station 1. The traits measured are fat percentage on averaged in the whole fillet measured using Near Infrared (NIR) machine, pigment, measured with machine using Visual spectra (VIS) to determine mg/kg of astaxanthin in the whole fillet and the last trait measured was filled yield, which is total fillet weight divided by weight of the whole fish. Result are in table 3.

	Diploid	Triploid	Total Group
Number of individuals	474	106	853
Mean of weight, Kg	4,8	4,7	4,8
Mean gutted weight, kg	4,4	4,4	4,4
Fillet %	0,6	0,7	0,6
Mean fat %	16,7	16,8	16,7
Mean colour mg/kg	7,0	7,0	7,0

Table 3 Quality parameters from breeding station 1

These preliminary results in table 3 show that there is no difference in the quality traits between the diploid and triploid fish.

In this study we had no possibility to provide a special diet for the triploid group. If such had not been the case we know that the deformities to be at the same level as in the diploid group, something which is confirmed by a range of other studies published. We recommend to our customers using triploid salmon eggs to use commercial triploid diet from start feeding through to harvest
and to consult their feed supplier upon ordering feed.

Best regards,

....

Rudi Ripman Seim
R&D and Technical Manager
Benchmark Genetics Ltd.

Appendix W-4

Local Fishermen

Thursday, March 22, 2018

To whom it may concern;

I have been a fisherman operating in central and western Placentia Bay for 27 years. During this time, I have never witnessed an ice problem in our bay as it is ice free. During April and May of last year, people were saying there was some ice on the eastern side as far north as Long Harbour hugging the land. This is a very rare occurrence and was nowhere near the sites that Grieg has proposed. I am absolutely sure that ice is not an issue in central and western Placentia Bay.

If anyone wants to contact me, they can call me on my home number listed below.

Yours Truly

Christopher Pearson

Christopher Pearson

P O Box 13

Petite Forte

A0E 3A0

(709) 428-4596

2018-03-25

To: Environmental Assessment Committee

Re: Ice Conditions in Placentia Bay

My name is Bernard Norman and I have worked for most of my adult life in and around Placentia Bay. For most of that time I have been a fish harvester. As a result, I feel I can provide a competent first-hand assessment of ice in Placentia Bay. Our bay is ice free. On rare occasions (one being spring of 2017) we can experience ice on the eastern side of the bay as far north Long Harbour. Last year I did not experience any issues travelling all over the bay. I did not experience any ice in the areas of the proposed Grieg sites in the center channel and on the western side of our bay. I have never witnessed any ice there at all.

Bernard Norman

Bernard Norman

Rushoon

27 March 2018

Dear Sir or Madame;

I have been asked if there is an ice problem in our bay. I have fished out of my birth home in South East Bite and my current residence in Petite Forte and I can honestly say there is no problem with ice in our bay. It is rare to see bergy bits and growlers but mostly you would find them washed ashore and they would not be an issue. I was out around our area in the spring of 2017 and did not see any ice. I can say with confidence that our bay is ice free.

Also, I have heard in the media that some are saying we didn't fish for lobster because of ice. We didn't put lobster pots out in the spring because there were no lobsters.

Sincerely Anthony Ward

Anthony Ward

Petite Forte

Appendix W-5
FSV multi-purpose vessel

FSV GROUP
Freight & Service Vessels

23th April 2018

Grieg NL
PO Box 457
205 McGettigan Blvd.
Marystown, NL A0E 2M0

ICE-CLASS ON FISH FARMING SERVICE VESSELS

FSV provides specialized services to the fish farming industry from planning to construction and commissioning of complete fish farming plants and auxiliary services to the industry, such as maintenance, inspections and service assignments. FSV operates a modern fleet of highly advanced vessels and equipment adapted to the industry and will provide such vessels for Grieg NL.

FSV is used to operating vessels under demanding conditions in Norway and is familiar with the conditions that can occur in Placentia Bay NL, including ice. If required, FSV can provide ice-class vessels.

Best Regards,

Arild Aasmyr
CEO

Appendix W-6

Burin Peninsula Waste Management Corporation

Burin Peninsula Regional Service Board

Perry Power
Human Resources Manager
Grieg NL
P.O. Box 457
205 McGettigan Blvd.
Marystown, NL
A0E 2M0

Dear Perry,

The Burin Peninsula Waste Management Corporation is pleased to confirm our agreement in principle with your company, to process your waste products associated with your proposed Placentia Bay Aquaculture Operation. This agreement is contingent on our Board sourcing the necessary funding for needed infrastructure and final approval of our Board of Directors.

As discussed, our proposed services to you will cover domestic waste, septic waste from the marine site, sludge from the hatchery, food waste, wood products, inorganic materials and composting.

We are looking forward to a long term, mutually beneficial relationship with your company.

Sincerely,

Harold Murphy
Chair

Route 210 Main Burin Highway North of Jean de Baie · P.O. Box 510 · Burin Bay Arm · N.L. · A0E 1G0
Tel. (709) 891-1717 · Fax. (709) 891-1727 · www.burinpenwaste.com · info@burinpenwaste.com

Appendix W-7

Shell-Ex

SHELL-EX
biomarine processing specialists

OFFICE:
4 Sherwood Drive
St. John's, NL
Canada A1E 2X4
T: 709.690.9886
F: 709.747.8321
www.shell-ex.com
diane@shell-ex.com

April 2, 2018

Candace Way
Facility Production Manager
Greig NL, PO Box 457
205 McGettigan Blvd.
Marystown NL

Dear Candace,

Thank you for your enquiry about ensilage removal services for Grieg NL.

Shell-Ex specializes in marine byproducts processing solutions and has developed capacity to process wet and dry forms of marine biomass into commercially viable animal feed, pharmaceutical ingredients and premium organic fertilizers. The team has built capacity in ensilage and hydrolyzate processing over the past three years and has the capacity to support aquaculture operations with ensilage removal services.

The hydrolysate line can intake a minimum of 20 ton of raw material per week, currently during the June -November season. Upgrades are in process to enable year-round processing in the fall of 2018, and capacity for 40 ton of raw material weekly year-round.

The Twillingate location can intake the projected volumes of ensilage for the next three years or more. During the Hatchery development period the ensilage can be trucked to our facility in secure totes and pumped into our hydrolysate tanks for processing, with appropriate biosecurity and sanitation measures.

"Steady State" production in year 4 and beyond will require at minimum "store and forward" infrastructure, and quite possibly processing units located in the landing region to support the ensilage output and fluctuations in supply that may occur during this period.

I look forward to developing an agreement with Grieg NL around the opportunity in the near future.

Kind Regards

Diane Hollett

Diane Hollett
President
Shell-Ex Biomarine

PLANT:
P O Box 599
15 Path End
Twillingate, NL
Canada A0G 4M0

Appendix W-8
Aller Aqua

Allervej 130
DK-6070 Christiansfeld
Denmark
Tel.: +45 70 22 19 10
CVR-nr. 30711726

www.aller-aqua.com

Grieg NL Seafarms Ltd.
P.O. Box 457
205 McGettigan Blvd.
Marystown, NL A0E 2M0
Canada

Attn: Knut Skeidsvoll, General Manager
ATTN: Candice Way, Facility Production Manager

Christiansfeld, 1 May 2018

Ensilage

Dear Sirs,

By this letter we confirm that we are buying ensilage from the salmon industry for our production of feed.

We would be interested in buying ensilage for our production from Grieg NL when your operation in Newfoundland has started.

Best regards
Aller Aqua Group A/S

Hans Erik Bylling
CEO/ President

Appendix W-9
Eimskip

EIMSKIP

33 Pippy Place- Suite 305- St. John's, NL A1B3X2 T: 709-754-7227 F: 709-754-799

DATE: 24.04.2018

Regarding Grieg Seafarms

Cargo: Ensilage
Non-hazardous cargo
Loaded into containers at Grieg Seafarms facility in Marystown

We, Eimskip Canada, hereby confirm below.

Containers will be sealed before being shipped from Argentia, NL Canada, they will be sealed all the way to Aarhus, Denmark. The containers will not be opened at any point during transportation as shipping will be based on FCL/FCL. We have weekly callings on Tuesdays from Argentia, our vessels will stop in Iceland and cargo transloaded on another vessel to go to Aarhus. Our vessels call Aarhus on a weekly basis as well, on Mondays.

Eimskip was founded in 1914 in Iceland. Eimskip is a highly respected company in the shipping industry, and we pride ourselves in Logistics solutions as well as good quality service.

On behalf of Eimskip Canada

Thordis Thorlacius
Liner Manager
Mobile: 709 682 2779

Appendix X

Proposed Workforce and Timeline

September 2016

PLACENTIA BAY ATLANTIC SALMON AQUACULTURE PROJECT

PROPOSED WORKFORCE AND TIMELINE

For NL Department of Advanced Education, Skills and Labour

(Revised, September 2016)

Grieg NL
Marystown, Newfoundland

Table of Contents

1.0 Introduction

Demand for quality seafood is increasing as is the concern over food security. Newfoundland, as an island, is very dependent on food importation and as such, risks food shortages should there ever be a disruption in either supply from mainland North America or with current transportation methods such as ferries and roads. As well, there are global concerns with regard to supplies for fresh quality seafood. However, Newfoundland has tremendous resources available that are currently being underutilized that could not only help alleviate concerns with food security but also assist with the increasing demand for high quality seafood products in North America and potentially even globally. Grieg NL (GNL) realizes this potential for Newfoundland and is pursuing a state-of-the art Recirculating Aquaculture System (RAS) for culturing triploid Atlantic salmon (*Salmo salar*) smolt in Marystown, Newfoundland and Labrador with on-growing marine cage sites in Placentia Bay, NL, and processing into high end quality salmon fillets and other speciality products at a facility in St. Lawrence, Newfoundland and Labrador (hereinafter referred to as the Project).

This project has strong potential in terms of export market opportunities and economic benefit, especially in outport Newfoundland. An operation of this size will provide very significant employment opportunities, resulting in a much needed major boost to the current economy of NL and providing prospects for graduates to utilize their skills and knowledge in their home province. Newfoundland is world renowned for some of its training facilities and the graduates that it produces. The Fisheries and Marine Institute of Memorial University is one such training facility that GNL has already utilized for recruiting skilled employees and will continue to utilize this and other training facilities in the province for its workforce.

The proposed Project was registered for Environmental Assessment (EA) review under the Newfoundland and Labrador *Environmental Protection Act* (NL EPA, Part 10) in February 2016. Following governmental and public review of the EA Registration, the Minister of Environment and Conservation announced on July 22, 2016 that the Project had been released from the EA review process, subject to a number of associated terms and conditions. These included the following:

> *Prior to the commencement of construction activities, the proponent must submit to the Department of Advanced Education and Skills additional information on workforce and timelines for the project...*

The preparation and submission of this document is intended to address the above noted condition of EA release for the Project. Specifically, this report details the proposed workforce for GNL as well as expected timelines for the Placentia Bay Atlantic Salmon Project.

The current (September 2016) version of this document has been prepared and submitted to the NL Department of Advanced Education, Skills and Labour, and addresses the various review comments and suggestions that were provided by the Department as part of its review of the original (August 19 2016) draft document submitted by GNL. The Table of Concordance provided below indicates where and how each of these review comments have been addressed in this revised report.

Table 1: Table of Concordance with Review Comments from the NL Department of Advanced Education, Skills and Labour

Review Comment	**Where / How Addressed in Revised Document (September 2016)**
• The proponent provide additional information regarding the timelines for individual occupations during various phases of the project; specifically, the numbers for different occupations making up the individual phases of the project (including relevant 4-digit NOC codes) should be further summarized, either monthly or quarterly. While the Department notes that Table 2 of the Workforce and Timelines document has expanded considerably upon the information from the earlier registration, the data related to timelines of employment (rather than hiring) remains incomplete at this time.	Additional information on the anticipated "temporal distribution" of these positions throughout the various phases of the Project has been added to the report. In particular, the Table (currently Table 3) has been revised to include data on the anticipated number of workers in each position / occupation for each quarter.
• The proponent should clarify how many of the 36 Deck Hands and 25 Aquaculture Labourers during the operations phase of the marine-based sea cage are full-time and how many are part-time.	This information has also been added to the Table, which now indicates the anticipated number of workers in each of these occupations that are expected to be full-time vs those that would be part-time in nature.
• The proponent should clarify how many of the 16 Captains and 36 Deck Hands during the operations phase of the marine-based sea cage will be contracted out and how many will be with GNL. In addition, it should be clearly stated how many of the "GNL" occupations in Table 2 will, in fact, be new direct hires. If all such employment labeled "GNL" in Table 2 will be new hires to the company, however, this can simply be stated in the descriptive text rather than create a new column in the existing table.	This information has also been added to the Table, with associated text, that now indicates the anticipated number of workers in each of these occupations are expected to be GNL employees (including those that will be new hires) vs those that would be contractors.

In preparing and submitting this report, GNL has undertaken to compile and provide the most up to date and comprehensive information on Project labour requirements and associated schedules possible, based on the current stage of Project planning and design. This includes attempting to address the various specifications and suggested content and structure of this information, as provided by Departmental officials on August 18, 2016 and in its subsequent discussions with GNL.

It should be noted, however, that the employment data provided herein are considered to be general and preliminary estimates, and reflect the current stage of Project planning and design. They may therefore be subject to further refinement as these aspects of the Project continue to progress.

