Appendix A
Stofnfiskur Certification
and
Verification (All-Female, Triploid)

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1.0 Introduction

Grieg NL developed its business model for the Placentia Bay Atlantic Salmon Aquaculture project based on the premise that European-strain sterile triploid all-female Atlantic salmon will be purchased and used as the sole source of salmon eggs (Appendix I-1). Grieg NL will be purchasing the salmon eggs from a company named Stofnfiskur in Iceland. This appendix provides details on:

- Stofnfiskur's background;
- Egg import requirements in Canada;
- Identification of the egg source (i.e., the origin of the broodstock) that will be used by Grieg NL;
- Procedures on triploid induction and verification; and
- Procedures for all-female verification, fertilization, and health.

Stofnfiskur has developed procedures and protocols for all processes within their facilities. However, given the proprietary nature of these Standard Operating Procedures (SOPs), this appendix summarizes procedures rather than providing detailed SOPs. Lists of Stofnfiskurs SOPs for fertilization and incubation procedures are provided in Appendix I-2.

2.0 Background on Stofnfiskur

Established in 1991 by the Icelandic state, Stofnfiskur is part of Benchmark Genetics, an innovative company in the aquaculture and agriculture sectors. Benchmark Genetics has two Atlantic salmon breeding programs today; namely Stofnfiskur and SalmoBreed. Stofnfiskur has been producing high-quality Atlantic salmon eggs, fry, parr and smolt built on a unique selective breeding program for more than 25 years. Stofnfiskur has a production capacity of 200 million eggs and has the capacity to deliver disease free salmon eggs worldwide every week of the year.

The company holds a number of accredited certifications including Global G.A.P., Compartmentalization, Freedom Food RSPCA monitored and RSPCA Assured as well as ISO 9001:2008 and are certified to Tún Standards for Organic Production. In addition to these recognized certifications, Stofnfiskur has a history of being free of notifiable virus diseases since the company was founded in 1991 (see Appendix I-3).

Global G.A.P. is the worldwide standard for Good Agriculture Practices (https://www.globalgap.org/uk_en/for-producers/globalg.a.p./integrated-farm-assurance-ifa/aquaculture/). The Global G.A.P. Aquaculture Standard sets strict criteria for legal compliance, food safety, workers occupational health and safety, Global G.A.P. Risk Assessment on Social Practice (GRASP), animal welfare, as well as environmental and ecological care. This standard covers the entire production chain in aquaculture hatcheries and farms and requires producers to have a high level of transparency and integrity by identifying the status of their product throughout.

Stofnfiskur operates under the strict surveillance of the Icelandic Food and Veterinary Authorities (MAST) who issues all health certificates for export. According to the official standard issued by MAST, Stofnfiskur has met all requirements to establish a “compartment” for their facilities. This “compartmentalization” is a recognition of the strict biosecurity procedures followed by Stofnfiskur which ensures the prevention of the introduction and spread of infectious disease agents including Infectious Salmon Anemia Virus (ISAV), Salmonid Alpha Virus (SAV), Piscine Reovirus (PRV), Piscine Myocarditis Virus/Totivirus (PCMV), Infectious Pancreatic Necrosis Virus (IPNV), Infectious Haematopoietic Necrosis (IHN), Viral Haemorrhagic Septicaemia (VHSV) and Bacterial Kidney Disease (BKD).

The Freedom Food RSPCA certification is an animal welfare assurance scheme (https://www.berspcaassured.org.uk/). The RSPCA welfare standards for farmed Atlantic salmon (*Salmo salar*) are used to provide the only RSPCA-approved scheme for the rearing, handling, transport and slaughter/killing of farmed Atlantic salmon. The standards are based upon the ‘Five Freedoms’ as defined by FAWC. Although these ‘freedoms’ define ideal states, they provide a comprehensive framework for the assessment of animal welfare on-farm, in transit and at the place of slaughter/killing, as well as representing an important element of farm assurance requirements.

Stofnfiskur is also ISO 9001:2008 certified. ISO 9001:2008 is a quality management system standard. It is an international standard and organizations can use the standard to demonstrate their ability to consistently provide products and services that meet customer and regulatory requirements.

Stofnfiskur has satisfied the requirements for inspection, operating procedures and production methods as specified in the Tún Standards for Organic Production. Vottunarstofan Tún (or Tún) Standard for Organic Production provides third-party independent verification of sustainability and chain of custody in five main areas:

1. Organic agriculture and processing as defined in Icelandic regulation 74/2002, based on European Union (EU) regulation 2092/91
2. Processing of organic ingredients as defined in standards set by Tún for production outside the remits of the EU organic regulations.
3. Sustainable harnessing of natural resources, including production of inputs permitted in organic farming and processing, as defined in standards set by Tún.
4. Sustainable fisheries as defined by standards set by the Marine Stewardship Council (MSC).
5. Chain of Custody of fish from sustainable fisheries as defined by standards set by the Marine Stewardship Council (MSC).

3.0 Egg Imports to Canada

Any finfish egg imports in Canada must be sourced from and received by facilities where robust quarantine measures are followed and which have been approved by regulatory agencies including the Canadian Food Inspection Agency (CFIA), Fisheries and Oceans Canada (DFO) and the Department of Fisheries and Land Resources (DFLR). Imports must be approved under the *Health and Animals Act*, and a permit issued, which is the responsibility of the CFIA. The issue of this permit is based on advice received from other regulatory agencies including DFO and DFLR. In 2012, experts from DFO and the Department of Fisheries and Aquaculture (now DFLR) visited Stofnfiskur's facility in Iceland as part of the approval process to import sterile/triploid eggs from Stofnfiskur into Canada. This approval process required, in part, extensive review of all Stofnfiskur's permits, procedures and certifications. Based on this assessment, DFO through the Canadian Science Advisory Secretariat (CSAS) process granted the approval for the importation and use of the European strain triploid Atlantic salmon being produced at Stofnfiskur facilities (DFO 2016). Based on these reviews and assessments, CFIA issued Grieg NL an import permit, recognizing Stofnfiskur as an approved exporter to Canada, in March 2016 (Permit No. Q-2016-00213-4) and Grieg NL has continued to renew this permit (Appendix H) every three months as per the regulations (Table 1).

Table 1. Grieg NL's CFIA permit to import triploid Atlantic salmon eggs from Stofnfiskur.

CFIA Permit #	Valid Dates	
	From	To
Q-2016-00213-4	14-Mar16	14-Jun-16
Q-2016-00470-4	23-Jun-16	23-Sep-16
Q-2016-00665-4	03-Oct-16	03-Jan-17
Q-2017-00016-4	10-Jan-17	10-Apr-17
Q-2017-00266-4	11-Apr-17	11-Jul-17
Q-2017-00576-4	12-Jul-17	12-Oct-17
Q-2017-00842-4	13-Oct-17	13-Jan-18
Q-2018-00073-4	24-Jan-18	24-Apr-18
Q-2018-00411-4	01-May-18	01-Aug-18

4.0 Identification of the Egg Source

The Atlantic salmon used by Stofnfiskur as broodstock was collected from two Norwegian strains, Mowi stock and Bolaks stock. The imported strains where originally selected from Norwegian rivers in the 1970s and imported to Iceland from 1984 to 1987. Stofnfiskur began to establish their salmon stock in 1991. Altogether 426 female and 142 male salmon were collected from two companies that had imported Atlantic salmon ova to Iceland. This is the baseline material of the Stofnfiskur stock and is distributed over six-year classes (http://stofnfiskur.is/). As selection has taken place (which began in 1995), a controlled mixture of stocks was made between the Mowi and the Bolaks strains. Furthermore two, three and four sea-winter salmon were mixed to secure a broad genetic base for future generations.

5.0 Procedures on Triploid Induction and Verification

As background, development of fish eggs is based on time (days) at a given water temperature. A higher temperature will decrease the time to hatching. For this reason, development of fish eggs is often referenced as degree days. Each day is counted as the temperature of the egg. For instance, a fish egg held in 5°C water for 10 days would be 50-degree days versus a fish egg held at 10°C water for 10 days would be 100-degree day development. Triploid induction in fish is commonly verified by taking a blood sample and analyzing the DNA content by flow cytometry. To verify triploidy in eggs, the developing embryo must reach a minimum of 350-degree days and can be extracted from the egg to be smashed and prepared for analysis with flow cytometry[1]. The use of flow cytometry for measurement of cellular DNA content with a high degree of resolution is considered a reliable and constant method (e.g., Lecommandeur et al. 1994).

Triploid organisms have three sets of chromosomes instead of the standard two (diploid). Triploidy induction is commonly conducted by treating newly fertilized eggs with hydrostatic pressure which disrupts the movement of chromosomes during meiosis (Benfey 1998). More specifically, it is based on normal gametogenesis with an extra set of maternal chromosomes (polar body) being retained early in development when the egg is subjected to hydrostatic pressure. In triploid fish, two sets of chromosomes are contributed by a female and one set by a male (2 N egg + 1N sperm = 3N). Prior to revised techniques currently used by Stofnfiskur, the use of pressure methods to induce triploidy resulted in >98% triploidy induction success (O'Flynn et al. 1997; Devlin et al. 2010 *in* Benfey et al. 2015).

New improved technology implemented in 2017 increased the success rate of inducing triploidy from approximately 98% to 100%. Stofnfiskur also utilizes smaller chambers for the egg pressurization technique (i.e., 2 L in volume) when they are subjected to hydrostatic pressurization. By using smaller chambers, all eggs are subjected to the same pressure whereas the use of larger chambers in the past resulted in some eggs not receiving the necessary pressure required to induce sterile triploidy (resulting in only >98% success). The result of this modification as well as the new improved technology is a process that now will produce 100% triploidy results. If an error occurs in the process (i.e. incorrect pressure or duration), the resulting percentage will be significantly less than 100% and easily detected in the two-tier sampling procedure Stofnfiskur follows.

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[1] During 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 so that at the correct wavelength it will fluoresce. The samples are then passed through a 0.45μm filter. At Stofnfiskur, the DNA content of approximately 30 larvae per treatment and the same amount of larvae as a control group were 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, single cells are measured in order to estimate the amount of DNA in diploid (2N) cells and compare it with the amount of DNA in the triploids (3N). The average value of the 20 – 30 control samples are compared with the values for the 3N samples.

Stofnfiskur has adopted a two-tier testing procedure based on degree day development of salmon eggs. Stofnfiskur has strict protocols and will not accept anything less than 100% for its verification of triploidy and all-female eggs. Given that to verify triploidy in Atlantic salmon eggs requires sacrificing the egg, a reasonable sample size that does not jeopardize the production process while providing an appropriate size for statistical analysis must be determined. Stofnfiskur's analysis process for triploid (3N) induction follows protocol "STS-H06" and is depicted in Figure 1 below. For the two-tier process, a small subset from each batch of eggs (10 eggs from each incubated female or 1250 eggs per million for this test) is cultured at a slightly higher temperature (8°C versus 6.5°C) thereby speeding up the development process. The result is a sample of the egg batch that can be sent for verification testing (i.e., once they reach 350-degree days) at least one week prior to testing the eggs cultured at 6.5°C. Any results less than 100% is an indication that there may have been an issue with the process and the batch is discarded. If the subset test results indicate 100% triploid rate, the primary batch is then sent for testing approximately one week later as a second confirmation of the success of the process (10 eggs from each incubated female or 1250 eggs per million for this test). Both the subset and the primary batch must have 100% sterile triploid verification (i.e., as determined by 1250 eggs per million/test x 2 tests = 2500 eggs per million) in order to be shipped to a customer. If verification tests indicate less than 100% sterile triploidy, the entire batch of eggs is discarded. Once the subset and primary batch test results indicate 100% triploidy, a triploid certificate is issued and the eggs are prepared for shipment to the purchaser. This two-tier testing approach increases the probability of detecting failure rates. [The smaller pressure chambers discussed above also allow Stofnfiskur to separate the eggs from each female salmon. This enhances biosecurity and permits the eggs from each female to be readily tracked and sampled for all verification testing.]

Just as described for the two-tier testing for triploidy, testing for all-female also undergoes a two-tier process (Figure 2). A subset of eggs are cultured at a slightly higher temperature (10 eggs from each incubated female or 1250 eggs per million for this test) and progeny testing can be conducted for all-female earlier than the primary batch. Genetic markers that have been developed for identifying males (Y-chromosomal) are used to confirm that all eggs are female (XX chromosomes only). Both the subset and primary batch must have 100% all-female test results (i.e., based on combined testing of 2500 eggs per million) in order to be approved for shipment to customers. Anything less than 100% will not be shipped as all-female.