2.0 The Grieg Team

2.1 Description of Proponent

Grieg Newfoundland Salmon Ltd. is a new company created as part of the Grieg Group of companies and OCI (Figure 1). It will be chaired by Per Grieg Jr, Chairman of the Board of Grieg Seafoods (one of the world's leading salmon farming companies) and having members from OCI on the board. The owner group represent more than 3,500 employees world-wide where the majority work within the fishery and aquaculture industry. The group represent a fully integrated salmon production system from roe to final product.

Grieg Newfoundland Salmon Ltd. plans to develop a substantial aquaculture operation in Marystown and Placentia Bay, NL. Construction is slated to begin in 2016 for the creation of both a hatchery and sea cage sites, which will produce 33, 000 metric tonnes of farmed salmon on an annual basis by 2023.

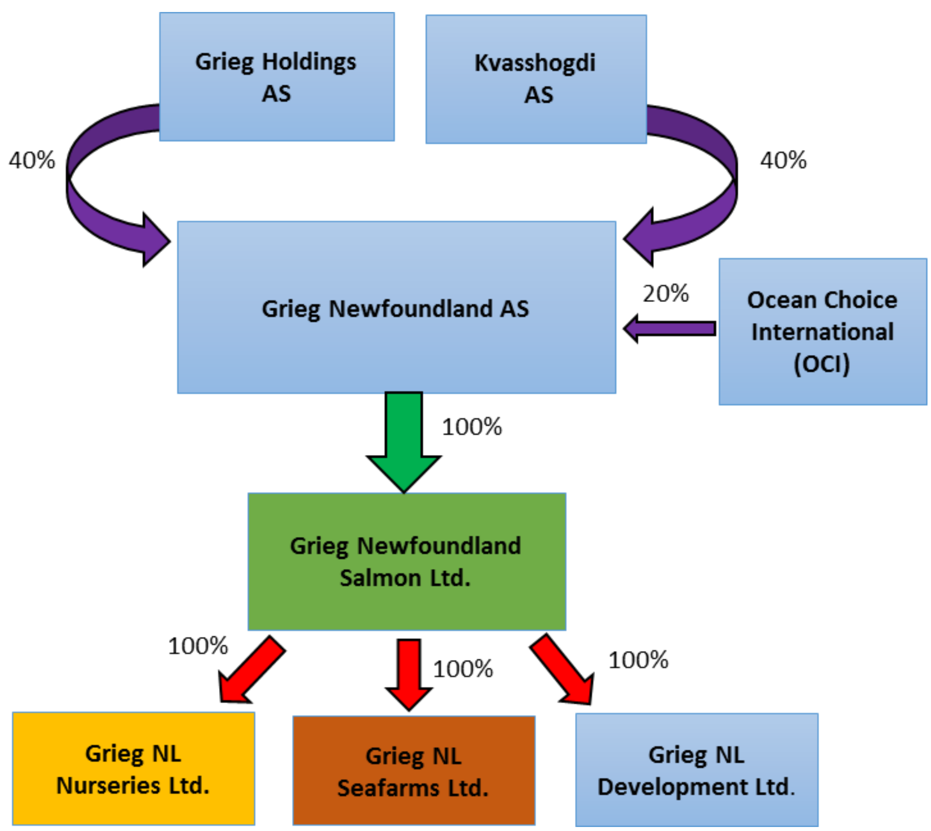


Figure 1. Corporate Structure of the Grieg Group of Companies

2.2 Proponent Track Record

The main farming operations, through Grieg Seafoods, has a solid track record in the salmon farming industry and currently owns and operates four salmon production centers: Rogaland and Finnmark in Norway, Shetland in the UK, and British Columbia in Canada. With a combined capacity of over 100,000 mt. Grieg Seafoods is one of Norway's largest salmon producers. In 2015, Grieg Seafoods harvested a total volume of 65,398 mt. of salmon generating revenues of US$ 550 million. Grieg Seafoods has been listed on the Oslo Stock Exchange since 2007 and Grieg Seafood's top five shareholders are: Grieg Holdings (55%), DNB Nor Markets (20%), Nordea Bank (6%) and Kontrari (5%). Grieg Newfoundland Salmon Ltd. will contribute to the project through a substantial equity stake combined with industrial competence, management, technology and a sales network.

2.3 Current Management Team

GNL has begun to assemble Highly Qualified Personnel (HQP) that will provide the necessary expertise to hatch, cultivate, and harvest Atlantic salmon. Together, they will form a strong management team to develop this project and provide knowledge as well as insight about optimizing the production of Atlantic salmon (Table 2).

Table 2: The current management team for Grieg NL

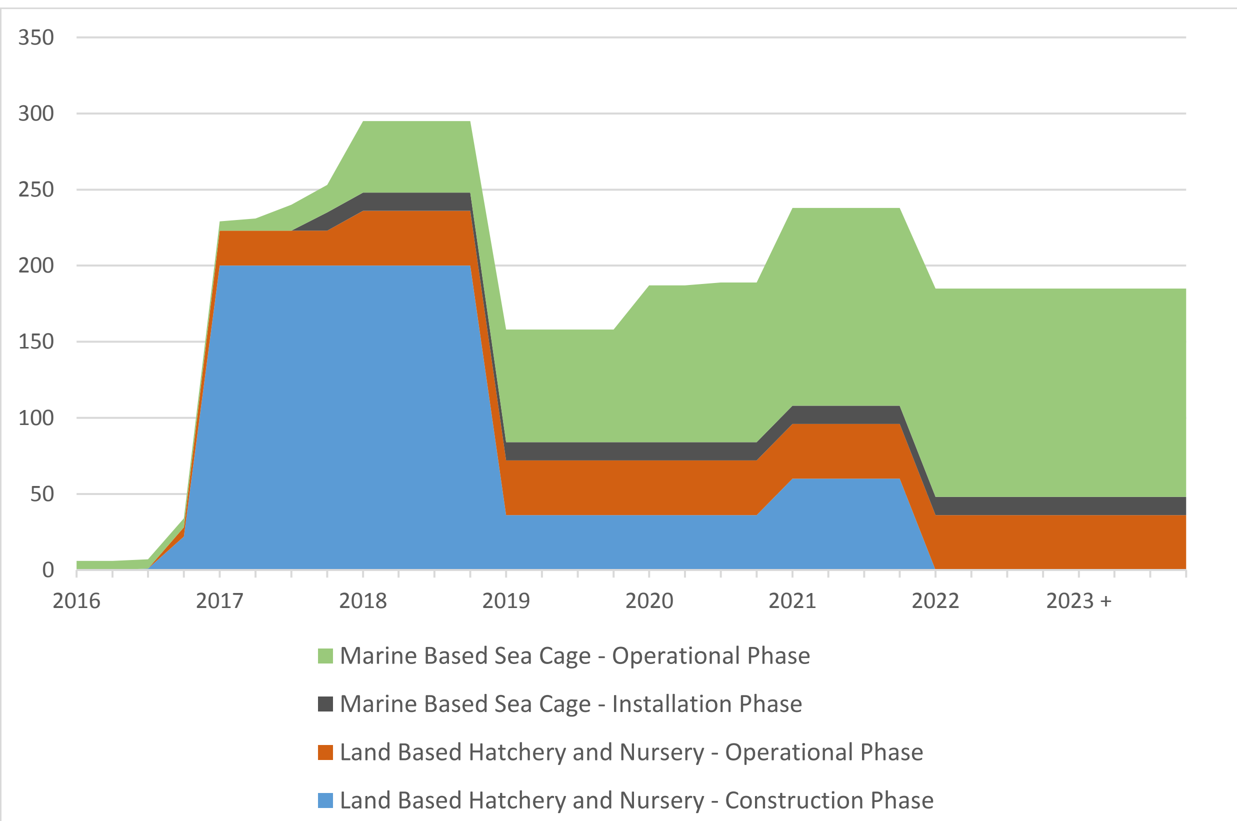
GNL HQP	Position	Hire Date
Knut Skeidsvoll	General Manager	September 1, 2015
Clyde Collier	Project Manager	September 1, 2015
Perry Power	Human Resources Manager	November 1, 2015
Sharon Murray	Administration Officer	September 1, 2015
Shalyn Ryan	Marine Site Manager	September 1, 2015
Candice Way	Hatchery Manager 1	March 22, 2016
Laura Purchase	Assistant Hatchery Manager 1	March 1, 2016
TBD	Hatchery Manager 2	Exact date TBD, Fall 2016
TBD	Hatchery Manager 3	Exact date TBD, Fall 2016

3.0 Proposed Workforce Structure and Schedule

Two subsidiaries of GNL will be Grieg NL Nurseries Ltd., a land based hatchery and nursery and Grieg NL Seafarms Ltd., a marine based sea cage grow out site. Each of these subsidiaries will be structured with a senior management team overseeing staff.

Construction of the land based hatchery and nursery is slated to begin in the Fall of 2016 and continue in phases through 2021. At its peak construction period in 2017-2018, it is estimated that upwards of 200 persons will be working on project-related construction activities. Once the land based hatchery and nursery facility is fully operational by 2018, an estimated 36 employees will be working there in permanent, year-round positions. (Table 3). GNL will also have four marine based areas for continued grow out of the salmon to market size. Once full production is reached in 2021 and all four marine areas are in use, it is expected that 137 employees will be working at these marine sites in Placentia Bay (Table 3). Figure 2 summarizes the general, estimated distribution of Project related employment during the various phases of the Project, based on the data provided in Table 3.

Figure 2. Estimated Temporal Distribution of Project Employment by Phase (All positions and employers)



With the exception of the company's current labour force in Newfoundland and Labrador (see Table 2), all of the employees labeled as "GNL" in Table 3 will be new hires to the company.

A lumpfish hatchery is also planned to be used as a cleaner fish in the cages with the salmon as a natural means of controlling sea lice infestations. It is expected that by 2017 the lumpfish hatchery will be employing 10 individuals (not employed directly by GNL).

In 2019, the first salmon are expected to be harvested and subsequent years will see an increase in processing needs as all four marine sites are harvested. By 2022, it is expected that 426 individuals working in the NL seafood processing will be involved in the processing and services needed to bring GNL Atlantic salmon products to market.

As noted previously, the employment data provided herein represent initial and preliminary estimates, and reflect the current stage of Project planning and design. These employment numbers and associated timelines may therefore be subject to change as Project planning and implementation continue to progress.

Table 3: Estimated Full Time (FT) and Part Time (PT) employees required for GNL Land Based and Marine Based Construction and Operations, 2016-2022 (By Year and Quarter)