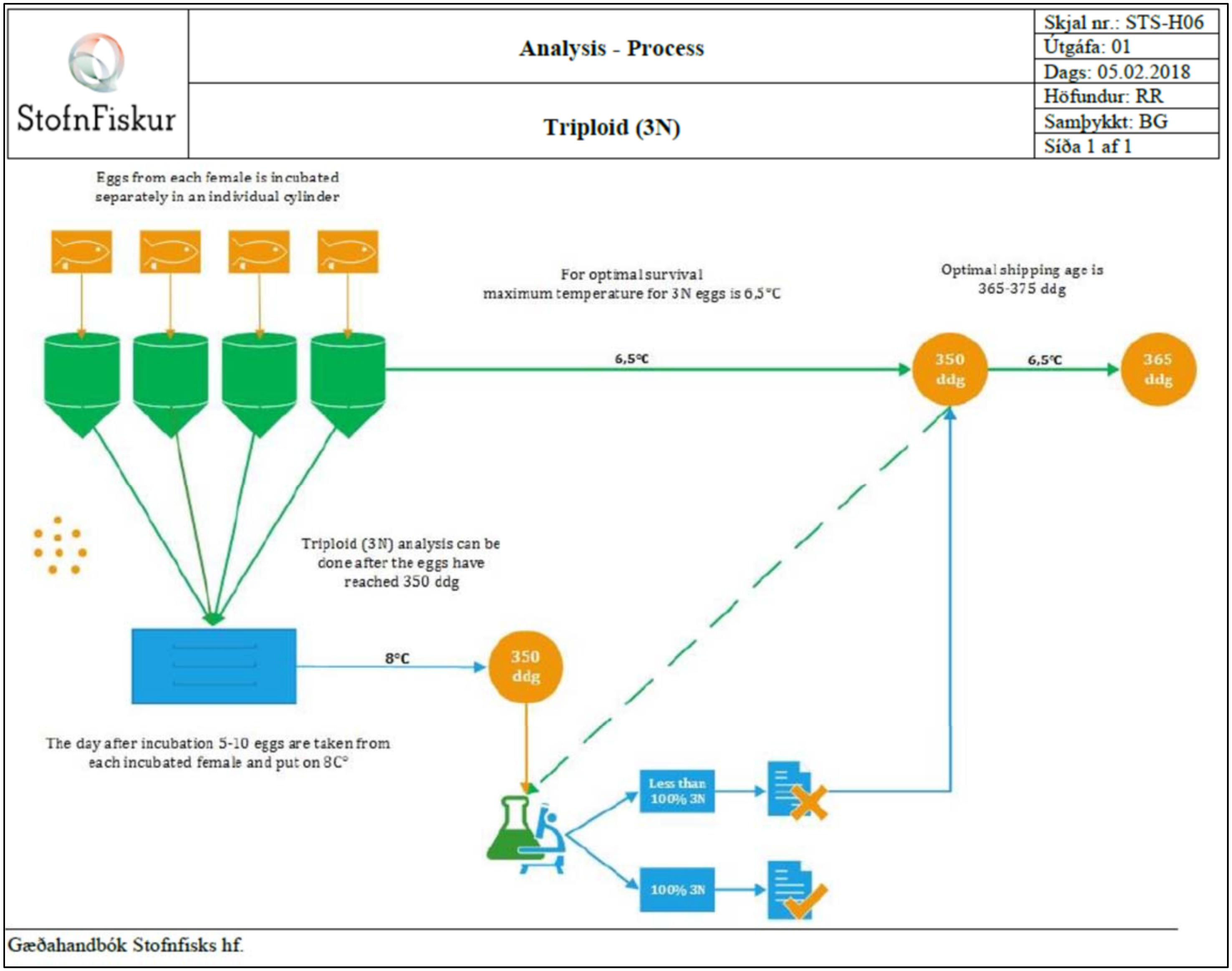

Figure 1. Two-stage process flowchart for analysis of triploid (3N) eggs produced by Stofnfiskur.

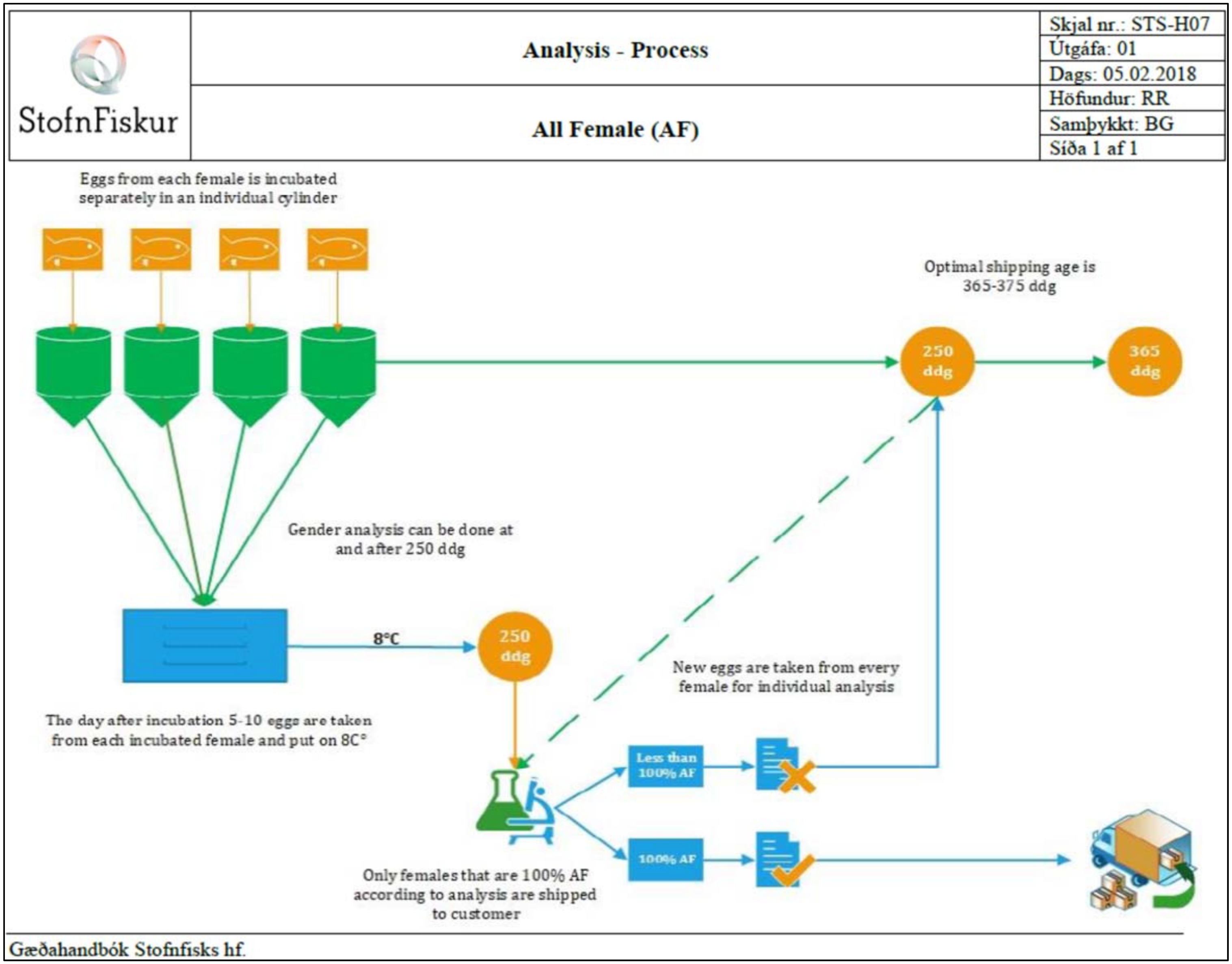

Figure 2. Two-stage process flow chart for analysis of all-female eggs.

6.0 Procedures on All-Female Verification, Fertilization, and Health

The fertilization process follows the procedure outlined in Figure 3. However, to produce all-female fish, only milt from masculinized (XX functional) males is used. DNA markers (Y-chromosomal) are used to confirm that each functional male has only XX milt. Fertilizing an XX egg with XX milt ensures the entire population is all-female (XX). Milt harvested from functional males can be used fresh or frozen. Fresh milt utilized from the gonads of the male salmon are harvested one day prior to fertilization and sent to a laboratory for express individual screening. Frozen milt is screened prior to storage for later use. This screening is a requirement for exportation to Chile; however, Stofnfiskur follows the procedure for all egg production. The test is for HPR0 which is a non-pathogenic variation of Infectious Salmon Anemia (ISA). Although this check is a requirement by Chile for importation, Stofnfiskur utilizes the screening to identify and remove any individuals that may carry this non-pathogenic variation and eliminate them from their breeding program. After fertilization and the triploidy process, eggs from all females are disinfected and incubated. Eggs for the breeding program will move forward according to this process while those intended for customers will move to the incubation center process.

Once the fertilization process is complete, the eggs are transferred to the incubation center and follow the steps outlined in Figure 4. One day after incubating the fertilized eggs, a quality control is made of the eggs. This quality control check is for fertilization rates, as indicated by cell division as viewed under a microscope. Eggs of females that do not pass the quality control are disposed. If eggs are triploid (3N) and/or All-Female (AF), eggs from each female are also gathered to perform 3N/AF as outlined in Figures 1 and 2 above.

Customers often request individual screening for specific pathogens. Should any specific individual screening be requested by the customer prior to shipment, this will be conducted and will determine if the eggs move forward in the production process or are discarded. If the eggs are AF or 3N, they will again be subjected to a verification process. A pass in this verification process is a grade of 100%. Any eggs that do not pass the verification process (<100%) are discarded from the production. Prior to shipping to customers, all eggs in the production process are subjected to a shocking process. The shocking process is a necessary step that allows dead or unfertilized eggs to be identified and removed. A sorting process will remove eggs that are inferior including pin-eyed, small-sized and non-viable followed by a packing process.

Stofnfiskur has a strict surveillance policy and is routinely audited by both national and international Fish Health Authorities. Stofnfiskur complies with the requirements of their customers, local authorities and Icelandic authorities. Stofnfiskur routinely performs individual screening of a variety of fish pathogens and parasites including ISAV, SAV, PRV, PCMV, IPNV, IHN, VHSV and BKD. Samples are collected by Icelandic Official Fish Health Veterinarians and scientists under the supervision of the Official Veterinarians. All samples are sent for screening to either the National Reference Fish Health Laboratory at Keldur in Reykjavik or international accredited reference laboratories for all the above-mentioned diseases. A minimum of 60 samples are collected per year class/year. However, with individual screening requests by customers, this number far exceeds the minimum. In 2017 for instance 12,456 samples were collected from Stofnfiskur for virological examination.

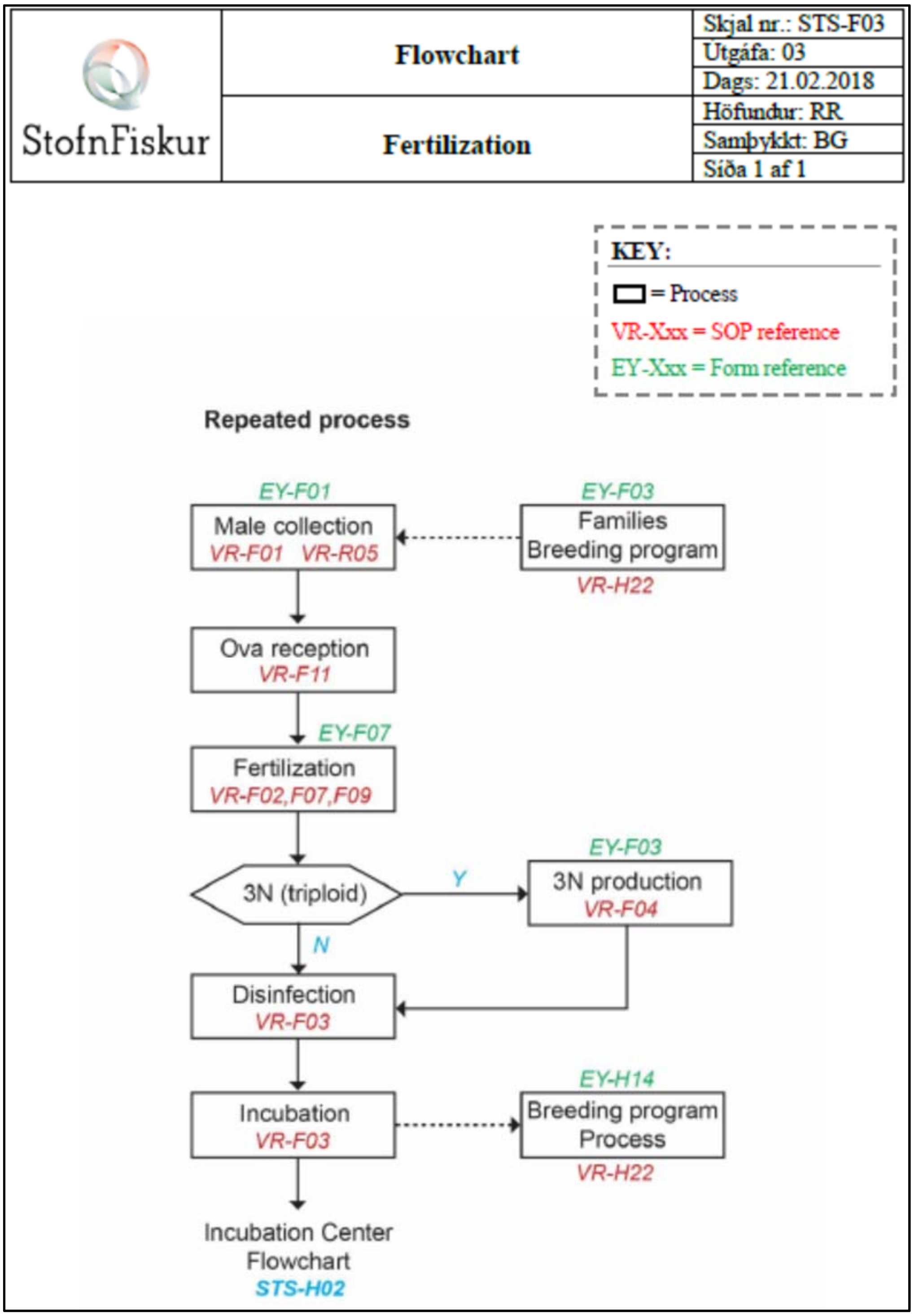

Figure 3. Flow chart outlining Stofnfiskur's egg fertilization process.