Occupation	NOC Code (2011)	FT/PT	Max # of Positions	GNL or Contractors (CT)	Years Required	2016				2017				2018				2019				2020				2021				2022				2023 +			
LAND BASED HATCHERY AND NURSERY PHASE						Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Construction Phase																																					
Engineering Manager	0211	FT	3	CT	2016-2021				1	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2	2								
Civil Engineers	2131	FT	2	CT	2016-2021				2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2								
Civil Engineering Technologists	2231	FT	2	CT	2016-2021				2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2								
Drafting Technologists/Technicians	2253	FT	1	CT	2017-2021					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1								
Land Survey Technologists/Technicians	2254	FT	1	CT	2016-2021			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1								
Construction Inspector	2264	FT	4	CT	2017-2021					4	4	4	4	4	4	4	4	1	1	1	1	1	1	1	1	2	2	2	2								
Electrical Power Line and Cable Workers	7244	FT	5	CT	2017-2021					5	5	5	5	5	5	5	5	2	2	2	2	2	2	2	2	2	2	2	2								
Telecommunication Line and Cable Workers	7245	FT	5	CT	2017-2021					5	5	5	5	5	5	5	5	2	2	2	2	2	2	2	2	2	2	2	2								
Steamfitters, Pipefitters and Sprinkler System Installers	7252	FT	20	CT	2017-2021					20	20	20	20	20	20	20	20	1	1	1	1	1	1	1	1	3	3	3	3								
Welder	7237	FT	10	CT	2017-2021					10	10	10	10	10	10	10	10	1	1	1	1	1	1	1	1	2	2	2	2								
Carpenters	7271	FT	20	CT	2017-2021					20	20	20	20	20	20	20	20	5	5	5	5	5	5	5	5	8	8	8	8								
Concrete Finisher	7282	FT	20	CT	2017-2021					20	20	20	20	20	20	20	20	2	2	2	2	2	2	2	2	4	4	4	4								
Heavy Equipment Mechanics	7312	FT	4	CT	2016-2021				1	4	4	4	4	4	4	4	4	1	1	1	1	1	1	1	1	1	1	1	1								
Crane Operators	7371	FT	2	CT	2017-2021					2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1								
Truck Drivers	7511	FT	5	CT	2016-2021				3	5	5	5	5	5	5	5	5	2	2	2	2	2	2	2	2	2	2	2	2								
Heavy Equipment Operators	7521	FT	4	CT	2016-2021				4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	2	3	3	3	3								
Construction Labourers	7611	FT	92	CT	2016-2021				8	92	92	92	92	92	92	92	92	11	11	11	11	11	11	11	11	22	22	22	22								
TOTAL			**200**																																		
Operational Phase																																					
Senior Management	0016	FT	1	GNL	2016-				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maintenance Manager	0714	FT	1	GNL	2016-				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Production Manager	0911	FT	1	GNL	2016-				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Aquaculture Managers	0823	FT	7	GNL	2016-				3	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Aquaculture Technicians	2221	FT	16	GNL	2017-					7	7	7	7	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Aquaculture Technicians	2221	PT	6	GNL	2017-					2	2	2	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Welder	7237	FT	1	CT	2017-					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Occupation	NOC Code (2011)	FT/PT	Max # of Positions	GNL or Contractors (CT)	Years Required	2016				2017				2018				2019				2020				2021				2022				2023 +			
Heavy Equipment Operators	7521	FT	1	CT	2017-					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Air Conditioning Mechanic	7313	FT	1	CT	2017-					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Power Systems Electrician	7202	FT	1	CT	2017-					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTAL			**36**																																		
MARINE BASED SEA CAGE PHASE						**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Installation Phase																																					
Captains	8261	FT	1	CT	2017-								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Engineering	0211	FT	1	CT	2017-								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Deck Hands	8441	FT	6	CT	2017-								6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Electrical Industrial	7242	FT	1	CT	2017-								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Welder Operator	7237	FT	1	CT	2017-								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Heavy Equipment Mechanic	7312	FT	1	CT	2017-								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Crane Operator	7371	FT	1	CT	2017-								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTAL			**12**																																		
Operational Phase																																					
Senior Managers	0016	FT	2	GNL	2016-	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Supervisor General Officer	1211	FT	1	GNL	2016-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Supervisor Financial	1212	FT	1	GNL	2016-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Human Resources Officer	1223	FT	1	GNL	2016-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Administrative Assistant	1241	FT	1	GNL	2016-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maintenance Manager	0714	FT	1	GNL	2017-						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Production Manager	0911	FT	1	GNL	2017-						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Aquaculture Managers	0823	FT	7	GNL	2017-							2	2	2	2	2	2	3	3	3	3	3	3	5	5	5	5	5	5	7	7	7	7	7	7	7	7
Aquaculture Technicians	2221	FT	33	GNL	2017-							6	6	9	9	9	9	14	14	14	14	21	21	21	21	28	28	28	28	33	33	33	33	33	33	33	33
Crane Operator	7371	FT	2	CT	2017-							1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Captains	8261	FT	4	GNL	2018-									1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
Captains	8261	FT	12	CT	2018-									3	3	3	3	6	6	6	6	10	10	10	10	12	12	12	12	12	12	12	12	12	12	12	12
Deck Hands	8441	FT	4	GNL	2018-									1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
Deck Hands	8441	PT	4	GNL	2018-									1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
Deck Hands	8441	FT	18	CT	2018-									7	7	7	7	11	11	11	11	15	15	15	15	18	18	18	18	18	18	18	18	18	18	18	18
Deck Hands	8441	PT	10	CT	2018-									3	3	3	3	5	5	5	5	7	7	7	7	10	10	10	10	10	10	10	10	10	10	10	10
Welder	7237	FT	1	CT	2017-								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Heavy Equipment Mechanics	7312	FT	6	CT	2018-									2	2	2	2	3	3	3	3	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6
Power Systems Electrician	7202	FT	3	CT	2018-									1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Aquaculture Labourers	8613	FT	20	GNL	2018-									5	5	5	5	10	10	10	10	15	15	15	15	20	20	20	20	20	20	20	20	20	20	20	20
Aquaculture Labourers	8614	PT	5	GNL	2018-									2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5
TOTAL			**137**																																		

3.1 Land Based Hatchery and Nursery Workforce Structure and Schedule

As indicated previously, Grieg NL Nurseries Ltd. will be constructing a land based Recirculating Aquaculture System (RAS) in Marystown, Newfoundland for culturing triploid Atlantic salmon from eyed eggs up to 1.5 kg for continued growth in their marine based sea cages. The RAS will be divided into three facilities: start feeding, smoltification and post-smolt based on culture and development needs of the Atlantic salmon. To expedite the start date, all three facilities will not be completed prior to the arrival of the first batch of Atlantic salmon eggs. The start feeding facility will be the first facility to be constructed and receive eyed eggs for culture until the young salmon reach the stage of smoltification. The start feeding facility should be completed by August 2017. As the young salmon in the start feeding facility grow, the smoltification facility will continue to be constructed and its completion is planned to coincide with the transfer of the first batch of salmon from start feeding to smoltification – December 2017. The third facility, post-smolt is the largest of the three facilities and its construction will be divided into 3 phases. Phase 1 of the post-smolt unit will have the construction of a portion large enough to handle the first batch of salmon eggs after smoltification and its completion is expected by February 2018. Phase 2 and 3 of construction for the post smolt facility will expand and complete the facility to accommodate maximum production numbers. Both Phase 2 and Phase 3 are expected to be completed by March 2019.

Once operational, each facility within the GNL land based Atlantic salmon RAS will be staffed with managers as well as technicians and other operational staff to ensure a strong management team and workforce responsible for each staffed facility (Figure 3). The senior management team including facility managers for each of the three RAS unit (start feeding, smoltification and post-smolt) is expected to be in place and provided with training prior to the completion of the start feeding facility (August 2017). These senior managers will be expected to be involved in the construction phase to ensure there is a clear awareness and understanding of each units' operational structures including plumbing, machinery and equipment. Technicians for each of the three RAS facilities will be hired as the completion date of construction nears. Therefore, although there will be 22 technicians (permanent and temporary positions) for the Atlantic salmon RAS facility, hiring will occur in phases to reflect the completion of construction and start up of each unit (see later Figures).

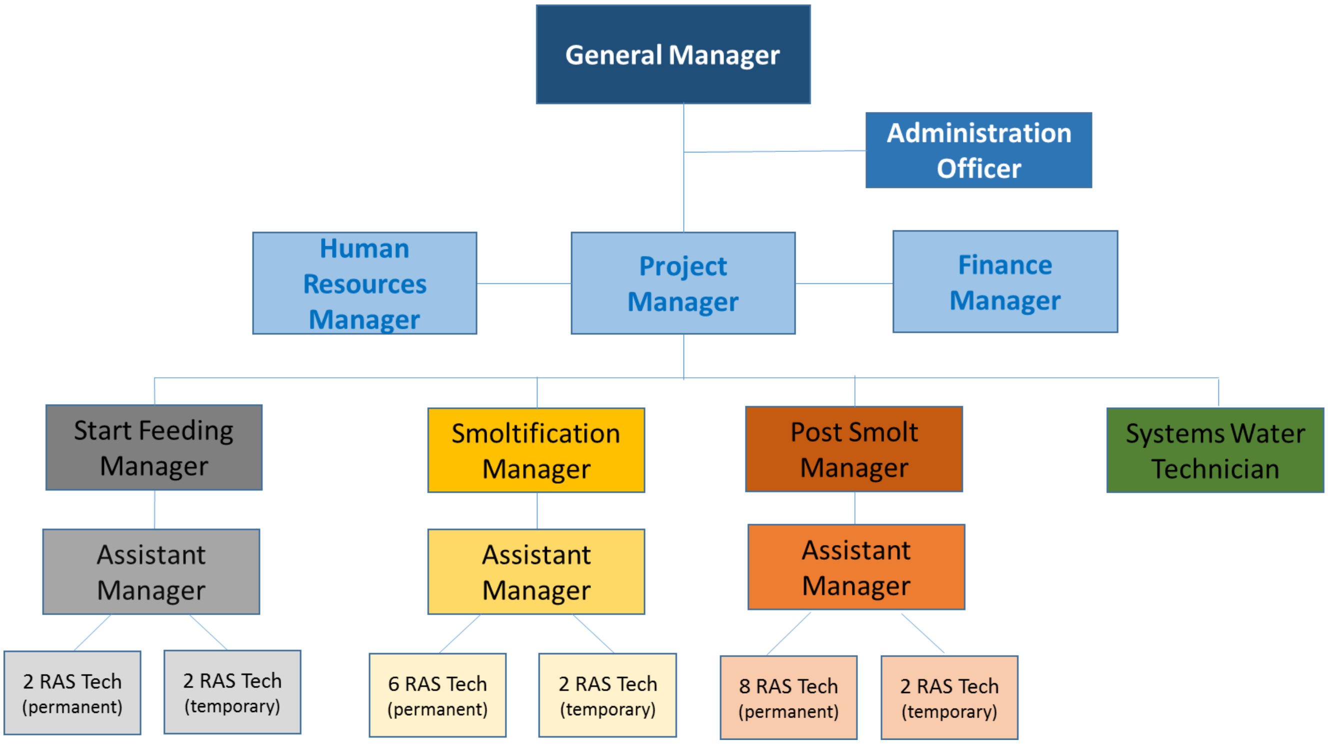


Figure 3: Proposed workforce structure for Grieg NL Nurseries Ltd.

Each technician and assistant manager for each facility within the RAS will report to the respective manager for each facility. The project manager will oversee the three facility managers as well as a system water technician. The reporting structure for Grieg NL Nurseries Ltd is detailed in Figure 4.

Figure 4: Reporting Structure for Grieg NL Nurseries Ltd.

3.2 Marine Based Sea Cage Workforce Structure

There will be four Bay Management Areas (BMAs) in Placentia Bay for the marine based continued growout of the Atlantic salmon to harvest size. These four BMAs will be used in a rotational manner such that each has an opportunity to lie fallow at least once during the cycle. The four BMAs will be as follows:

1. Red Island BMA
2. Merasheen BMA
3. Rushoon BMA
4. Long Harbour Seasonal BMA

Three of the BMAs (Red Island, Merasheen and Rushoon) will have three cage sites with 12 cages in each site. The seasonal Long Harbour BMA will have two sites to be used during fall harvest but not as continued growout.

Each BMA will have an area manager as well as an assistant manager. Feed technicians, net cleaning technicians and service vessels staffed with crew will be assigned to each BMA to ensure that the required culture and husbandry practices will be available and implemented (Figure 5).

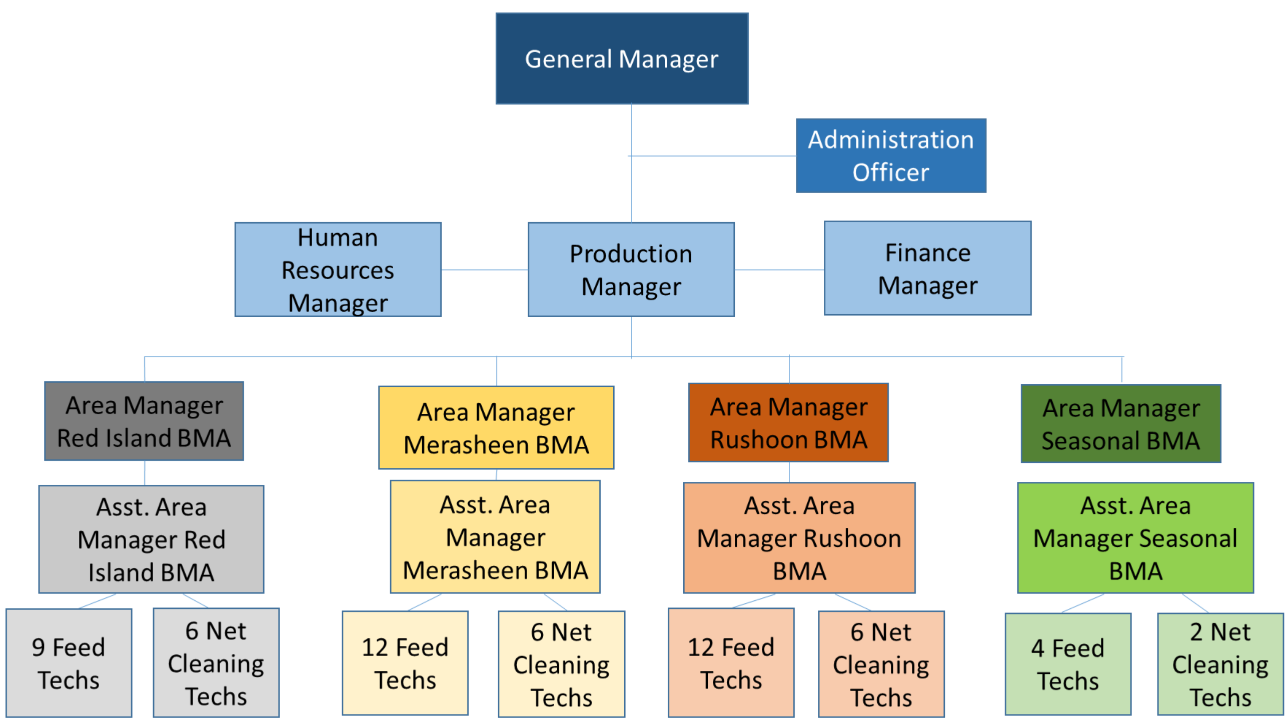


Figure 5: Proposed workforce structure for Grieg NL Seafarms Ltd.

Each BMA will be overseen by the production manager. Feed technicians, net cleaning technicians and assistant area managers will report directly to the area manager. The reporting structure for the Red Island BMA is outlined in Figure 6, Merasheen in Figure 7, Rushoon in Figure 8 and the seasonal BMA in Figure 9.