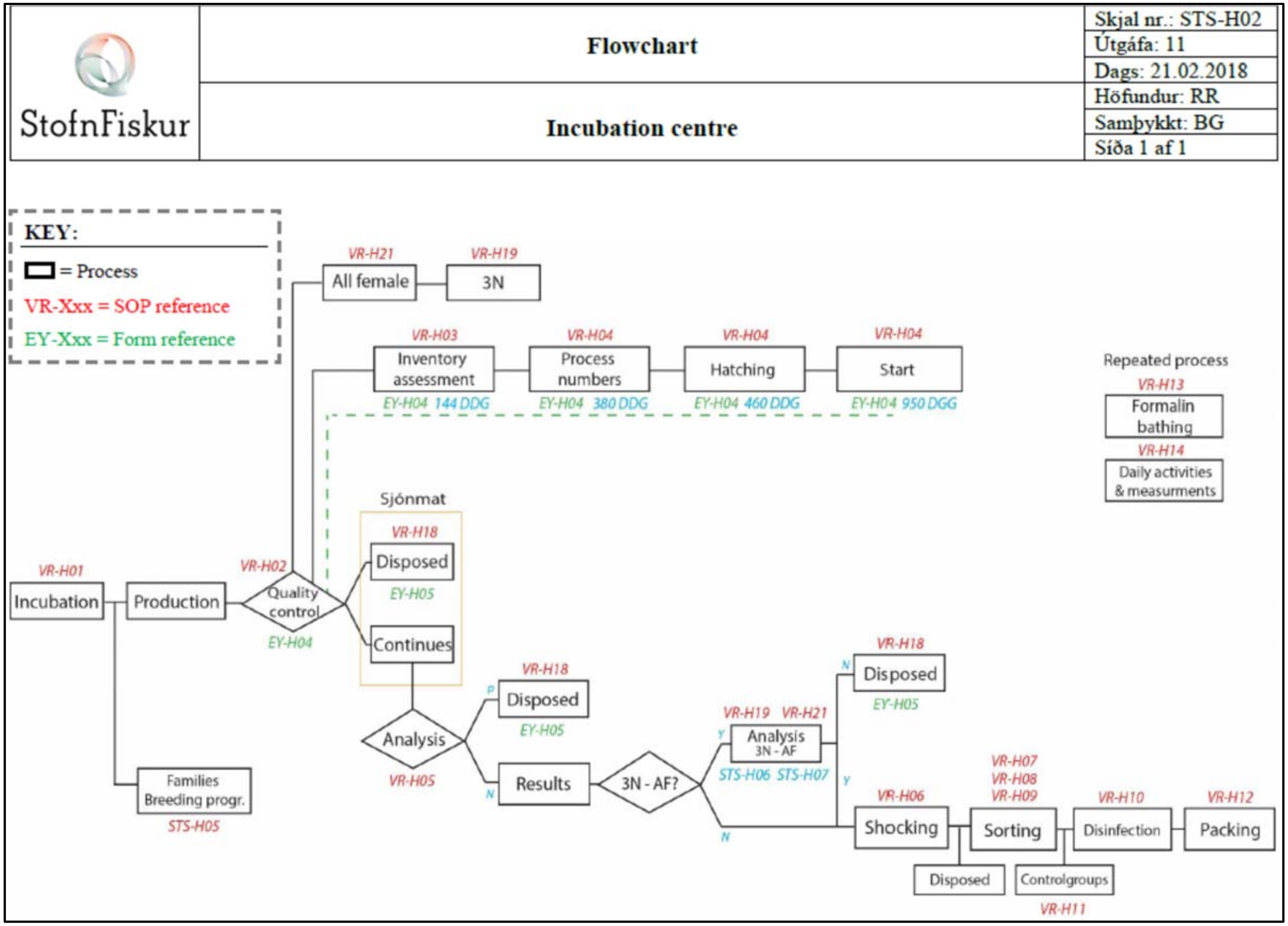

Figure 4. Flow chart outlining Stofnfiskur's incubation center production process.

7.0 Literature Cited

Benfey, T.J. 1998. Use of triploid Atlantic salmon (*Salmo salar*) for aquaculture. CSAS Res. Doc. 98/166. 11p.

Benfey, T.J. 2015. Biocontainment measures to reduce/mitigate potential post-escape interactions between cultured European-origin and wild native Atlantic salmon in Newfoundland. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/003. v + 28 p.

DFO. 2016. Proposed Use of European-Strain Triploid Atlantic Salmon in Marine Cage Aquaculture in Placentia Bay, NL. DFO Can. Sci. Advis. Sec. Sci. Resp. 2016/034.

Lecommandeur, D., P. Haffray, and L. Philippe. 1994. Rapid flow cytometry method for ploidy determination in salmonid eggs. Aquaculture Research 25(3): 345-350.

O'Flynn, F., S.A. McGeachy, G.W. Friars, T.J. Benfey, and J.K. Bailey. 1997. Comparisons of cultured triploid and diploid Atlantic salmon (*Salmo salar* L.). ICES J. Mar. Sci. 54:1160-1165.

Appendices

Appendix I-1 Stofnfiskur Amendment to Contract with Grieg NL

Appendix I-2 Stofnfiskur Fertilization and Incubation Center SOPs

Appendix I-3 Certificates

Stofnfiskur Veterinarian Certificate-Health
Stofnfiskur GLOBALG.A.P. Certificate
Stofnfiskur Approval of a Compartment
Stofnfiskur NSF Certification (Freedom Food)
Stofnfiskur ISO 9001:2008
Stofnfiskur Tun Vottorð
Stofnfiskur Veterinary Certificate-GMO

Appendix I-1

Stofnfiskur Amendment to Contract with Grieg NL

GRIEG NL

APPENDIX 5 Replacement (updated version March 22, 2018)

Department Fisheries and Oceans Terms and Conditions

As per attached letter from June 14, 2016, the Regional Director General, Newfoundland and Labrador Region for Fisheries and Oceans Canada these are the terms and conditions that must be met by Stofnfiskur / SalmoBreed for supplying triploid Atlantic salmon eggs to Grieg NL.

It should be noted that since this letter, Grieg NL has been released from any further Environmental Assessment, as well has been conditionally approved for the Aquaculture License application for a hatchery at Marystown, NL and the issuance of the license will occur once financing arrangements have been completed. Therefore, the Provincial and Federal regulatory review processes as well as issuance of Provincial site licenses have been completed and there is no impediment to receiving the license to import the triploid Atlantic salmon eggs from Stofnfiskur.

- Stofnfiskur will supply all female triploid Atlantic salmon beginning in Year 1 and continuing throughout the duration of the project.

Knut Skeidsvoll
General Manager
Grieg NL

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

PO Box 5667
St. John's, NL AIC 5XI

JUN 1 4 2016

Per Grieg
c/o Grieg NL Nurseries Ltd.
PO Box 205 McGettigan Blvd.
Marystown, NL A0E 2M0

Dear Mr. Grieg:

In response to the application from Knut Skeidsvoll received March 7, 2016, this is to advise that the Department has completed its review of the request to import triploid Atlantic salmon eggs from Stofufiskur, Iceland.

Subject to completion of the Provincial and Federal regulatory review processes and the issuance of Provincial aquaculture site licenses; there is no impediment to the issuance of a licence to import the eggs as per your request.

Once all approvals have been secured, regional officials will work with officials from Grieg NL Nurseries Ltd. to establish appropriate conditions of licence.

Should you have any questions, please contact Geoff Perry, Regional Manager, Aquaculture at 709-772-0183.

Sincerely,

Kevin G. Anderson
Regional Director General
Newfoundlandand Labrador Region

cc: Knut Skeidsvoll, General Manager, Grieg NL Seafarms Ltd.

Appendix I-2

Stofnfiskur Fertilization and Incubation Center SOPs

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		[illegible]

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Appendix I-3
Certificates

Stofnfiskur Veterinarian Certificate-Health

Stofnfiskur GLOBALG.A.P. Certificate

Stofnfiskur Approval of a Compartment

Stofnfiskur NSF Certification (Freedom Food)

Stofnfiskur ISO 9001:2008

Stofnfiskur Tun Vottorð

Stofnfiskur Veterinary Certificate-GMO

mast
Icelandic Food and Veterinary Authority

Selfoss, January 8th 2018
Ref.: 1801022

To whom it may concern

Veterinary Certificate

Subject: Fish health situation in Iceland and StofnFiskur Ltd.

I the undersigned Gísli Jónsson, Veterinary Officer for Fish Diseases, and a Certifying Official for Iceland, do hereby certify following:

StofnFiskur Ltd., the only hatchery of origin which is exporting live Atlantic salmon eyed eggs, has a history of being free of notifiable virus diseases since founded in 1991. Parasitic diseases like ***Gyrodactylus salaris*** and **Whirling disease** (*Myxobolus cerebralis*) have never been detected in Icelandic aquaculture. **Enteric redmouth disease** (*Yersinia ruckeri*) and **Pscirickettsiosis** have never been detected in StofnFiskur. In addition, at least 60 females from every year-class and stripping group are tested for **BKD** with an ELISA and RT-PCR methods, also with a negative outcome through all the years. In this context, it is appropriate to inform that StofnFiskur's broodstock sites are being visited weekly by an official fish health veterinarian almost all year around which gives a unique possibility to monitor the development of fish health in our core establishments distributing eggs to other domestic and foreign companies. That close contact to the fish, opening almost every single male and female for tissue sampling, gives the authority valuable information about the general health situation at any time.

All transmissible diseases which have the potential for very serious and rapid spread and which are of serious socio-economic importance in the international trade of live fish, eggs and gametes are defined as List A diseases in Iceland. They will be met with stamping out procedures as these diseases are considered as dangerous and exotic in Iceland. The surveillance systems that are directed to certain List A diseases are based on risk assessments. For instance, the Icelandic Food and Veterinary Authority (MAST) has implemented targeted surveillance with regular samplings of diagnostic material in Icelandic salmonid farms regarding diseases like **IPN**, **VHS**, **IHN** and **BKD** which is in line with the European rules and regulations. StofnFiskur is formally declared free of **IHN**, **VHS** and **ISA** by the fish health authority of the European Union and also of **IPN** and **BKD** by the Icelandic fish health authority. MAST also performs intensive samplings at broodfish sites regarding **PD/SAV**, **PRV**, **CMS** (PMCV) and Yersiniosis, but that is more upon a request from international customers. In 2017, totally 12.456 samplings were taken from the StofnFiskur's broodfish for virological examination. All test results up to date have been negative for above mentioned diseases.

Respectfully yours;

Gísli Jónsson
Veterinary Officer for Fish Diseases

Icelandic Food and Veterinary Authority – Veterinary Services

DNV·GL

GLOBALG.A.P CERTIFICATE

Certificate No.	Date of Certification Decision	Valid
80228-2010-EUREPGAP-NOR-ACCREDIA	2017-07-11	2017-07-11 – 2018-06-07
Registration No.: DNV CERT06542009GGANORDNV	GGN Number.: 4050373223472	

This is to certify that the processing activities of

Stofnfiskur hf

Staðarberg 2-4, 221 Hafnarfjörður
Country of production: **Iceland**

Has been found to conform to the standard:

GLOBALG.A.P. AB OPT1 Version 5.0_July 2015

Integrated Farm Assurance GLOBALG.A.P. General Regulations Version 5.0_July 2015
GLOBALG.A.P. General Regulations, Aquaculture Rules Version 5.0_July 2015
Aquaculture Module (Crustaceans, Finfish, Molluscs) Control Points and Compliance Criteria Version 5.0_July 2015

The annex contains details of the production sites and product handling units included in the scope of this certificate
DNV GL declares that after the relevant inspection, the above mentioned producer has been found to be compliant in accordance with the standard.

GLOBALG.A.P.®
OPT 1-Individual Multisite Producer

For the following product(s)

Product	Scientific name	GLOBALG.A.P. Product Certificate Number	Broodstock purchased	Seedlings purchased	Product handling	GFSI recognized (post-farm) certificate at the time of the inspection?	Number of production sites	Parallel production	Parallel ownership
Atlantic salmon eggs	Salmo Salar Ova	00054- TNTPN-0005	No	Yes	Yes	No	1	No	No
Atlantic salmon juveniles	Salmo Salar Juveniles	00054- TNTPN-0005	No	Yes	Yes	No	1	No	No
Atlantic salmon Broodstocks	Salmo Salar	00054- TNTPN-0005	No	Yes	Yes	No	2	No	No

Place and date:
Vimercate (MB), 2017-07-11

Kjell Bekkevold
Lead auditor

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO

SGQ N° 003 A
SGA N° 003 D
SGE N° 007 M
SCR N° 004 F
EMAS N° 009 P
PRD N° 003 B
PRS N° 094 C
SSI N° 002 G

Membro di MLA EA per gli schemi di accreditamento SGQ, SGA, PRD, PRS, ISP, GHG, LAB e LAT, di MLA IAF per gli schemi di accreditamento SGQ, SGA, SSI, FSM e PRD e di MRA ILAC per gli schemi di accreditamento LAB, MED, LAT e ISP

for the Accredited Unit:
DNV GL Business Assurance Italia S.r.l.

Nicola Privato
Management Representative

DNV·GL

Certificate No: 80228-2010-EUREPGAP-NOR-ACCREDIA
Place and date: Vimercate (MB), 2017-07-11

Appendix to Certificate (GGN 4050373223472)

The Product handling Units and Production Management Units related to Stofnfiskur hf included in the scope of Certification are the following:

Production Sites

PMU name and address	Product(s)	Parallel production
Vogavík Broodstock Vogavík, Vogar 190 - Iceland	Atlantic salmon [Salmo Salar Broodstocks]	No
Kalmanstjörn Broodstock Nesvegur 50, Reykjanesbær 233, Iceland	Atlantic salmon [Salmo Salar Broodstocks]	No
Kollafjörður Smolt Kollafjörður, Mosfellsbær 270, Iceland	Atlantic salmon [Salmo Salar juveniles]	No
Incubation Centre Vogavík, Vogar 190 - Iceland	Atlantic salmon [Salmo Salar Ova]	No

Product Handling Units (PHUs)

GGN or GLN or CoC	PHU name and address	Product(s)	Parallel ownership
4050373223472	Vogavík Vogavík 190, Vogar, Iceland	Atlantic salmon [Salmo Salar]	No
4050373223472	Kalmanstjörn: Nesvegur 50, 233 Reykjanesbær, Iceland.	Atlantic salmon [Salmo Salar]	No

Place and date:
Vimercate (MB), 2017-07-11

Kjell Bekkevold
Lead auditor

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO

SGQ N° 003 A
SGA N° 003 D
SGE N° 007 M
SCR N° 004 F
EMAS N° 009 P
PRD N° 003 B
PRS N° 094 C
SSI N° 002 G

Membro di MLA EA per gli schemi di accreditamento SGQ, SGA, PRD, PRS, ISP, GHG, LAB e LAT, di MLA IAF per gli schemi di accreditamento SGQ, SGA, SSI, FSM e PRD e di MRA ILAC per gli schemi di accreditamento LAB, MED, LAT e ISP

for the Accredited Unit:
DNV GL Business Assurance Italia S.r.l.