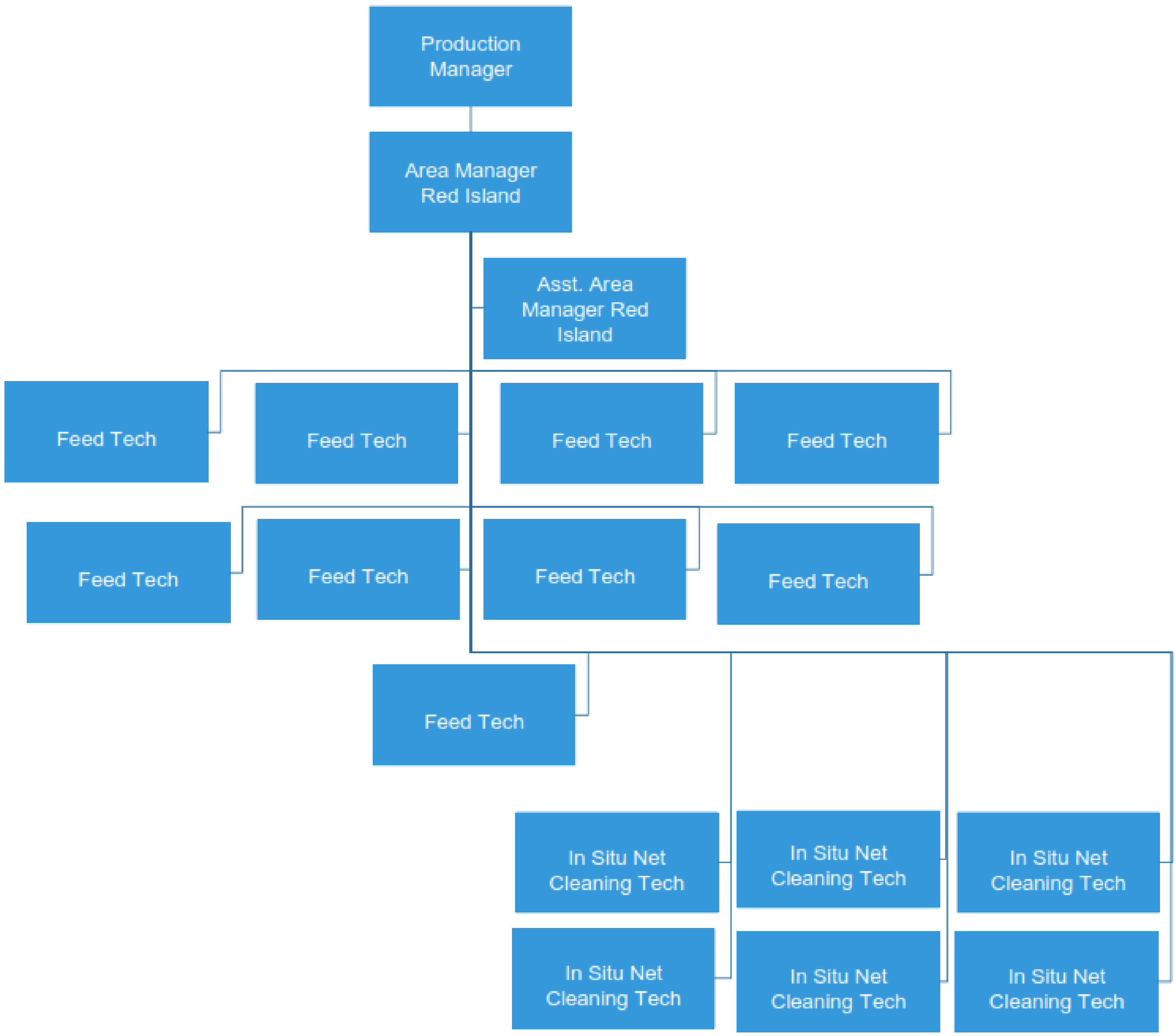


Figure 6: Red Island BMA reporting structure for Grieg NL Seafarms Ltd.

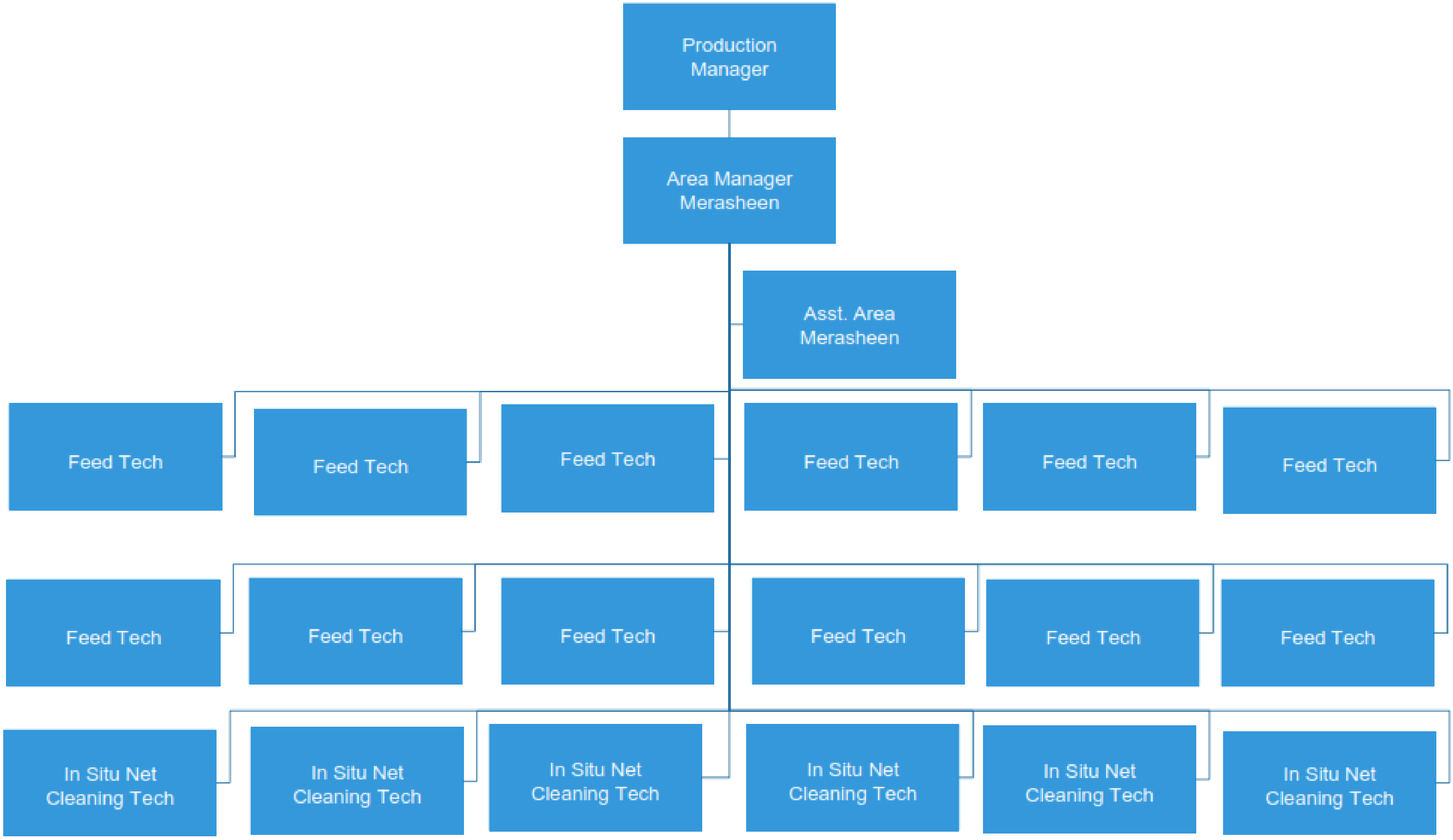


Figure 7: Merasheen BMA reporting structure for Grieg NL Seafarms Ltd.

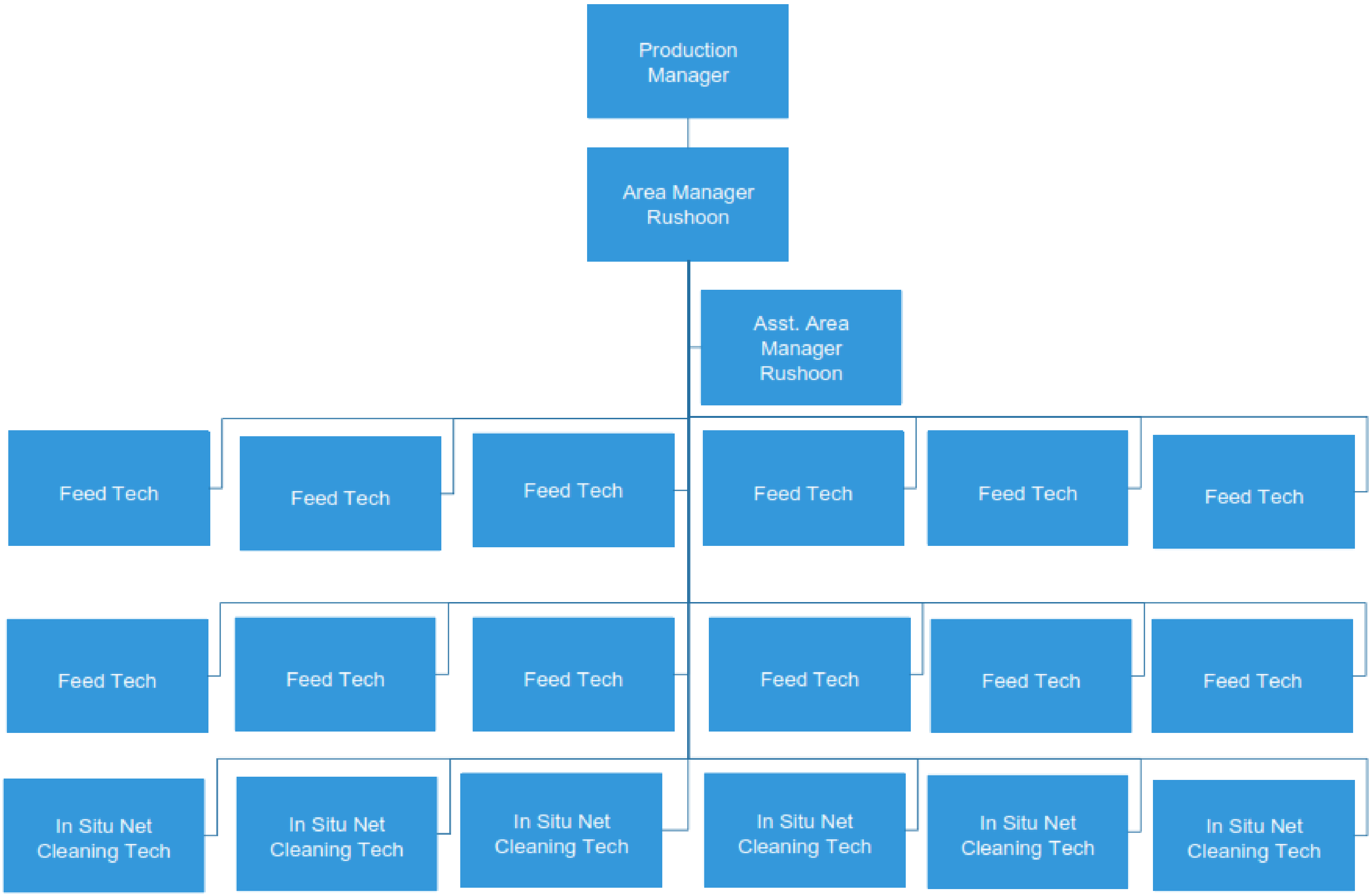


Figure 8: Rushoon BMA reporting structure for Grieg NL Seafarms Ltd.

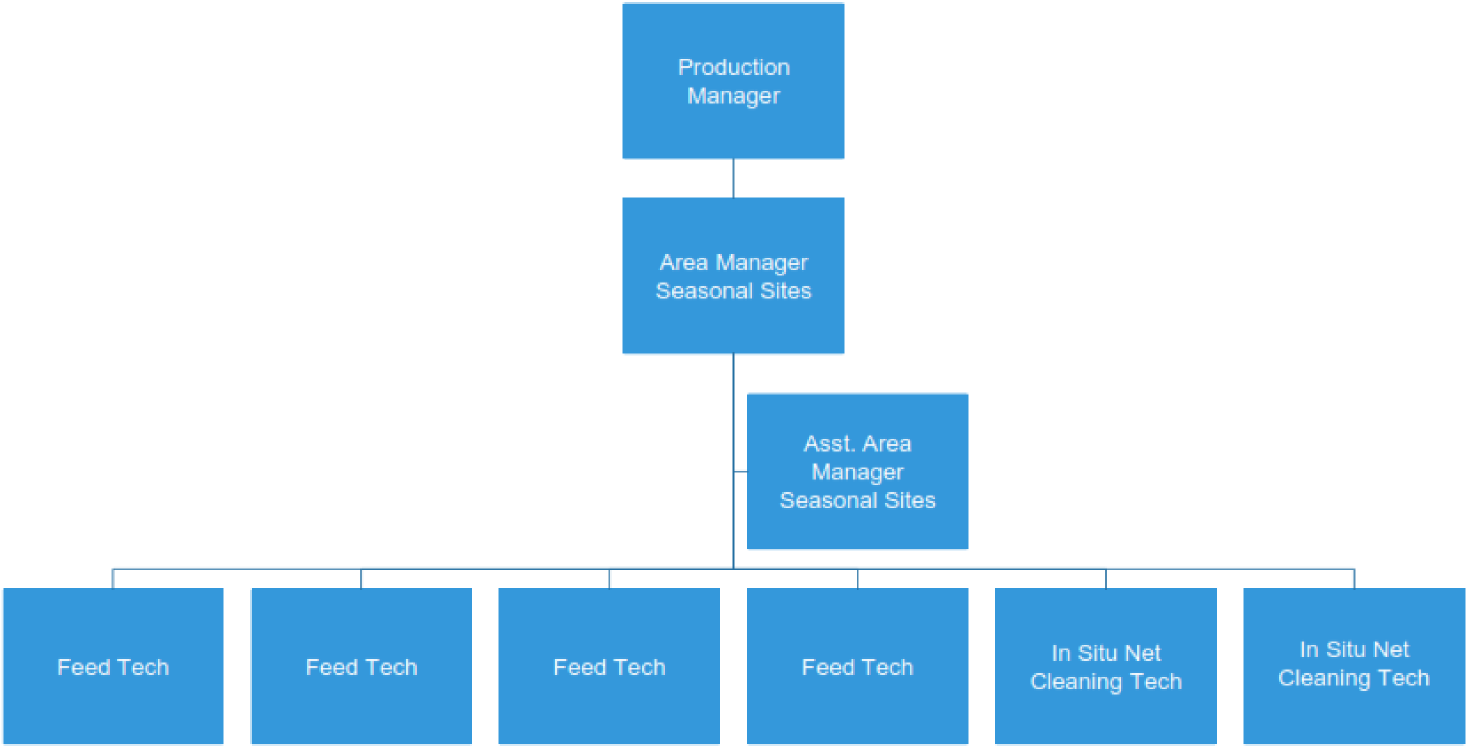


Figure 9: Marine seasonal BMA reporting structure for Grieg NL Seafarms Ltd.

To accommodate the marine sites, each BMA will have a service vessel equipped with crew. Figure 10 outlines the reporting structure for the service vessels.

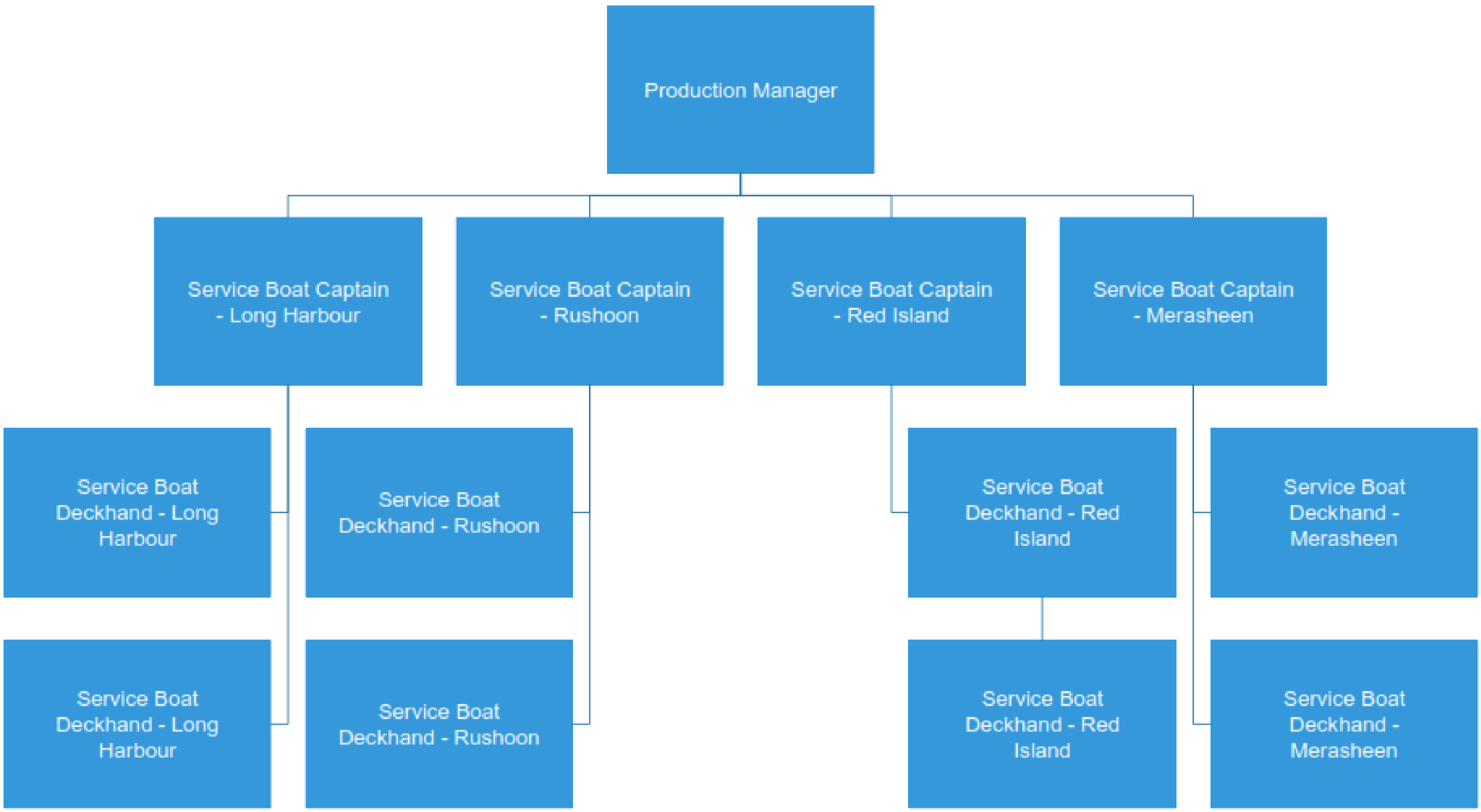


Figure 10: Marine service vessel reporting structure for Grieg NL Seafarms Ltd.

The preceding sections have provided a general indication (current estimate) of the likely numbers and range of occupations that will be required for Project construction and operations, based on the current stage of planning and design. These employment numbers and associated timelines may therefore be subject to further refinement and change as Project planning and implementation continue to progress.

As illustrated, the construction and operations workforce will include a range of occupations over several sub-phases, most of which will be full-time in nature. For the most part, the nature and composition of the Project's workforce (proponent and contractors), including with regard to the associated entry requirements, skill levels and compositions, and the ratio of journeypersons and apprentices (likely 25 percent apprentices for trades positions) will likely be very similar to other similar, recent projects in Newfoundland and Labrador. Information on the general duties and qualifications (training and experience) requirements for each of the occupations listed above can be found at *Human Resources and Skills Development Canada (2011) - 2011 National Occupational Classification (NOC). Available at: http://www5.hrsdc.gc.ca/NOC/English/NOC/2011/Welcome.aspx*

4.0 Recruitment for the Workforce

Wherever possible, Grieg NL intends to source the required workforce for Project operations from Newfoundland and Labrador, where local personnel are available, qualified and interested in obtaining employment on this Project. Attracting and retaining a local workforce is considered desirable by the Proponent, in order to maintain an adequate and stable labour force for the Project (including persons who are experienced in working with the specific species, conditions, equipment and activities that will comprise this Project), as well as likely being possible given the presence of local training institutions and programs in Newfoundland and Labrador.

The Fisheries and Marine Institute of Memorial University of Newfoundland is a world class center of advanced marine technology, education, and training. The Marine Institute specifically recognizes its integral role within the province. The mission of the institute is to foster economic development in strategic sectors in the Newfoundland and Labrador economy, particularly the fisheries and offshore, and to enable Newfoundlanders and Labradorians to participate in the marine industry nationally and internationally.

The Institute intends to continue moving forward as it has a substantial mandate which encompasses education and training, applied research, and technology transfer, that serves a client base drawn from the St. John's area, Newfoundland and Labrador, Canada, and world-wide. GNL is proud to have aligned themselves with the Marine Institute for recruiting skilled people to become a part of the GNL team but also as a resource for Research and Development. These programs at training institutes such as the Fisheries and Marine Institute offer skills and trades that are very applicable to the Grieg group of companies (Table 4). GNL will commit to coordinating with institutes such as the Fisheries and Marine Institute for recruitment fairs as well as work term placements as a resource for HQP.

Table 4: Enrollment numbers for 2014 and fall 2015 Diploma and Advanced Diploma programs at the Fisheries and Marine Institute of Memorial University of Newfoundland

Marine Institute Program	2014	2015
Advanced Diploma	**24**	**17**
Food Safety	12	9
Sustainable Aquaculture	7	3
Water Quality	5	5
Diploma in Technology		
Food Technology	**15**	**14**
Year 1	4	
Year 2	2	4
Year 3	5	1
Year 4	4	9
Marine Environmental Technology	**35**	**30**
Year 1	16	9
Year 2	11	12
Year 3	8	9
Total Potential Recruits	**74**	**61**

Source: Marine Institute, School of Fisheries, 2016

The Burin Peninsula is an area of high Employment Insurance (EI) prevalence and Grieg NL will have a significant positive impact on the labour force and ultimately the overall economy of the region. The following table depicts the EI beneficiaries reported for the entire Burin Peninsula 2012-2014. As indicated in Table 5, 40% of the local labour force (4,770 individuals) filed EI claims in 2014. Since operations for Grieg NL will be full time and not seasonal, this project could employ persons in small communities on the Burin Peninsula where employment is often difficult to find and can provide them with long term employment security as opposed to relying on EI benefits for a portion of the year. In addition, the processing plant will create jobs in St. Lawrence and Fortune, two towns where at the present there is very little new employment activity. Many of these potential employees may have skills and knowledge already related to the fishery that can be an asset to GNL or may be willing to enroll in training programs offered by institutions such as the Fisheries and Marine Institute to enhance their skills and knowledge for employment with GNL.

Table 5: Prevalence of EI beneficiaries - Burin Peninsula, Newfoundland 2012-2014

	2012	2013	2014
Labour force	11,940	11,927[3]	11,925
EI beneficiaries	5,710	5,260	4,770
EI prevalence	47.8%	44.1%	40.0%
Age of Beneficiary			
Youth (less than 25)	430	360	305
Prime labour force (25-54)	3,470	3,150	2,875
Age 55+	1,810	1,740	1,585
Gender of Beneficiary			
Male	3,615	3,380	2,965
Female	2,095	1,880	1,805
% female	36.7%	35.7%	37.8%

Source: Government of Newfoundland Community Accounts

5.0 Employment Timelines

GNL began hiring for the Placentia Bay Atlantic Salmon Project in September 2015. Since this time, other key management personnel have joined the team to assist in establishing the project. Figure 11 below generally illustrates the current and proposed hiring schedule for GNL.

5.1 Grieg NL Nurseries Ltd. Hiring Timeline

Figure 12 below outlines the proposed hiring timeline for Grieg NL Nurseries Ltd. This includes summary information on the anticipated dates of hiring completion as well as the positions to be hired and anticipated numbers.

5.2 Grieg NL Seafarms Ltd. Hiring Timeline

Figure 13 outlines the hiring timeline for the marine sites for Grieg NL Seafarms Ltd. A Production Manager for the sea cage sites will be hired in September 2017 to allow opportunity and time for training. Each BMA; Red Island, Merasheen, Rushoon and the Seasonal site, will be staffed as production increases and they are brought on-line. All four BMAs should be in full production and completely staffed with managers, assistant managers, feed technicians, net cleaning technicians as well as service vessels and crew by April 2021.

As noted previously, the employment data provided herein represent initial and preliminary estimates only, reflecting the current stage of Project planning and design. These employment numbers and associated timelines may therefore be subject to change as Project planning and implementation continue to progress.

6.0 Monitoring and Reporting

GNL will also report to the Government of Newfoundland and Labrador on the Project's labour force. The reporting will include information on the number of persons employed by occupation (4-digit NOC 2011), including the number of full-time/part-time employees, the number of apprentices (by level) and journeypersons, as well as available information on the gender and source of the workforce.

It is proposed that this reporting will begin upon commencement of Project construction and will extend into the initial 2-3 years of operation, until such time as the entire Project workforce is in place and has largely stabilized. The nature and frequency of this reporting will be determined and developed in consultation with the NL Department of Advanced Education, Skills and Labour.

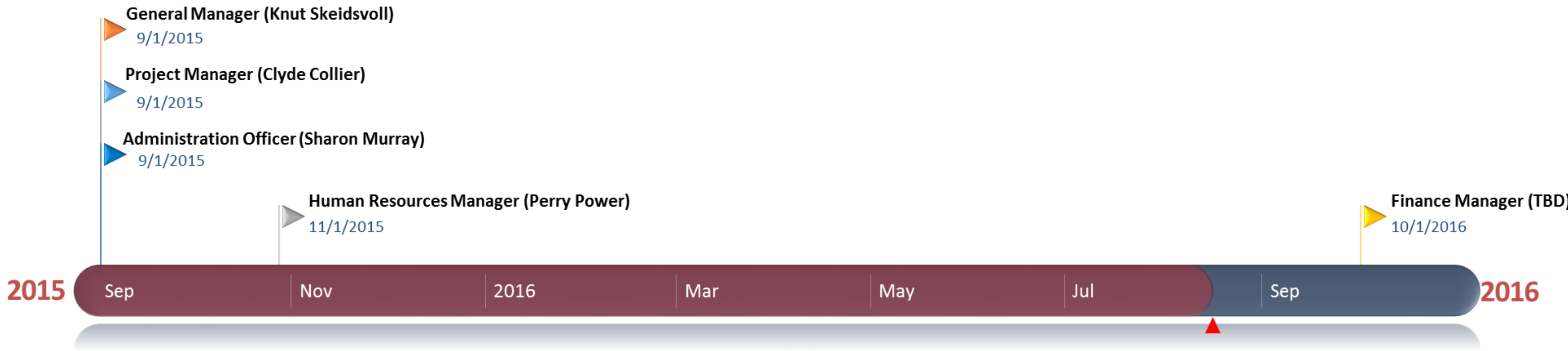


Figure 11: Hiring timeline for Grieg NL management team indicating date of hire and position (Estimated, Approximate).