Nicola Privato
Management Representative

DÝRALÆKNIR FISKSJÚKDÓMA
VETERINARY OFFICER FOR FISH DISEASES

MAST
Icelandic Food and Veterinary Authority

Selfoss, 2. október 2015
Tilvísun: Mast15010061

STOFNFISKUR HF.
c/o Jónas Jónasson, framkvæmdastjóri (*Managing Director*)
og Bára Gunnlaugsdóttir, ábyrgðarmaður smitvarnarhólfs (*Compartment manager*)
Staðarbergi 2-4
221 Hafnarfjörður

Viðurkenning á smitvarnarhólfi

(*Official Approval of a Compartment*)

Vísað er til umsóknar Stofnfisks hf., dags. 15. september 2015, þar sem farið er fram á viðurkenningu Matvælastofnunar (MAST) á að fyrirtækið uppfylli skilyrði um smitvarnarhólf (Compartment) eins og frekar er kveðið á um í sérstökum Staðli (Official Standard) útgefnum af MAST 25. mars 2015. Tilgangur viðurkenningar er að koma á móts við kröfur yfirvalda í Chíle (Sernapesca) um hertar smitvarnir í takt við nýlega þarlenda reglugerð frá 3. mars 2015. Með þessu skal styrkja enn frekar öryggi í viðskiptum landanna með útflutning á laxahrognum frá Íslandi sem hófst í byrjun árs 1996. Fyrirmynd að slíkri viðurkenningu er sótt í leiðbeiningu Alþjóðadýraheilbrigðisstofnunarinnar í París (OIE) sem gefin var út haustið 2014 (Aquatic Animal Health Code).

Það skal hér með staðfest að Stofnfiskur hf. hefur innleitt og uppfyllir settar kröfur um heildstæða heilbrigðisáætlun um smitvarnarhólf. Litið er á Stofnfisk sem eitt smitvarnarhólf með 4 eftirtöldum eldiseiningum; **1)** klak- og seiðastöðin í Kollafirði, kynbótastöðvarnar tvær **2)** Kalmanstjörn og **3)** Vogavík og loks **4)** Hrognahúsið í Vogavík. Í þessu skyni er lögð megin áhersla á veirusjúkdómana blóðþorra (ISA), brisveiki (PD), brisdrep (IPN), veirublæði (VHS), iðradrep (IHN) og hjartarof (CMS). Auk þess tekur öryggishólfun á vörnum gegn nýrnaveiki (BKD).

Mast mun síðan til framtíðar taka að sér að sjá um eftirfylgni þessarar vinnu í samvinnu við gæðateymi Stofnfisks. Það skal undirstrikað að Stofnfiski ber að tilkynna MAST um hvers kyns breytingar sem gætu raskað eða með einhverju móti haft áhrif á núverandi samþykkta áætlun um smitvarnarhólf.

(***It is hereby confirmed that*** **Stofnfiskur Ltd.** ***has been approved by the Icelandic Food and Veterinary Authority (MAST) to fulfil all requirements regarding establishing a Compartment according to the Official Standard issued by the Authority on 25 March 2015.*** *It has been proven that the Compartment ensure the prevention of the introduction and the spread of following infectious disease agents for which the compartmentalization was defined: ISAV, SAV, IPNV, VHSV, IHNV, PMCV and BKD. The Stofnfiskur Compartment is divided into four following subunits;* ***1)*** *Kollafjörður hatchery & smolt farm,* ***2)*** *Kalmanstjörn brood fish farm,* ***3)*** *Vogavík brood fish farm and* ***4)*** *Egg incubation centre. MAST will ensure compliance with the Standard by regular audits along with official surveillance activities determined by a risk assessment for each unit. The Compartment manager is responsible for contacting MAST of any changes that might disrupt or somehow affect the current approved program of a Compartment*)

MAST Matvælastofnun

Virðingarfyllst,

Dýralæknir fisksjúkdóma

147112

NSF Certification™

Certificate of Conformity

Registration No 3769.0001FS.G

Stofnfiskur hf.
Hrognahus Staoarberg 2-4 221 Hafnarfjorour Iceland

Salmon Hatchery - Hrognahus

has satisfied the certification requirements of the

RSPCA Assured Farmed Atlantic Salmon

and is approved for the above animals specifically reared for the RSPCA Assured Scheme in accordance with the RSPCA welfare standards for Salmon (Production)

as an Authorised User in Category A
and may use the approved Scheme Mark for

Salmon Hatchery

The certificate is valid between the dates below

From 01 January 2018 To 01 January 2019

Clive Brazier, RSPCA Assured
(Freedom Food Ltd)

Anita Roberts
Director Agriculture, EMEA, NSF Certification UK Ltd.

This certificate is the property of NSF Certification UK Ltd and must be returned immediately on request.
To check its validity telephone 0300 123 0014 or write to

NSF Certified Freedom Food Scheme at Wilberforce Way, Southwater, Horsham, West Sussex, RH13 9RS.
It is the responsibility of the holder to inform all customers of the certified products of any changes in certification status. It is the responsibility of customers purchasing certified products to verify the certification status with Freedom Food.

RSPCA ASSURED
Certification Mark

UKAS PRODUCT CERTIFICATION
085

NSF Certification UK Ltd, Hanborough Business Park, Long Hanborough, Oxon, OX29 8SJ, UK.
E: certificationuk@nsf.org

DNV·GL

MANAGEMENT SYSTEM CERTIFICATE

Certificate No:	Initial certification date:	Valid:
79238-2010-AQ-NOR-NA	08 June 2010	08 June 2016 - 15 September 2018

This is to certify that the management system of

Stofnfiskur hf

Staðarberg 2-4, 221 Hafnarfjörður, Iceland

and the sites as mentioned in the appendix accompanying this certificate

have been found to conform to the Quality Management System standard:
ISO 9001:2008

This certificate is valid for the following scope:

Aquaculture; Production of Salmo salar ova, Salmo salar juveniles and Salmo salar for harvest.

Place and date:
Høvik, 06 June 2016

NORWEGIAN
ACCREDITATION
MSYS 002

For the issuing office:
DNV GL – Business Assurance, Norway

Jøran Laukholm
Management Representative

DNV·GL

Certificate No: 79238-2010-AQ-NOR-NA
Place and date: Høvik, 06 June 2016

Appendix to Certificate

Stofnfiskur hf

Sites included in the certification are as follows:

Site Name	Site Address	Site Scope
Stofnfiskur hf, Hrognahús	190 Vogar, Vogavik, Iceland	Same as Main Scope
Stofnfiskur hf, Kalmanstjörn	233 Hafnir, Kalmanstjörn, Iceland	Same as Main Scope
Stofnfiskur hf, Kollafjõrður	116 Kjalarnes, Kollafjöròur, Iceland	Same as Main Scope
Stofnfiskur hf, Skriftstofa	Staðarberg 2-4, 221 Hafnarfjörður, Iceland	Same as Main Scope
Stofnfiskur hf, Vogavik	190 Vogar, Vogavik, Iceland	Same as Main scope

Certificate

Vottunarstofan Tún ehf.
(EN45011 – ISAC Accreditation No. 11)
certifies that:

Stofnfiskur hf.
Iceland

has satisfied the requirements for inspection, operating procedures and production methods as specified in the **Tún Standards for Organic Production** for the following:

TYPE OF OPERATION:	Aquaculture: Ova production
CERTIFIED PRODUCTS:	Organic: Atlantic salmon ova
CERTIFICATE RENEWAL DATE:	31.12.2018
LICENSE NUMBER:	IS-LIF-01 TUN-117

Signed on behalf of Vottunarstofan Tún ehf.

Vottunarstofan Tún ehf. • Tharabakki 3 • IS-109 Reykjavík • Iceland
Tel: +354 511 1330 • Fax: +354 511 1331 • tun@tun.is • www.tun.is

Vottunarlýsing Trading Schedule

Vottunarlýsing er hluti af vottorði, er háð skilmálum þess um notkun, og er eign Vottunarstofunnar Túns. Vottunarlýsing tilgreinir umfang vottunar, þar með talið framleiðslugreinar, aðsetur vottaðrar starfsemi, og afurðir sem heimilt er að merkja og markaðssetja með tilvísun til lífrænna aðferða og vottunar Túns.

Trading Schedule is a part of Certificate, its use is subject to same terms, and is the property of Vottunarstofan Tún ehf. Trading Schedule provides details of the scope of the Certificate of Registration, including activities and operating sites of the certified unit, and products that may be labelled and promoted with reference to organic methods and Tún´s certification.

Nafn vottunarhafa: *Name of Certificate Holder*	**Vottunarnúmer:** *Certificate Licence Number*
Stofnfiskur hf. **Staðarberg 2-4, 221 Hafnarfjörður**	**TÚN-117**

Aðsetur vottaðrar starfsemi: *Sites of Certified Operation*	**Eldisstöðvar: Vogavík og Kalmanstjörn**		
Vottaðar framleiðslugreinar: *Certified Activities*	**Fiskeldi: Framleiðsla á laxahrognum til fiskeldis** *Aquaculture: Production of Atlantic salmon ova*		
Vottorð gefið út (dags.): *Certificate Issue Date*	**8.1.2018**	**Vottorð rennur út (dags.):** *Certificate Expiry Date*	**31.12.2018**
Vottunarlýsing útgefin (dags.) *Trading Schedule Issue date*	**8.1.2018**	**Eftirlitsdagsetning:** *Control date*	**15.11.2017**

Vottaðar afurðir – Certified Products

Vöruheiti (söluheiti) *Product name (sales name)*	**Lýsing á vöru** *Description of product*	**Framleiðsluferli** *Production process*	**Merkingarflokkur** *Labelling Category*
Laxahrogn	Lifandi hrogn til fiskeldis	Fiskeldi	Lífrænt
Atlantic salmon ova	*Ova for aquaculture*	*Aquaculture*	*Organic*

*) breyting frá síðustu vottunarlýsingu / *amendment to last schedule*

(áritun/*signature*)

Vottunarstofan Tún ehf. • Þarabakki 3 • IS-109 Reykjavík • Iceland • Tel: +354 511 1330 • Fax: +354 511 1331 • tun@tun.is • www.tun.is

DÝRALÆKNIR FISKSJÚKDÓMA

VETERINARY OFFICER FOR FISH DISEASES

mast
Icelandic Food and Veterinary Authority

Selfoss, January 8th 2018
Ref.: 1801022

TO WHOM IT MAY CONCERN

Veterinary Certificate

SUBJECT: STATEMENT REGARDING GMO OF FISH - STOFNFISKUR LTD.

I the undersigned Gísli Jónsson, Veterinary Officer for Fish Diseases, and a Certifying Official for Iceland, do hereby certify following:

STOFNFISKUR LTD., the only broodfish farm of origin which is exporting live salmon eggs from Iceland, is exclusively working with pure strain of Atlantic salmon (*Salmo salar* L.). This means that the genetic material of the broodfish, or any other stage of development, has not been genetically modified (GMO) in any way. All aquaculture products coming from StofnFiskur Ltd. meet in all respects the criteria of "No genetic engineering involved" under the terms of EU Regulations No. 1829/2003 and 1830/2003. It can also be confirmed that GMO is totally forbidden in aqua- and agriculture due to Icelandic law.

Respectfully yours;

ICELANDIC FOOD AND VETERINARY AUTHORITY • VETERINARY SERVICES •

Gísli Jónsson
Veterinary Officer for Fish Diseases

Appendix B

Metocean Conditions

for the Placentia Bay Aquaculture Sites

Oceans Ltd.

February 2018

Metocean Conditions
For the Placentia Bay
Aquaculture Sites

Submitted to
LGL Limited
388 Kenmount Road
St. John's, NL
A1B 4A5

by

Oceans LTD.

85 LeMarchant Rd.
St. John's, NL
A1C 2H1

Telephone: (709) 753-5788
Facsimile: (709) 753-3301
Email: oceans@oceansltd.com

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.