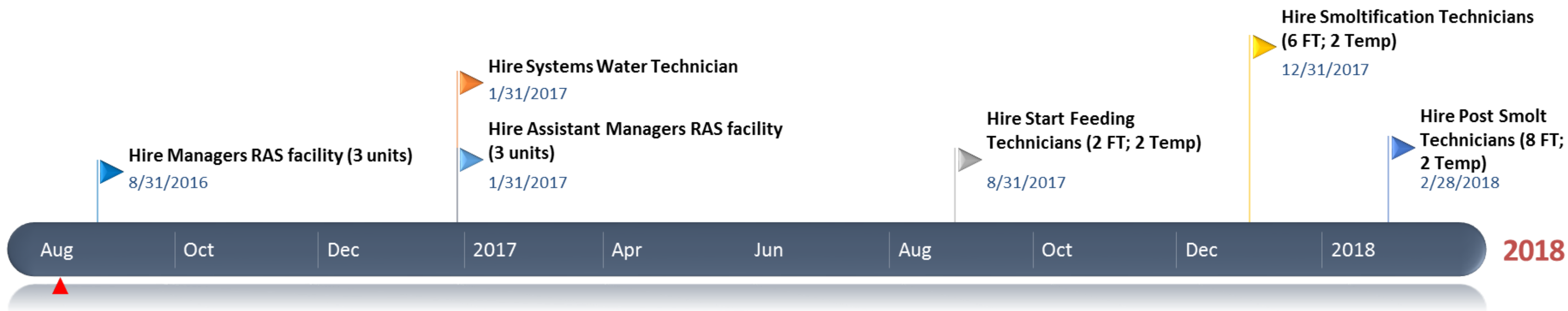


Figure 12: Hiring timeline for Grieg NL Nurseries Ltd. indicating hiring completion date, position and number of positions to be filled (Estimated, Approximate).

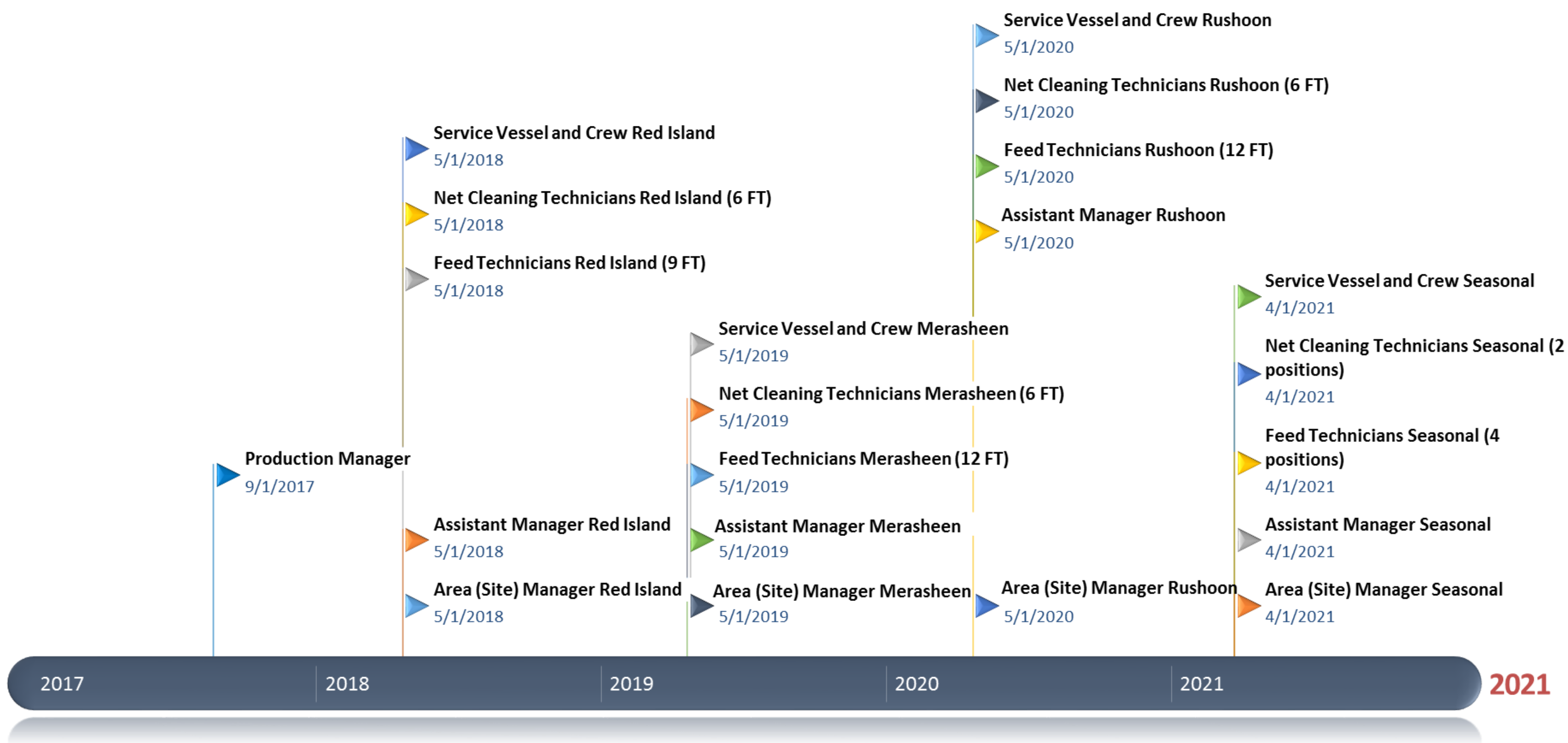


Figure 13: Hiring timeline for Grieg NL Seafarms Ltd. indicating date of hiring, position and number of positions to be filled (Estimated, Approximate).

Appendix Y
Women's Employment Plan

GRIEG NL

2016

Placentia Bay Atlantic Salmon Aquaculture Project Women's Employment Plan

Grieg NL

Marystown, Newfoundland

9/9/2016

Grieg NL

Table of Contents

1.0 Introduction

Demand for quality seafood is increasing as is the concern over food security. Newfoundland, as an island, is very much dependent on food importation and as such, risks food shortages should there ever be a disruption in either supply from mainland North America or with current transportation methods such as ferries and roads. As well, there are global concerns with regard to supplies for fresh quality seafood. However, Newfoundland has tremendous resources available that are currently being underutilized that could not only help alleviate concerns with food security but also assist with the increasing demand for high quality seafood products in North America and potentially even globally.

Grieg NL (GNL) realizes this potential for Newfoundland and is pursuing a state-of-the art Recirculating Aquaculture System (RAS) for culturing triploid Atlantic salmon (*Salmo salar*) smolt in Marystown, Newfoundland and Labrador (NL) with on-growing marine cage sites in Placentia Bay, NL, and processing into high end quality salmon fillets and other speciality products at a facility in St. Lawrence, NL (Figure 1).

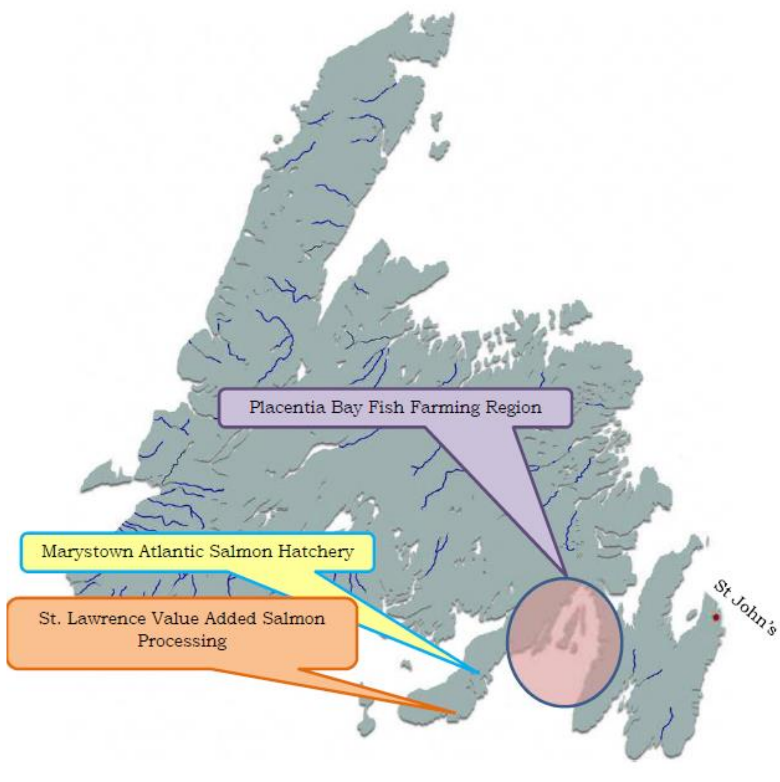


Figure 1: Location in Placentia Bay Newfoundland of Grieg NL operations

Grieg Newfoundland Salmon Ltd. (the holding company in Newfoundland for Grieg Newfoundland AS of Norway (Grieg Holding AS 40%, Kvassh□gdi AS 40%, and Ocean Choice International (OCI) 20%)) has three subsidiary companies, Grieg NL Nurseries is the land based hatchery operations, Grieg NL Seafarms is the marine based sea cage site and Grieg NL Development Ltd (Figure 2), together they form Grieg NL (GNL). The Grieg group of companies are one of the world's leading fish farming enterprises specializing in Atlantic salmon, with operations in Norway, British Columbia and Shetland, UK. GNL's focus is on sustainable use of resources while achieving profitable growth.

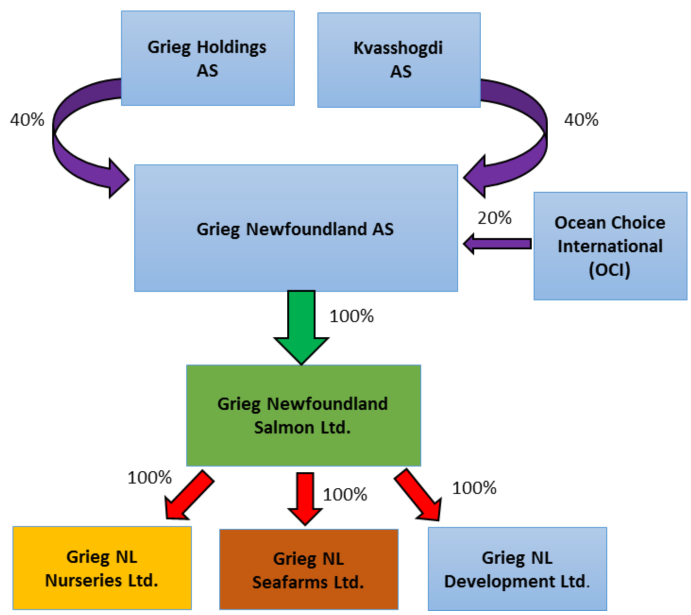


Figure 2: Corporate Structure of the Grieg Group of Companies

This project has strong potential in terms of export market opportunities and economic benefit, especially in outport Newfoundland. An operation of this size will provide very significant employment opportunities, resulting in a much needed major boost to the current economy of NL and providing prospects for graduates to utilize their skills and knowledge in their home province. Newfoundland is world renowned for some of its training facilities and the graduates that it produces. The Fisheries and Marine Institute of Memorial University is one such training facility that GNL has already utilized for recruiting skilled employees and will continue to utilize this and other training facilities in the province for its workforce.

The proposed Project was registered for Environmental Assessment (EA) review under the Newfoundland and Labrador *Environmental Protection Act* (*NL EPA*, Part 10) in February 2016. Following governmental and public review of the EA Registration, the Minister of Environment and Conservation announced on July 22, 2016 that the Project had been released from the EA review process, subject to a number of associated terms and conditions. These included the following:

> *Prior to the commencement of construction activities, the proponent must submit a Women's Employment Plan for the project to the Women's Policy Office that meets the approval of the Deputy Minister.*

The preparation and submission of this document is intended to address the above noted condition of EA release for the Project.

This Plan provides an overview of the various measures that GNL will take to help ensure the involvement of a diverse and inclusive workforce during the implementation phase of the Project. This includes measures to enhance and maintain the participation of women in the Project during its various phases.

1.1 Project Workforce and Schedule

The subsidiaries of GNL will be Grieg NL Nurseries Ltd., a land based hatchery and nursery and Grieg NL Seafarms Ltd., a marine based sea cage grow out site. Each of these subsidiaries will be structured with a senior management team overseeing staff.

Construction of the land based hatchery and nursery is slated to begin in the Fall of 2016 and continue in phases through 2021. At its peak construction period in 2017-2018, it is estimated that upwards of 200 persons will be working on project-related construction activities. Once the land based hatchery and nursery facility is fully operational by 2018, an estimated 36 employees will be working there in permanent, year-round positions. (Table 1).

GNL will also have four marine based areas for continued grow out of the salmon to market size. Once full production is reached in 2021 and all four marine areas are in use, it is expected that 137 employees will be working at these marine sites in Placentia Bay (Table 1).

Table 1: Estimated Full Time (FT) and Part Time (PT) employees required for GNL Land Based and Marine Based Construction and Operations, 2016-2022

Occupation	NOC Code (2011)	FT/PT	Max # of Positions	GNL or Contractors (CT)	Years Required
LAND BASED HATCHERY AND NURSERY PHASE					
Construction Phase					
Engineering Manager	0211	FT	3	CT	2016-2021
Civil Engineers	2131	FT	2	CT	2016-2021
Civil Engineering Technologists	2231	FT	2	CT	2016-2021
Drafting Technologists/Technicians	2253	FT	1	CT	2016-2021
Land Survey Technologists/Technicians	2254	FT	1	CT	2016-2021
Construction Inspector	2264	FT	4	CT	2016-2021
Electrical Power Line and Cable Workers	7244	FT	5	CT	2016-2021
Telecommunication Line and Cable Workers	7245	FT	5	CT	2016-2021
Steamfitters, Pipefitters and Sprinkler System Installers	7252	FT	20	CT	2016-2021
Welder	7237	FT	10	CT	2016-2021
Carpenters	7271	FT	20	CT	2016-2021
Concrete Finisher	7282	FT	20	CT	2016-2021
Heavy Equipment Mechanics	7312	FT	4	CT	2016-2021
Crane Operators	7371	FT	2	CT	2016-2021
Truck Drivers	7511	FT	5	CT	2016-2021
Heavy Equipment Operators	7521	FT	4	CT	2016-2021
Construction Labourers	7611	FT	92	CT	2016-2021
TOTAL			**200**		
Operational Phase					
Senior Management	0016	FT	1	GNL	2016-
Maintenance Manager	0714	FT	1	GNL	2016-
Production Manager	0911	FT	1	GNL	2016-
Aquaculture Managers	0823	FT	7	GNL	2016-
Aquaculture Technicians	2221	FT	16	GNL	2017-
Aquaculture Technicians	2221	PT	6	GNL	2017-
Welder	7237	FT	1	GNL	2017-
Heavy Equipment Operators	7521	FT	1	GNL	2017-
Air Conditioning Mechanic	7313	FT	1	GNL	2017-
Power Systems Electrician	7202	FT	1	GNL	2017-
TOTAL			**36**		

Occupation	NOC Code (2011)	FT/PT	Max # of Positions	GNL or Contractors (CT)	Years Required
MARINE BASED SEA CAGE PHASE					
Installation Phase					
Captains	8261	FT	1	CT	2017
Engineering	0211	FT	1	CT	2017
Deck Hands	8441	FT	6	CT	2017
Electrical Industrial	7242	FT	1	CT	2017
Welder Operator	7237	FT	1	CT	2017
Heavy Equipment Mechanic	7312	FT	1	CT	2017-
Crane Operator	7371	FT	1	CT	2017-
TOTAL			**12**		
Operational Phase					
Senior Managers	0016	FT	2	GNL	2016-
Supervisor General Officer	1211	FT	1	GNL	2016-
Supervisor Financial	1212	FT	1	GNL	2016-
Human Resources Officer	1223	FT	1	GNL	2016-
Administrative Assistant	1241	FT	1	GNL	2016-
Maintenance Manager	0714	FT	1	GNL	2016-
Production Manager	0911	FT	1	GNL	2016-
Aquaculture Managers	0823	FT	7	GNL	2016-
Aquaculture Technicians	2221	FT	33	GNL	2017-
Crane Operator	7371	FT	2	CT	2017-
Captains	8261	FT	16	GNL & CT	2017-
Deck Hands	8441	FT & PT	36	GNL & CT	2017-
Welder	7237	FT	1	CT	2017-
Heavy Equipment Mechanics	7312	FT	6	CT	2017-
Power Systems Electrician	7202	FT	3	GNL	2017-
Aquaculture Labourers	8613	FT & PT	25	GNL	2017-
TOTAL			**137**		

A lumpfish hatchery is also planned to be used as a cleaner fish in the cages with the salmon as a natural means of controlling sea lice infestations. It is expected that by 2017 the lumpfish hatchery will be employing 10 individuals (not employed directly by GNL).

In 2019, the first salmon are expected to be harvested and subsequent years will see an increase in processing needs as all four marine sites are harvested. By 2022, it is expected that 426 individuals will be working in the NL seafood processing will be involved in the processing and services needed to bring GNL Atlantic salmon products to market.

1.2 Employment Diversity Principles and Commitments

GNL 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 GNL intends to pursue to build a team that will continue to support the Grieg group of companies values and principles. GNL 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.

GNL has developed this Women's Employment Plan (WEP) for Grieg NL and its subsidiary companies. This plan is intended to encourage a proactive approach toward a workplace environment with policies and practices that promote moral fairness and provide a work environment free from harassment and discrimination. Although traditionally male-dominated, aquaculture and other marine related careers have in recent years seen an increase in women in these non-traditional roles. This is reflected in the current workforce of GNL, with seven employees, four of whom are women (thereby representing 57% of the current workforce). GNL recognizes that talent is not gender specific, and as such will promote a workplace culture that is supportive of women in order to attract and retain talented individuals that can contribute to the success of GNL.

GNL expects all its employees to support this WEP by actively discouraging any behaviour or language that can be considered gender insensitive or not respectful of others. In addition, all managers of GNL will be expected to ensure that staff are aware of equality in the workplace, participate in any training programs offered by GNL to increase awareness of gender sensitivity and contend in a timely and appropriate manner with any personnel that exhibits gender insensitive behaviour.

GNL has developed a number of strategies and initiatives to aid in reaching our goal of an inclusive and reflective workforce. Striking a balance between merit and equality is paramount for our organization. Establishing the proper framework for gender equality will be met through the following responsibilities and beliefs by senior management in our planning and our operations:

- Senior management is committed to gender equality

- GNL has sufficient resources including an on-site mentor and knowledgeable personnel, along with a positive atmosphere that will promote gender equality
- There are accountability frameworks which ensure that the gender equality policy is implemented
- Gender equality is treated as an objective in and of itself
- Gender equality is recognized as relevant to every aspect of operations
- Gender analysis is integrated into Project planning
- Methods are identified to ensure there is broad participation of women and men as decision makers in the planning process, and
- Clear, measurable, and achievable gender equality results are developed in the earliest phases of the process

2.0 Community and Communication

GNL is prepared to learn from other organizations within the aquaculture industry and other sectors, in order to establish, implement and maintain a positive approach to employment diversification. GNL is committed to working with the community as well as the public sector, government agencies, various women's groups such as the Newfoundland and Labrador Organization for Women Entrepreneurs (NLOWE), Provincial Advisory Council on the Status of Women, Women in Resource Development Corporation, Women in Science and Engineering Newfoundland and Labrador (WISE), the NL Department of Advanced Education, Skills and Labour and educational institutions such as the Fisheries and Marine Institute to maximize opportunities for women.

2.1 Community

GNL is committed to supporting local communities, particularly with regard to employment opportunities for women. Specifically, GNL will:

- Work with education and training institutions and relevant industry and stakeholder organizations including the Office to Advance Women Apprentices (OAWA) to generate overall awareness of job opportunities associated with the Project and the necessary skills required.

- Participate in information sessions at the community level, with the assistance of government and non-government stakeholders, which are responsive to women needs.

- Provide associated career information to guidance counsellors in secondary school systems.
- Provide support for Women's Job Information Workshops.
- Incorporate gender based analysis information gathered from external stakeholders into the company's policy and workplace design decisions.
- Link with and provide support to women's organizations / networks, which support the employment of women such as OAWA.
- Meet with community groups and women's organizations to review existing and potential women's employment initiatives and strategies.
- Profile female employees working in non-traditional occupations in internal and external company communications material.
- Continue to develop and maintain a corporate culture and work environment within the company that facilitates the achievement of the career goals of women, and provides them with the training and support they need to help them meet their goals and the corporation's business objectives. This includes continuing to offer assistance programs and mentorship to provide employees with an opportunity to enhance knowledge and skills relevant to their work and to advance within the organization according to their goals and aspirations.

2.2 Communication

GNL is taking a hands-on approach to encourage women's participation in non-traditional roles, it also recognizes that in order to significantly affect women's employment levels, industry and government organizations will have to work together to promote a positive message. This message should outline the advantages of gender diversity in the workplace in addition to referencing the current levels of employment by women in the various trade and professional occupations.

To support gender diversity at the local level, as outlined throughout the Women's Employment Plan, GNL will develop and utilize the following tools as part of its own communications strategy.

- GNL will provide women's organizations with Project information to ensure members of key target audiences are informed of available employment and business opportunities. The company will also support successful contractors and subcontractors to provide timely employment information to relevant stakeholder organizations.

- Working with stakeholder organizations to provide information and assistance to help ensure that women and other members of underrepresented groups understand the job application process, including the role of contractors and unions, and how to register and apply for Project-related positions.
- The use of appropriate language and imagery in all job ads and other communications to encourage women to apply for job opportunities. A gender equity and diversity statement will be included in any such promotional materials related to the development of the Project.
- Any Project-related promotional and communications materials will use positive images and articles / profiles regarding the involvement of women in working on the Project and in the aquaculture industry as a whole.
- GNL will include statements in Project-related tender documents to inform potential contractors of their obligation to assist with maximizing the involvement of women and in reporting the results of efforts and outcomes with regard to their employment.
- Working with high schools and post secondary institutions in the area to promote the aquaculture industry as a viable career for young women considering post-secondary education options.
- Reinforcing key messages and promote women's employment, particularly in non-traditional roles, in the local community.
- Conducting school visits at the grade and post secondary levels to promote employment opportunities in the aquaculture industry. When conducting such visits, GNL will use female role models employed by the company.
- Reinforce key messages promoting women's employment in media interviews and presentations.
- Sponsor programs designed to promote women's employment (e.g. Women in Science and Engineering (WISE) program.)

3.0 Land Based and Marine Based Operations

3.1 Recruitment

GNL is committed to being an equal opportunity employer devoted to gender diversity with competitive benefits, compensation, and the continuous improvement associated with the advancement of employment of women within the organization. This includes with respect to its own direct workforce, as well as supporting contractors and subcontractors to maximize the involvement of women in the Project's labour force where qualified for Project requirements.

To support the recruitment of women in its workforce GNL will adhere to the following policies and practices:

- Commit to working with training institutions in the province (including the Fisheries and Marine Institute) as well as organizations such as the Office to Advance Women Apprentices (OAWA) to support the integration of female registered students and their transferrable skills into the GNL workforce. These programs at training institutes such as the Fisheries and Marine Institute are skills and trades that are applicable to the Grieg group of companies and have representation of females in all fields (Table 1). GNL will commit to coordinating with these institutes for recruitment fairs as well as work term placements for female graduates.

Table 1: Enrollment by gender for the fall 2014 and fall 2015 Diploma and Advanced Diploma programs at the Fisheries and Marine Institute of Memorial University of Newfoundland

Marine Institute Program	Total Enrollment (# Females)	
	Fall 2014	Fall 2015
Advanced Diploma	24 (7)	17 (6)
Food Safety	12 (3)	9 (2)
Sustainable Aquaculture	7 (2)	3 (2)
Water Quality	5 (2)	5 (2)
Diploma in Technology		
Food Technology	15 (8)	14 (6)
Year 1	4 (4)	
Year 2	2 (1)	4 (4)
Year 3	5 (1)	1
Year 4	4 (2)	9 (2)

Marine Institute Program	Total Enrollment (# Females)	
	Fall 2014	**Fall 2015**
Marine Environmental Technology	35 (30)	30 (24)
Year 1	16 (13)	9 (6)
Year 2	11 (9)	12 (10)
Year 3	8 (8)	9 (8)

Source: Fisheries and Marine Institute, School of Fisheries, 2016

In addition to the various communication measures described in the previous section, GNL will also implement the following related to recruitment of the Project workforce:

- Develop training sessions to educate supervisors and managers in the recruitment processes to guarantee practices free of gender prejudice.
- Have a hiring panel consisting of men and women who support gender diversity.
- Provide equal worth to job qualifications and work experience despite gender.
- Consider, where possible and practical, job shadowing and on-the-job opportunities to women enrolled in science, technology fields, and industrial trades where women are underrepresented (WISE program, student work terms).
- Continue to practice a zero tolerance policy on discrimination and harassment.
- Continue to support and promote hiring practices that are consistent with a healthy and productive working environment.
- Ensure that women are appropriately represented throughout the workplace.
- Conduct exit interviews for analysis and feedback into the Company's recruitment and retention plan.

The Burin Peninsula is an area of traditionally high Employment Insurance (EI) prevalence and GNL will have a significant positive impact on the labour force and ultimately the EI use in the region. The following table depicts the EI beneficiaries reported for the entire Burin Peninsula 2012-2014. As indicated in Table 2, 40% (4,770 individuals) of the labor force on the Burin Peninsula filed EI claims in 2014 with 38 % (1,805 individuals) of these beneficiaries being female. The very nature of this work will have positive impacts on the female workforce and particularly the prime labour force. Since operations for GNL will be full time and not seasonal, this project could employ persons, particularly females in small communities on the Burin Peninsula where employment is often difficult to find and can provide them with long term employment security as opposed to relying on EI benefits for a portion of the year. In addition, the processing plant will create jobs in St. Lawrence and Fortune, two towns where at the present there is very little new employment activity.