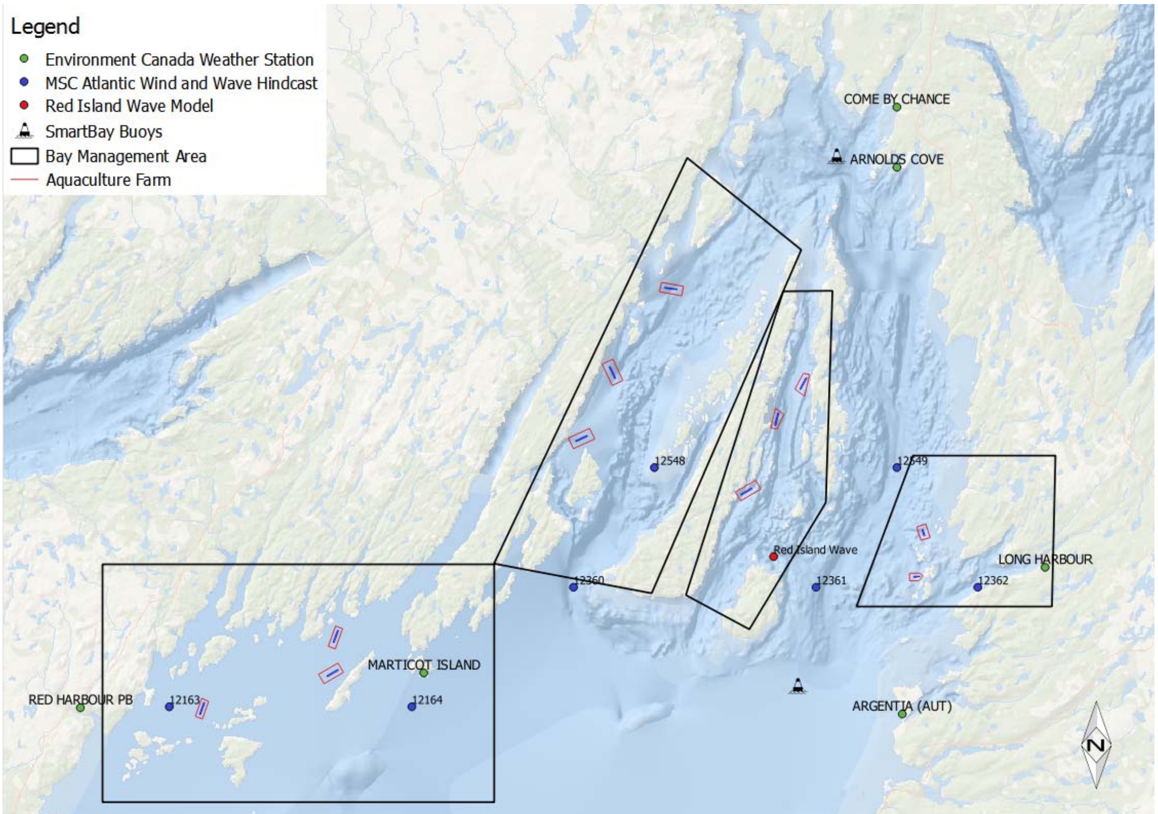


Figure 2.1 Location of Data Sources

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

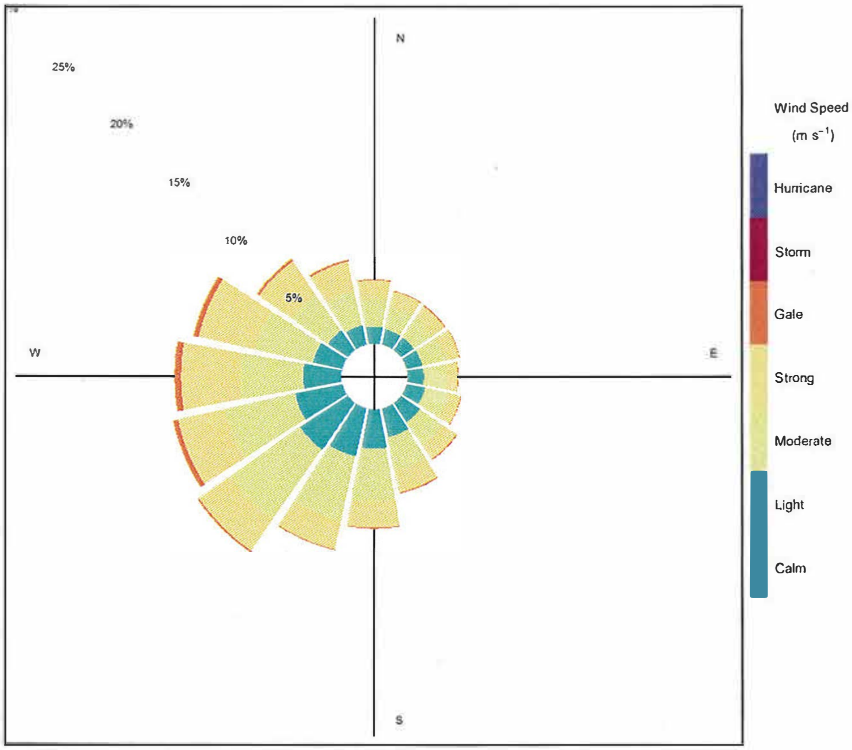
	Argentia	SmartBay Red Island Shoal	GP 12549	GP 12361	GP 12362
January	8.3	8.5	10.7	10.7	10.7
February	8.0	8.7	10.1	10.1	10.1
March	7.5	8.0	9.3	9.3	9.3
April	6.6	7.3	8.0	8.0	8.0
May	5.8	5.6	6.4	6.4	6.4
June	5.6	5.4	5.7	5.7	5.8
July	5.5	5.5	5.5	5.5	5.5
August	5.5	5.7	6.1	6.0	6.1
September	6.0	6.7	7.3	7.3	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



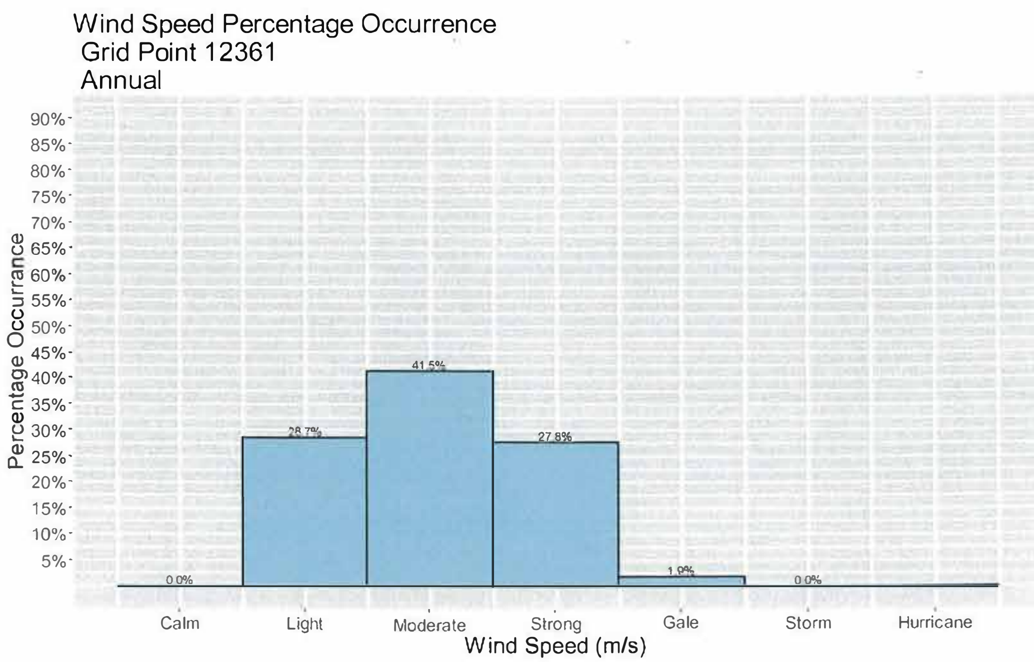


Figure 2.2 Wind Rose and Percentage Frequency Histogram for MSC50 Grid Point 12361 located at 47.4°N; 54.1W near Red Island

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

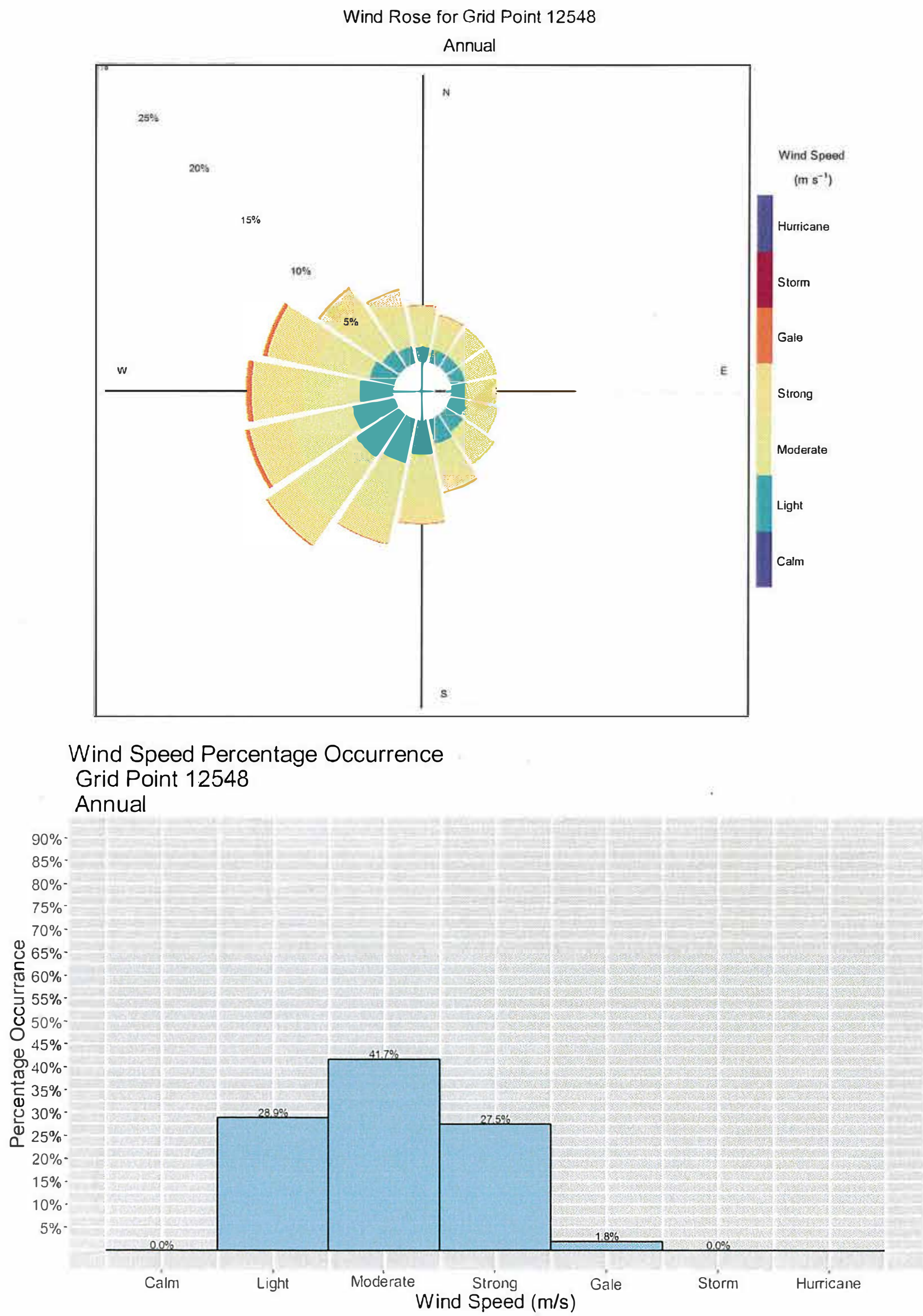


Figure 2.3 Wind Rose and Percentage Frequency Histogram for MSC50 Grid Point 12548 located at 47.5°N; 54.3W within the Merasheen BMA

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

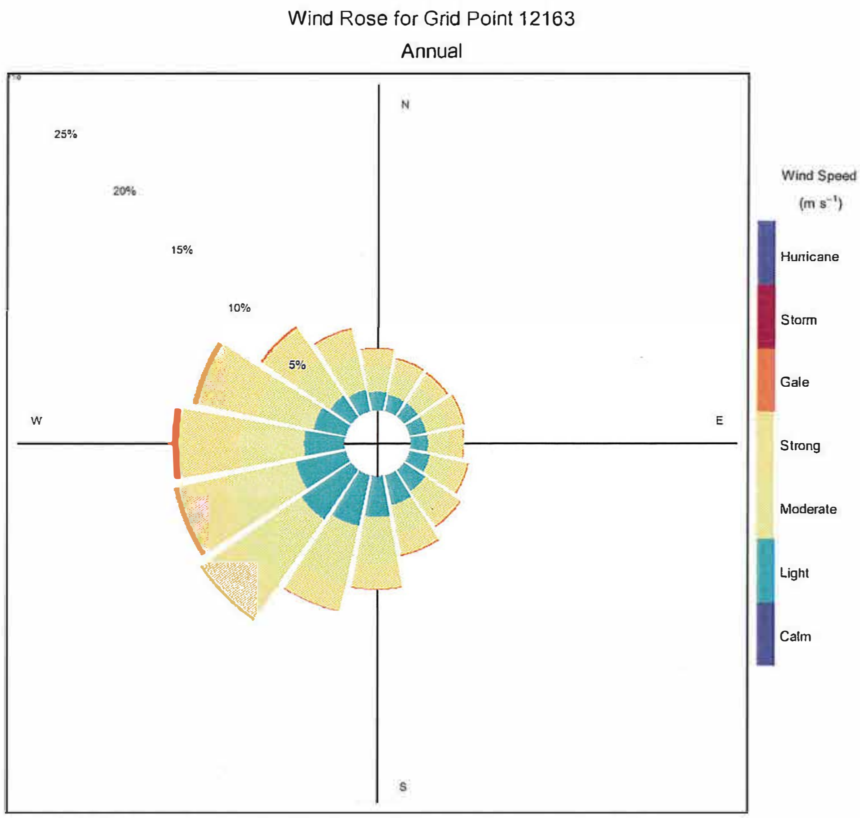
	GP 12163	GP 12164
January	10.6	10.6
February	10.0	10.1
March	9.3	9.3
April	7.9	8.0
May	6.3	6.3
June	5.6	5.7
July	5.3	5.4
August	6.0	6.0
September	7.2	7.2
October	8.5	8.6
November	9.4	9.4
December	10.3	10.4

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



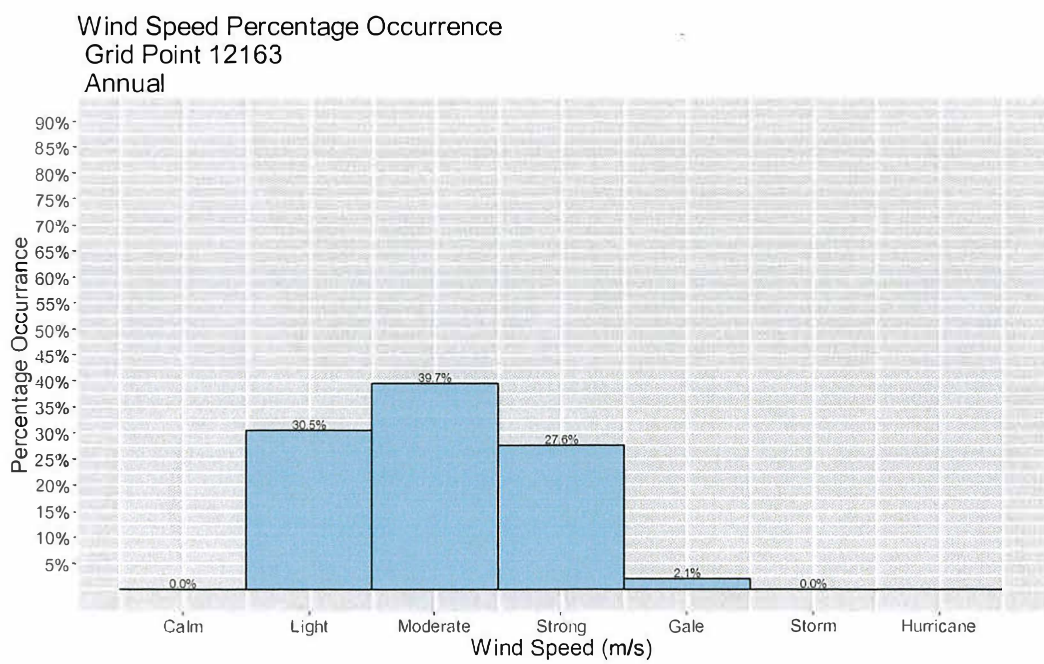


Figure 2.4 Wind Rose and Percentage Frequency Histogram for MSC50 Grid Point 12163 located at 47.3°N; 54.3W within the Rushoon BMA near Oderin Island Farm.