Table 2: Prevalence of EI Beneficiaries Burin Peninsula, Newfoundland 2012-2014

	2012	2013	2014
Labour force	11,940	11,927[3]	11,925
EI beneficiaries	5,710	5,260	4,770
EI prevalence	47.8%	44.1%	40.0%
Age of Beneficiary			
Youth (less than 25)	430	360	305
Prime labour force (25-54)	3,470	3,150	2,875
Age 55+	1,810	1,740	1,585
Gender of Beneficiary			
Male	3,615	3,380	2,965
Female	2,095	1,880	1,805
% female	36.7%	35.7%	37.8%

Source: Government of Newfoundland Community Accounts

The Office to Advance Women Apprentices (OAWA) was contacted by GNL to identify apprentices that are currently in the Burin Peninsula area. OAWA has identified over 1500 female apprentices in the Province of Newfoundland and Labrador with 252 registered females in the Marystown and Burin Peninsula area, 18 of which have reached Journey Person status. A breakdown of registered female apprentices in trades relevant to this Project in the Burin Peninsula are outlined in Table 3. GNL will continue to work with OAWA once the recruitment process begins to ensure qualified female tradespeople in the Burin area will be contacted.

Table 3: Number of female apprentices in Burin area in trades relevant to Grieg NL Aquaculture Project

Trade	Number of Female apprentices registered in Burin area
Power Line	0
Steamfitter	47
Welder	9
Carpenter	13
Cement	0
HDET	1
HEO	21
Crane	10
Electrical	27

Source: OAWA (September 9, 2016)

3.2 Hiring

The hiring process that GNL and contractors utilize must ensure that fair and equitable access is provided to all eligible candidates. Further, all employees must accept the importance and value of gender diversity in establishing a healthy productive workplace. Currently GNL has seven employees, four of which are women. In the future GNL intends to hire 24 full time employees and six temporary employees for land based operations with a 25% female target. The target percentage for the other occupation categories is outlined in Table 4.

Table 4: Estimated target female employment percentage for occupations for the Grieg NL Placentia Bay Atlantic Salmon Aquaculture Project 2016-2022

Occupation	FT/PT	Max # of Positions	Target % Female	GNS or Contractors (CT)	Years Required
LAND BASED HATCHERY AND NURSERY PHASE					
Construction Phase					
Management	FT	3	15%	CT	2016-2021
Professional	FT			CT	2016-2021
Engineers	FT	2	15%	CT	2016-2021
Technologists/Technician	FT	4	15%	CT	2016-2021
Skilled Trades	FT	99	15%	CT	2016-2021
Journeyman	FT	79	15%	CT	2016-2021
Apprenticeship	FT	20	15%	CT	2016-2021
Labourers	FT	92	15%	CT	2016-2021
Administration	FT	1	100%	CT	2016-2021
Operational Phase					
Management	FT	10	50%	GNS	2016-
Professional	FT			GNS	2016-
Technicians	FT	22	25%	GNS	2016-
Trades Workers	FT	4	25%	GNS	2016-
Occupation	**FT/PT**	**Max # of Positions**		**GNS or Contractors (CT)**	**Years Required**
MARINE BASED SEA CAGE PHASE					
Installation Phase					
Professionals	FT	2	15%	CT	2017-
Trades Workers	FT	10	15%	CT	2017-
Operational Phase					
Management	FT	14	25%	GNS	2016-
Professional Technicians	FT	49	15%	GNS	2016-
Trades Workers	FT	48	15%	GNS	2016-
Labourers	FT	25	15%	GNS	2016-
Administration	FT	1	100%	GNS	2016-

In support of this objective, GNL will implement the following initiatives:

- Ensure job advertisements state that GNL is an equal opportunity employer and will show women engaged in work when graphics / pictures are utilized.
- Participate in career fairs and school visits. Utilize women employed in non-traditional occupations and other success stories to support such efforts.
- Provide work term opportunities to women enrolled in cooperative education programs in the science, trades and technology fields.
- Ensure that individuals involved in the recruitment process are familiar with applicable Federal and Provincial Human Rights, labour, occupational health and safety, worker's compensation and other relevant legislation through the distribution of published educational material.

3.3 Career Planning

GNL is focused on strengthening, mentoring, and coaching structures that provide employees with the knowledge, skills and motivation to accomplish short and long terms goals within the aquaculture industry. GNL will use a series of management programs to fully support women at all levels within the organization through training, workshops, policies, etc. as they express interest to advance in their careers. The programs will be modified as feedback is received from employees and from monitoring developments in technology and learning from other organizations.

In addition, GNL will support women's advancement in their careers by:

- Developing and maintaining an internal commitment from managers and supervisors to identify potential employees for higher-level positions within the company.
- Promoting a culture that supports a positive relationship between men and women.
- Providing opportunities to enhance women's professional development.
- Identifying and addressing barriers that can be deterrents to peak performance.
- Allocating required resources, including mentors, to assist employees in career planning and aspirations.
- Examining innovative ways for employees to network and support career growth and planning for women.

GNL's Human Resources Department will take the necessary steps to align operational requirements with employee needs. GNL is confident that with sound business practices and clear company goals gender diversity will play an important role in the Grieg group of companies' workforce in addition to the training future of leaders.

3.4 Retention

GNL will develop a strategy to address the challenge of employee retention in the long-term in accordance with GNL's overall Human Resources philosophy. The major challenge for employers and workers is the retention of women in traditionally male-dominated industries and occupations. A key component to improve the situation is again the effectiveness of the gender analysis information where women and men working together contribute to policy and workplace conditions decision-making. GNL's plan for gender diversity starts with the premise that both men and women must be involved in building a welcoming and productive workplace.

In addition to the recruitment of women, GNL has also initiated policies and practises to retain and promote its existing women's work force. These include but are not limited to:

- A zero tolerance approach to gender-related harassment.
- Provide work schedules that promote better work/life balance and career path planning that offer the flexibility necessary to attend to family responsibilities.
- Reduce sources of unnecessary stress in the workplace such as harassment and work-family conflict.
- An employment equity policy throughout GNL.
- Work with contractors to ensure consistency in policy development and implementation.
- Hire qualified women to be developed as trainers and mentors where possible.
- Ensure that the compensation system provides for equal pay for equal work.

GNL will continue to communicate and update its policies with regards to gender diversity and women's employment.

By implementing the above policies and practices GNL believes that it is working toward a better, healthier working environment free of any form of harassment and discrimination towards women. Further details on GNL plans to help ensure a diverse, safe and respectful workplace for its Project are detailed in the sections that follow.

4.0 Workplace Policies and Conditions

GNL has developed a number of workplace policies and practices to be adopted by the Company's Human Resources Department to ensure women are not only represented within GNL and its subsidiaries but also will have equality in all aspects of the business including compensation, respect, and dignity. These initiatives include but are not limited to:

1. GNL has developed a Code of Conduct and Ethics that supports women in the workplace. Employees will be expected to adhere to this Code and act in a positive manner in all that they do and say. Behaviour or conduct that is offensive including any form of harassment will not be tolerated and disciplinary action, including termination if necessary, will be taken.
2. Ensuring that all employees, contractors and subcontractors are aware of GNL standards, practices and policies related to the employment and involvement of underrepresented groups. These will be clearly documented and displayed at the Project worksite.
3. All Project workers will be provided with an orientation and induction program that includes health and safety, cultural awareness, gender sensitivity, and environmental awareness training. Organizations such as The Women in Resource Development Corporation (WRDC) will be contacted for assistance in providing training including Respectful Workplace.
4. Strict enforcement of corporate policies and practices related to women's employment and respectful workplaces, and a requirement for contractors to have an associated standard with a zero tolerance for harassment.
5. All Project facilities will comply with applicable regulatory requirements, including those related to accessibility and gender, as a minimum. This will include providing gender separate accommodations, washroom facilities and locker or change rooms wherever possible, as well as correctly fitting personal protective equipment. and appropriate tools and equipment to accommodate women's needs where feasible.
6. The use of gender inclusive / neutral language in all written correspondence and verbal communications with employees. Also, ensuring that gender equity and workplace diversity is evident in any images used in regular employee communications and notices.

7. GNL employees will be expected to use gender sensitive language in all their work activities.
8. GNL will ensure that opportunities exist for representation by women on all workplace committees where interest exists.
9. Providing on-going assistance and support in the workplace, including on-site workplace committee(s), employee assistance programs, and mentoring for women.
10. Ensuring that applicable policies and practices related to inclusion and diversity are known and communicated, including clearly outlined incident reporting procedures.
11. Providing supervisors with respectful workplace training to enable them to address any situations that may arise in a timely, safe and appropriate manner.
12. Continual reinforcement of Project-related policies and requirements about gender equity and diversity through regular tool box talks, lunch and learns, supervisory training, meetings, worksite posters and other such means.
13. Ensuring adequate and appropriate security onsite at all times, including that worksites, common areas and parking lots are well lit to support personal safety.
14. Conducting, through the HR Department, exit interviews with all employees (including females) and using this information to identify and address any identified concerns, including those that may be related to workplace conditions.

4.1 Non-discrimination Policies

GNL recognizes and respects the *Canadian Human Rights Act* which prohibits employers from discriminating against individuals in hiring, firing, or the terms and conditions of employment because of certain personal characteristics. GNL expects this same commitment from its employees in all business activities. GNL has developed a Code of Conduct and Ethics that will also apply to gender in the workplace in which GNL clearly states that it expects the following behaviour from all its employees in all business activities:

- Respect the dignity of all individuals and ensure your actions and your workplace environment is free from all forms of discrimination including harassment and bullying.
- Do not label, categorize or treat others as a member of a different class.
- Ensure all decisions (employment, promotion, assignments) are based on job qualifications (education, training, experience) and merit.

- Consult with management if a conflict should arise that you feel is in violation of the laws, customs, beliefs or policies for any individual.
- Report any form of discrimination including hostile environments that you observe or may have experienced in the workplace.

4.2 Contractors and Partner Companies

GNL recognizes that as the Proponent of the Project it has overall leadership responsibility for advancing gender equity and diversity in the development of this Project. This will be guided and driven by the corporation's overall goals and core values, along with its policies, strategies and initiatives related to workplace diversity and equity as highlighted earlier in this document.

The implementation and success of the various initiatives outlined in this Plan also depends, however, on the cooperation and support of a variety of Project participants and stakeholders, including GNL contractors and their subcontractors, Project workers, government departments and agencies, industry associations, social and advocacy organizations, and others.

The goals, objectives and requirements of this Plan will be clearly communicated to all organizations and individuals involved in the Project. Given for example that the construction of the Project itself, and therefore any associated hiring, will be primarily undertaken by contractors, these companies will clearly have a key role in implementing this Plan and seeking to achieve its underlying goals and objectives. To this effect, GNL will work closely with contractors to ensure they are progressive in maximizing opportunities for females in trades, occupations and apprenticeships. GNL will encourage contractors to work with organizations such as OAWA and WRDC for assistance with recruiting tradeswomen for employment. These organizations will also be involved in the delivery of Respectful Workplace training as part of worker orientation for contractors. Regular reporting and meetings will take place between GNL and its contractors to clarify as well as monitor contractors' compliance with GNL' Women's Employment Plan.

All contractors will be required to take proactive steps to increase the involvement of women through their respective hiring practices, and to implement the measures outlined in this Plan in a timely and effective manner. This will include strategies and procedures for the creation and maintenance of a safe, respectful and inclusive workplace, including associated policies and procedures and their communication, worker orientation and training, ensuring appropriate facilities and equipment, addressing any incidents or complaints, and other such measures as outlined in this Plan. All contractors will also be required to track and regularly report to GNL as requested on their various equity and diversity initiatives and outcomes.

As an equal opportunity employer, GNL will therefore ensure that contractors and partner companies will be informed of our Women's Employment Plan as well as the GNL code of conduct. GNL will work with contractors and partner companies and organizations to promote the Women's Employment Plan and its initiatives.

5.0 Monitoring and Reporting

GNL also recognizes the importance of monitoring and evaluating its women's employment objectives and initiatives, and to making adjustments to this Plan as required based on the principle of continuous improvement and through an on-going adaptive management approach. The company will use various means to gather information on the outcomes of its initiatives, including discussions with workers, supervisors and management which may take the form of workplace committees, focus groups (both formal and informal), exit surveys, and other discussions.

GNL will establish a four-person committee comprised of the General Manager, the Human Resources Manager and two other senior staff to monitor the Women's Employment Plan and program. One of these committee members or another qualified representative will be designated as an on-site mentor that can be used as a point of contact for women hired for the project, both during construction and operation phases. This Committee will meet at least annually to review the company's performance. Any recommendations for changes arising from this feedback will be considered with respect to safety, productivity and cost, and a plan for execution of any necessary corrective measures will be developed.

GNL will also report to the Government of Newfoundland and Labrador on the Plan's implementation and outcomes. Specifically, this will involve regular reporting to the Minister Responsible for the Status of Women on the implementation of the various initiatives outlined in this Plan. These reports will include employment data by identified group and occupation (NOC) during the implementation phases of the Project. The reporting will indicate the number of individuals and total work hours undertaken by women during the Project for the reporting period in question.

It is proposed that this reporting will begin upon commencement of Project construction and will extend into the initial 2-3 years of operation, until such time as the entire Project workforce is in place and has largely stabilized. The nature and frequency of this reporting to the Women's Policy Office will be at a minimum of annually or more often if necessary to discuss progress as well as challenges in implementing the WEP.