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.

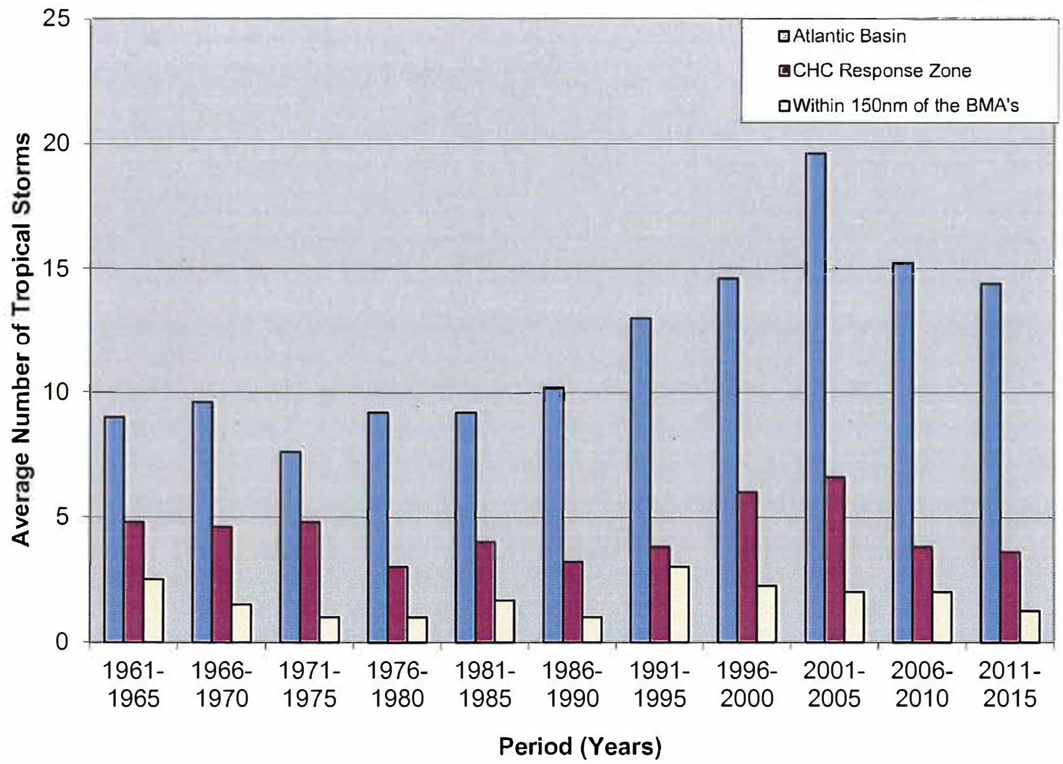


Figure 2.5 5-Year Average of the Number of Tropical Storms which formed in the Atlantic Basin since 1961

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.

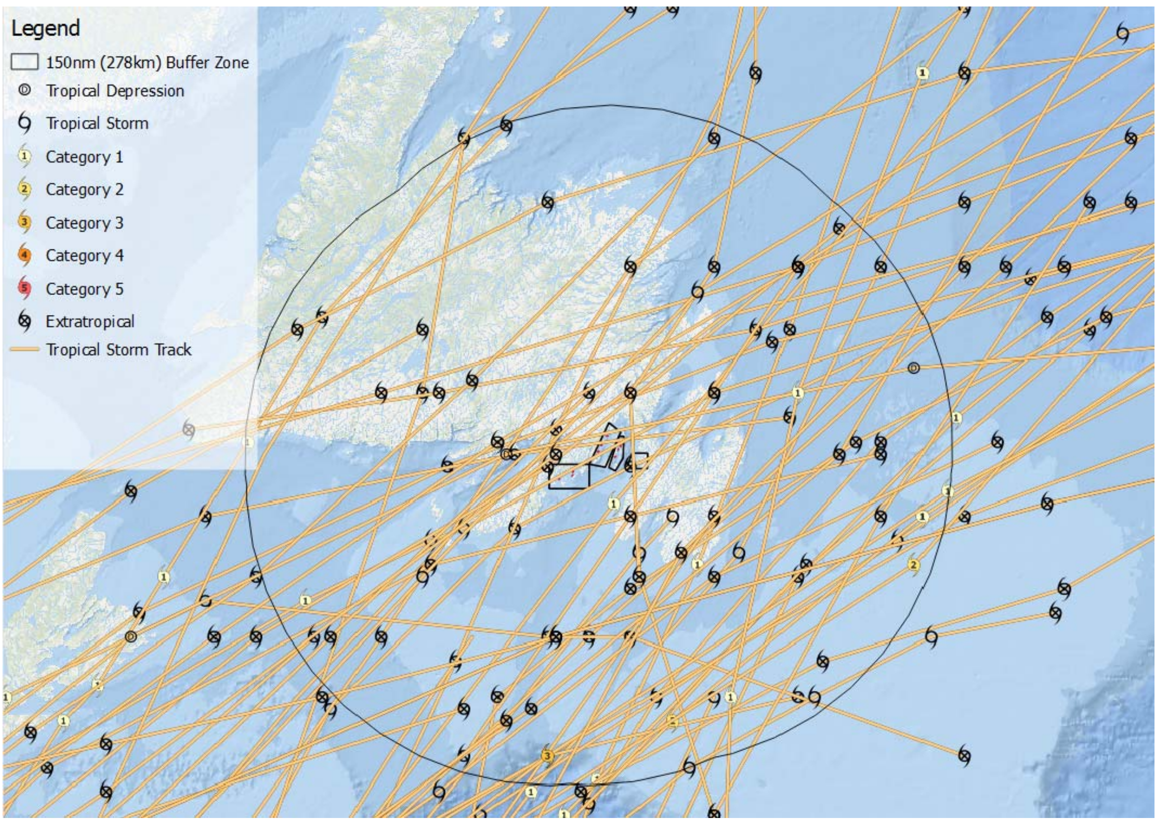


Figure 2.6 Storm Tracks of Tropical Systems Passing within 150 nm (278 km) of the Bay Management Areas (1960 to 2015)

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.

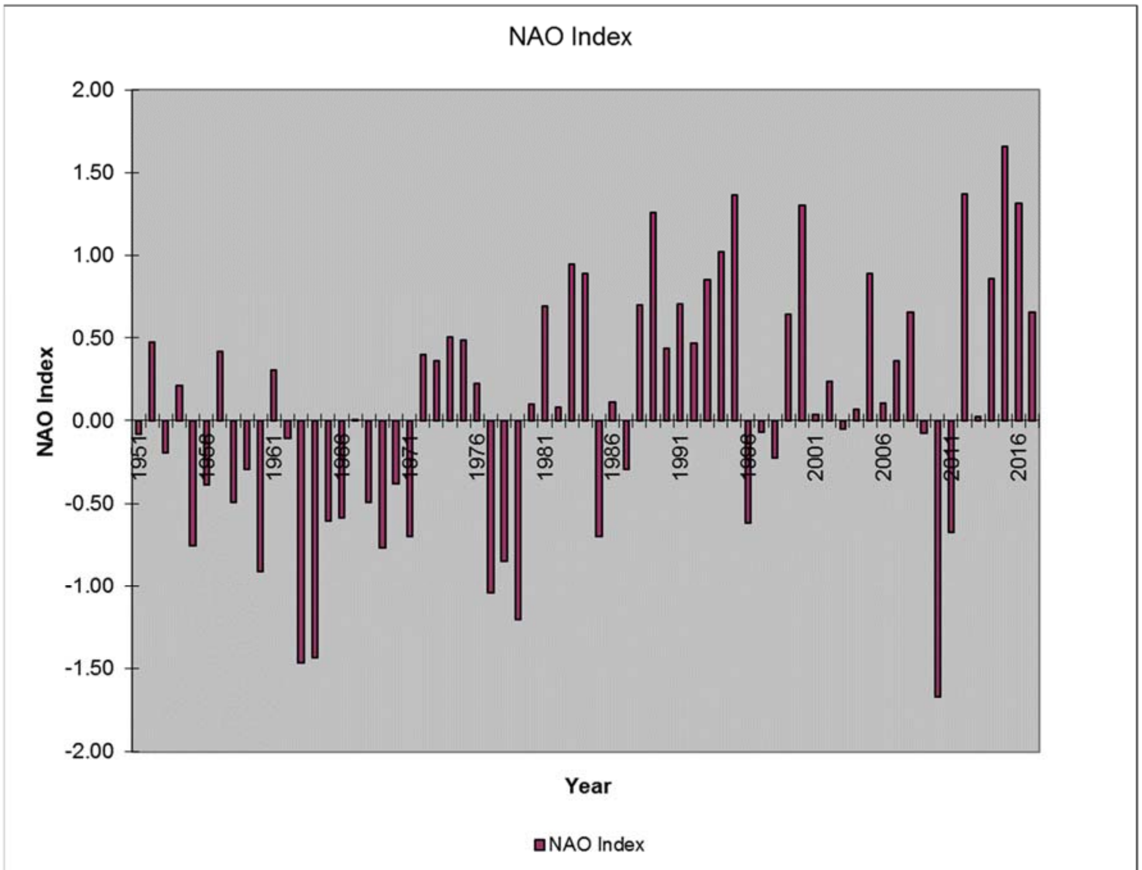


Figure 2.7 The Winter North Atlantic Oscillation Index

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.

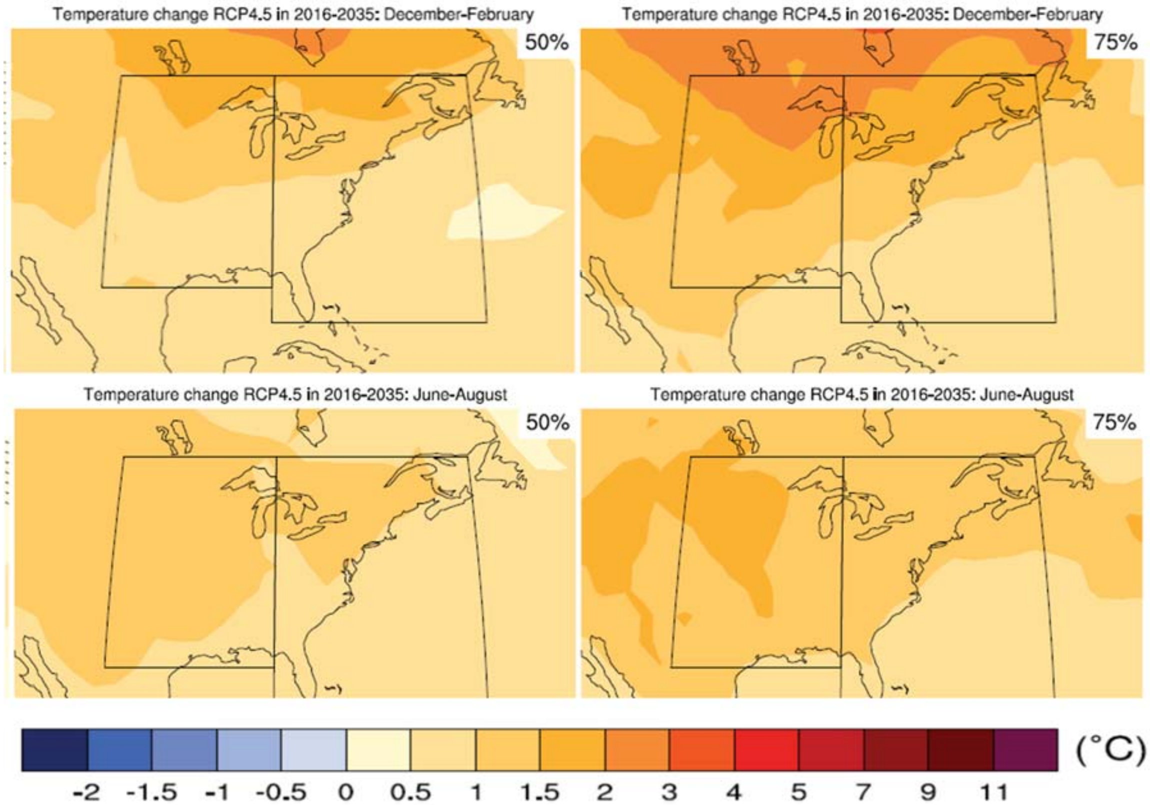


Figure 2.8 Possible future temperature change from the CMIP5 ensemble model running the RCP4.5 scenario for Eastern North America

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.

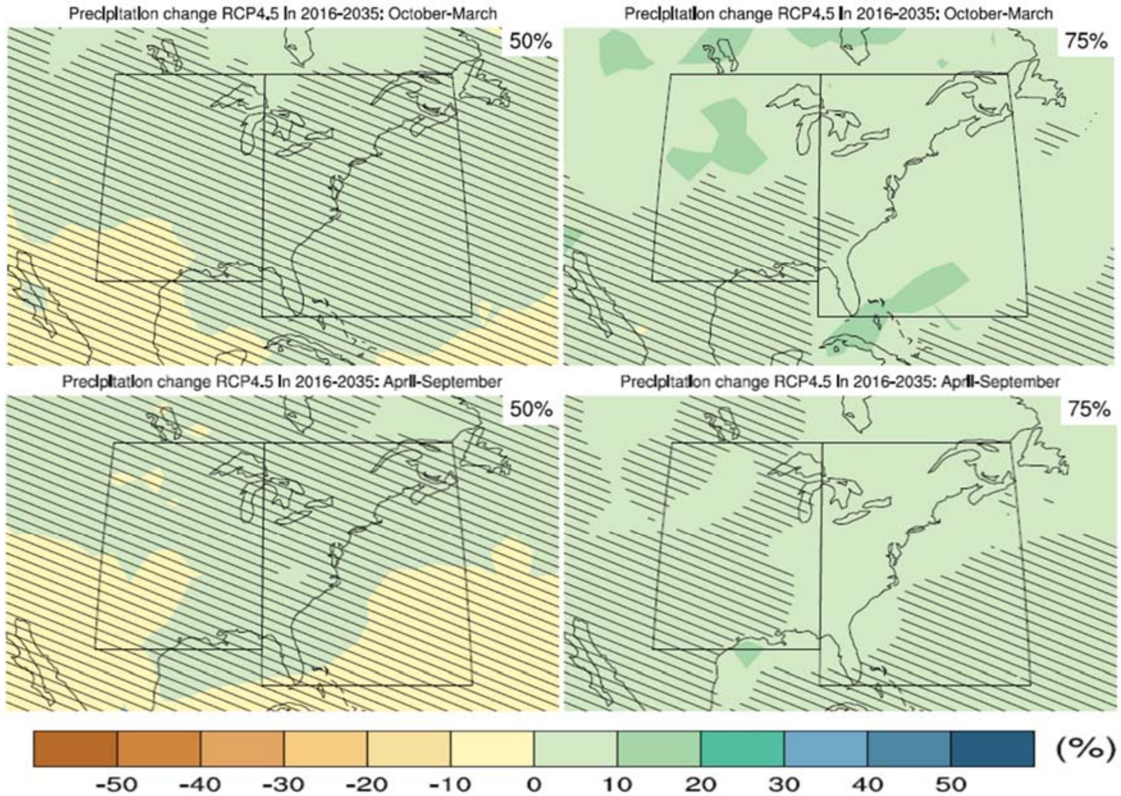


Figure 2.9 Possible future precipitation change from the CMIP5 ensemble model running the RCP4.5 scenario for Eastern North America

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.

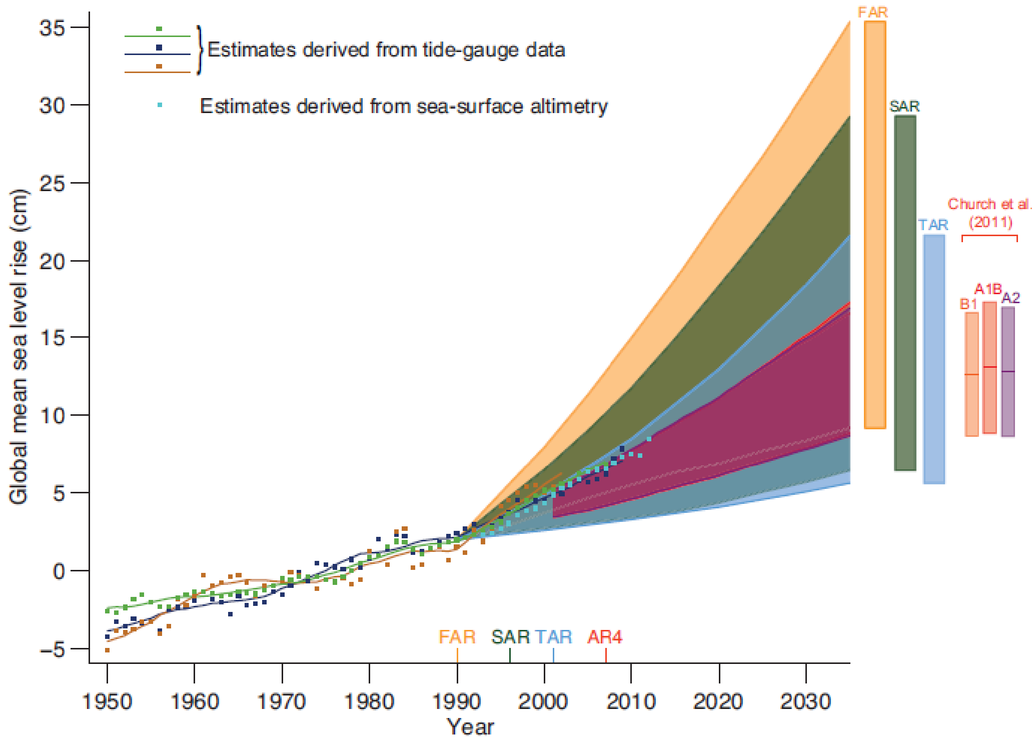


Figure 2.10 Past and future likely ranges of global mean sea-level rise (IPCC, 2013)

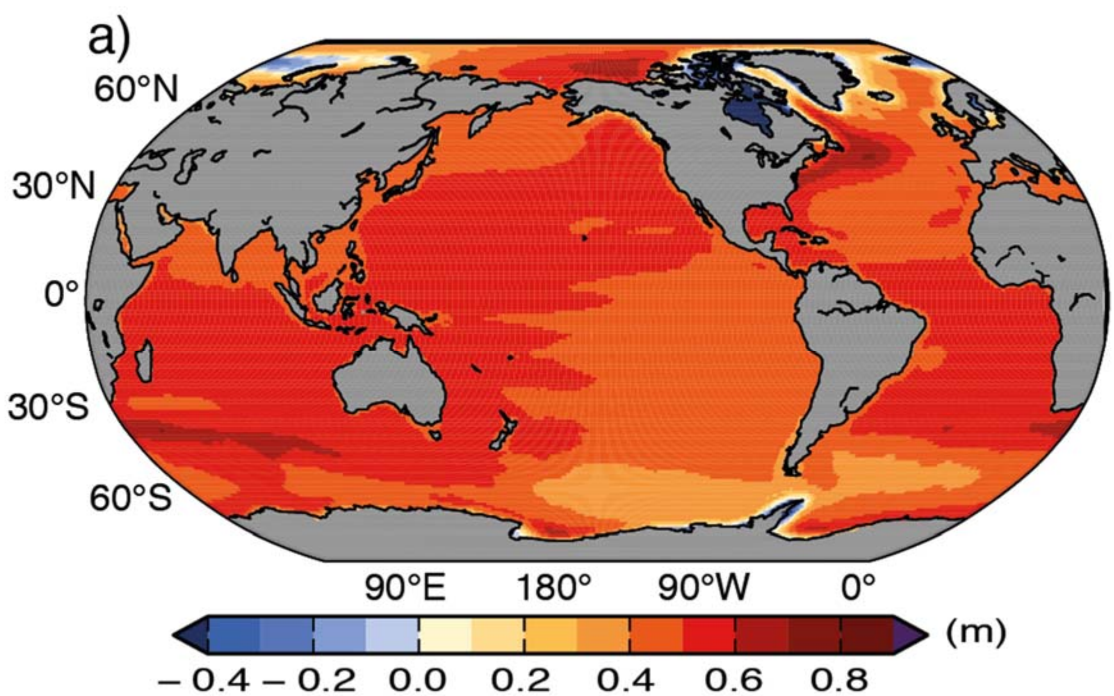


Figure 2.11 Ensemble mean regional relative sea level change (m) evaluated from 21 models of the CMIP5 scenario RCP 4.5 between 1986 - 2005 and 2081 - 2100

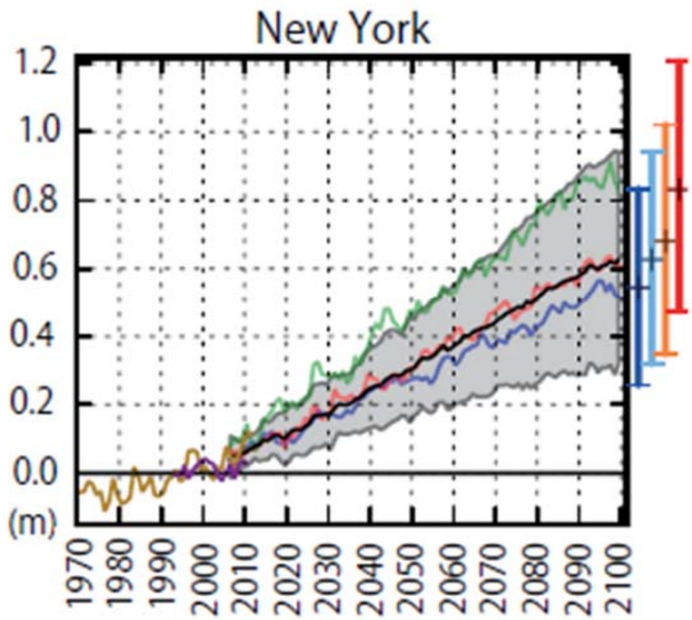


Figure 2.12 Observed and Projected Sea Level Change near New York.

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.

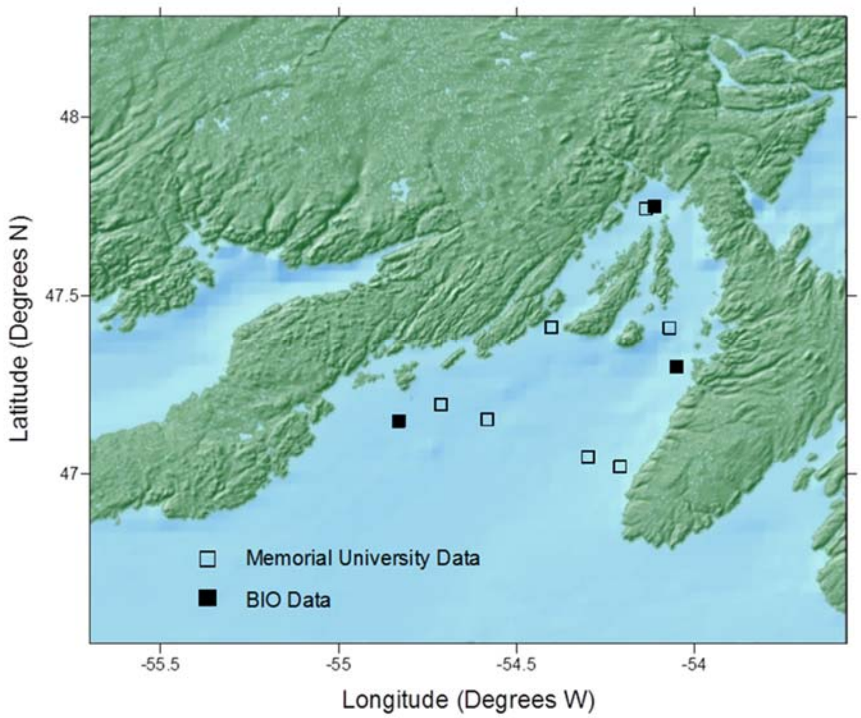


Figure 3.1 Location of Current Meter Moorings in Placentia Bay

3.1.2 Proposed Long Harbour BMA

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

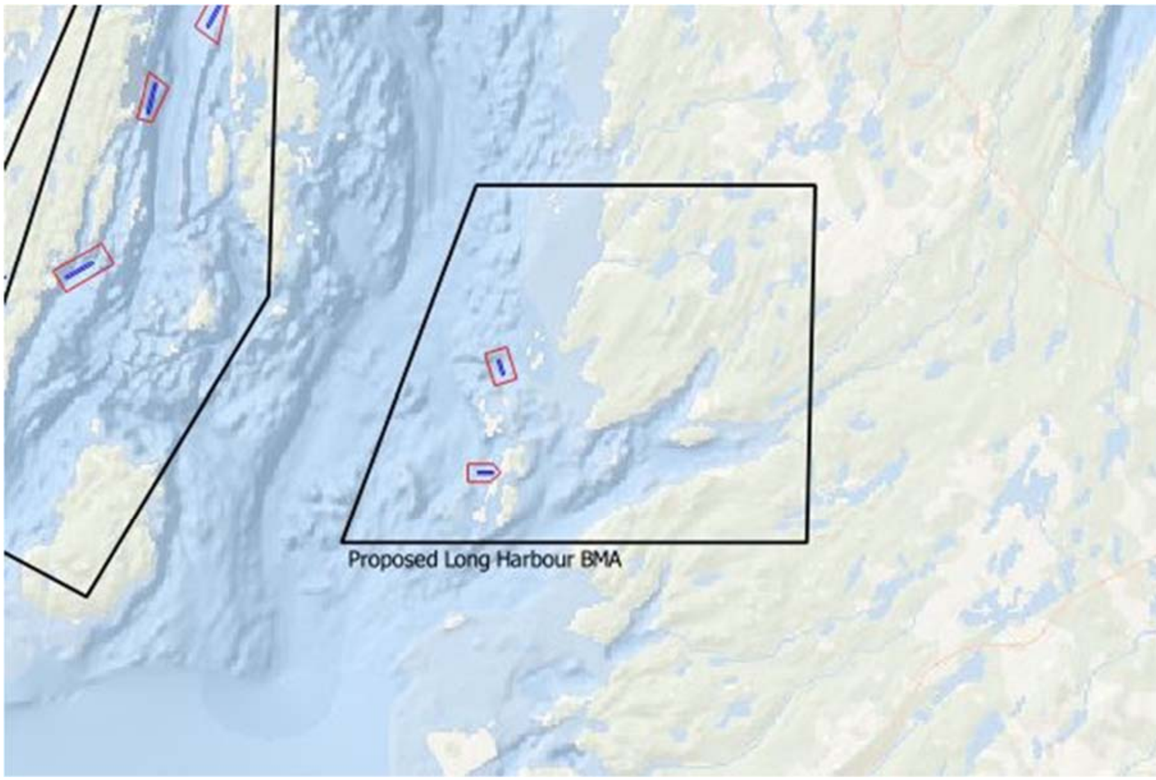


Figure 3.2 Proposed Long Harbour Aquaculture Sites

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

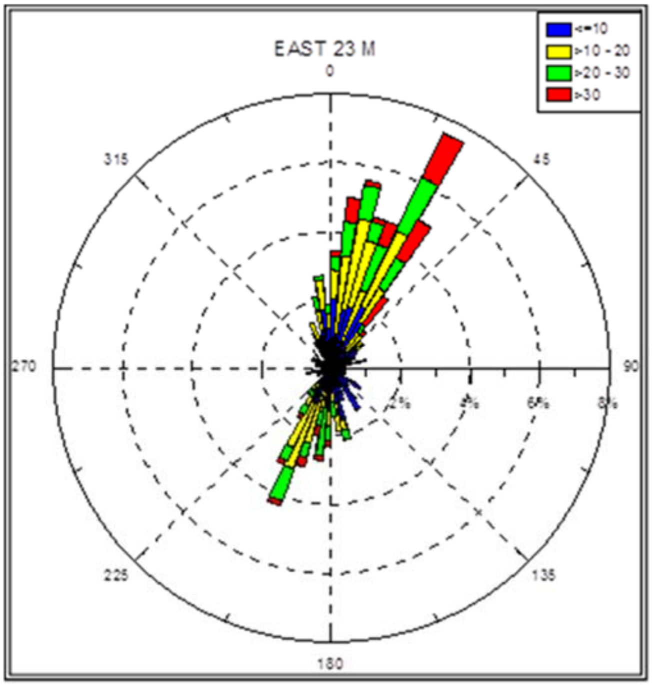


Figure 3.3 Rose Plot of the Near-Surface Current Speeds and Directions Outside Long Harbour in 1988

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.

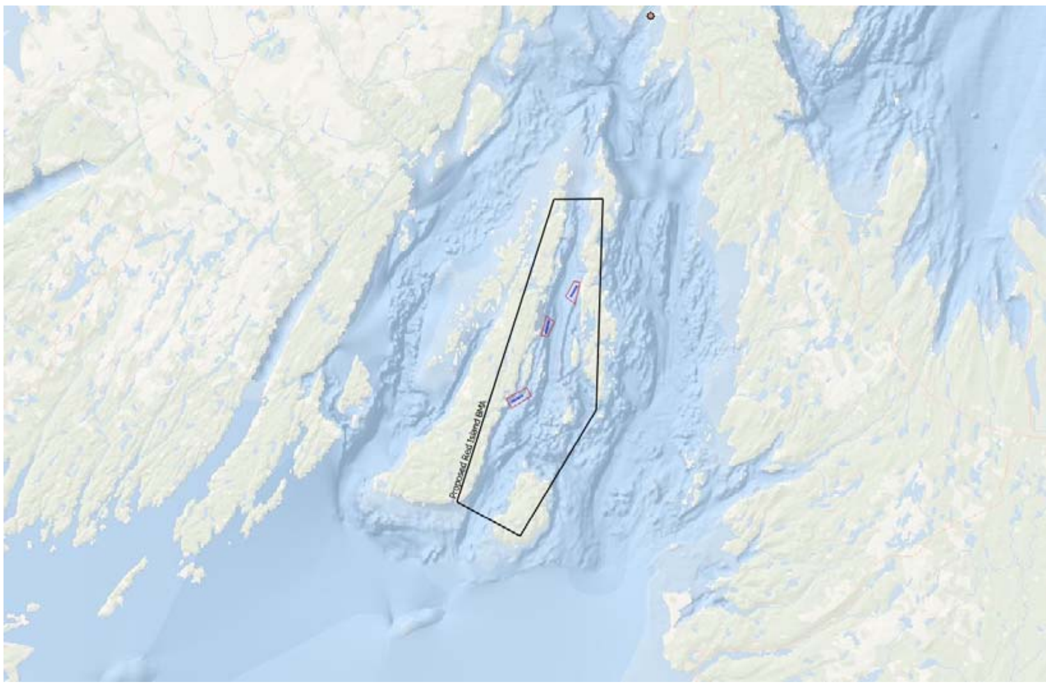


Figure 3.4 Proposed Red Island Aquaculture Sites

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.

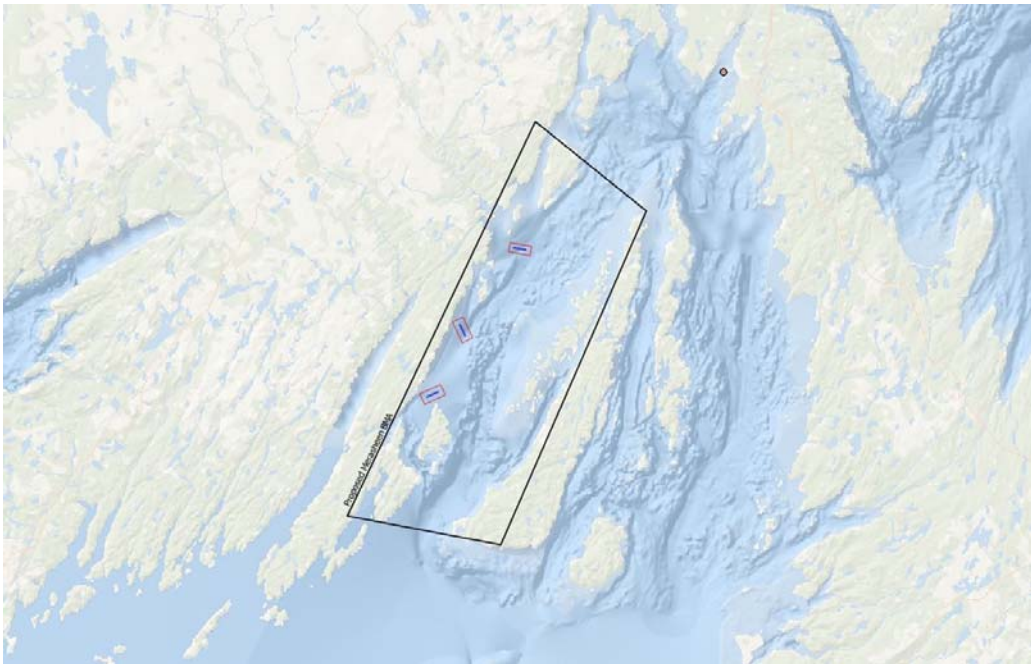


Figure 3.5 Proposed Merasheen Aquaculture Sites

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.

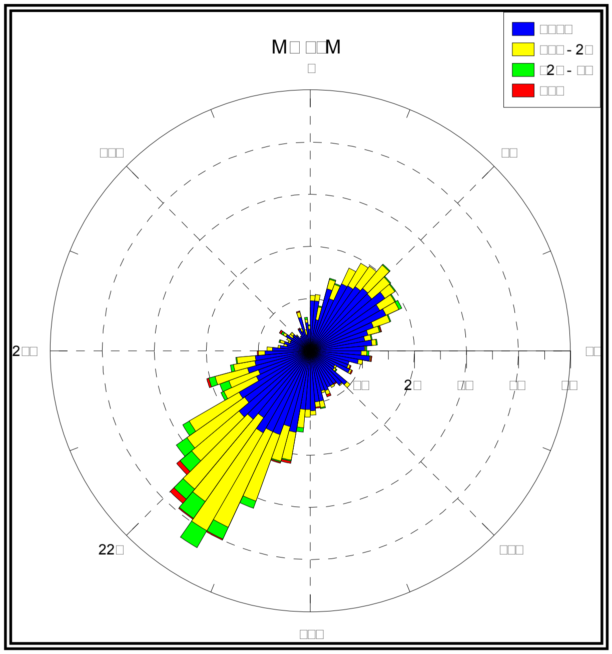


Figure 3.6 Rose Plot of Current Speed and Directions at 36 m west of Merasheen Island

3.1.5 Proposed Rushoon BMA

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

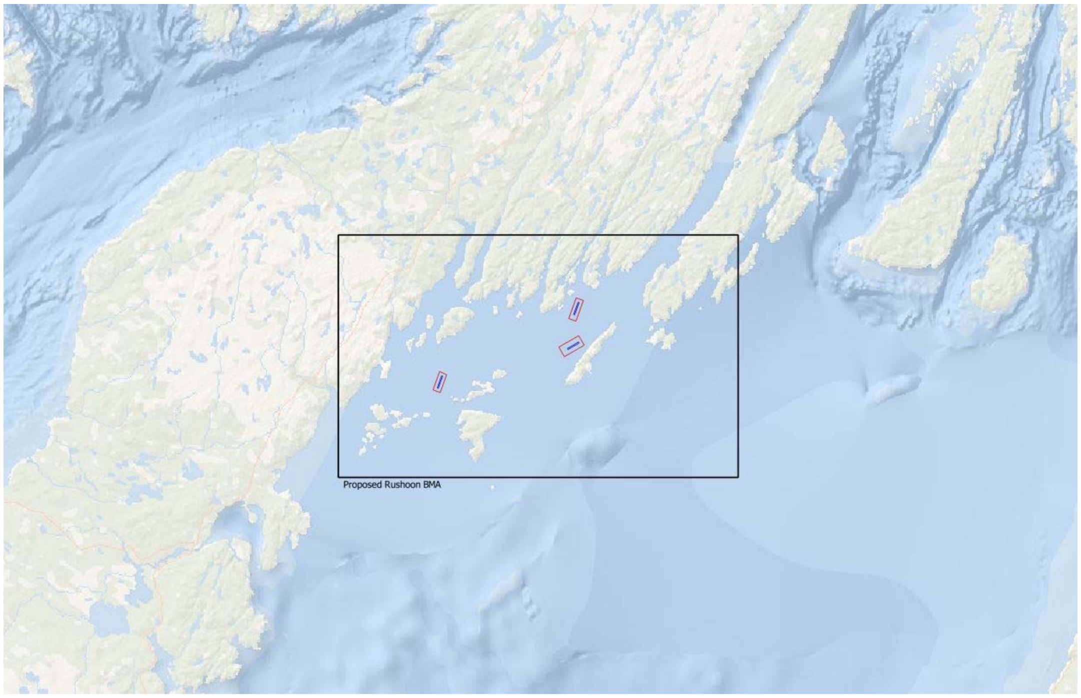


Figure 3.7 Proposed Rushoon Aquaculture Sites

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 Greig 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.

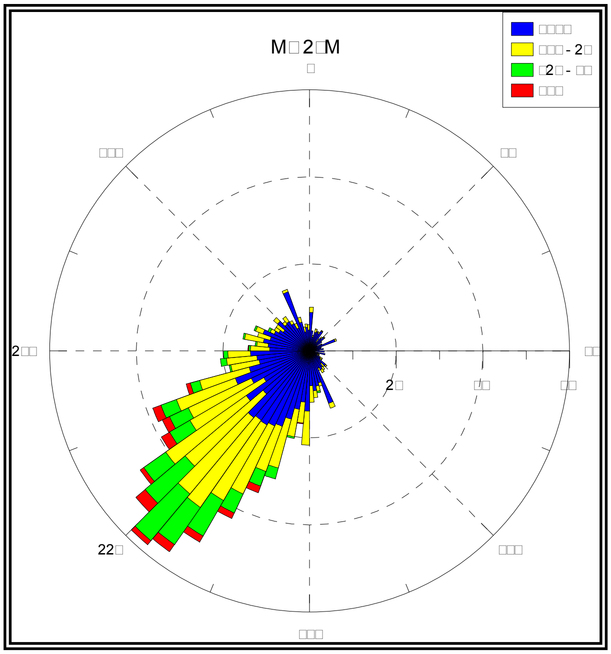


Figure 3.8 Rose Plot of the Near-Surface Current Speeds and Directions from the Memorial University Data Set

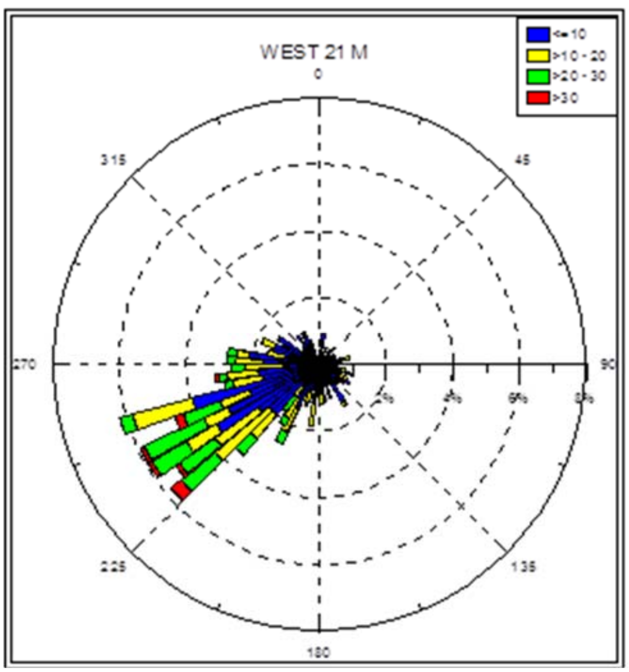


Figure 3.9 Rose Plot of the Near-Surface Current Speeds and Directions Corresponding to the BIO Fall Data Set

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.

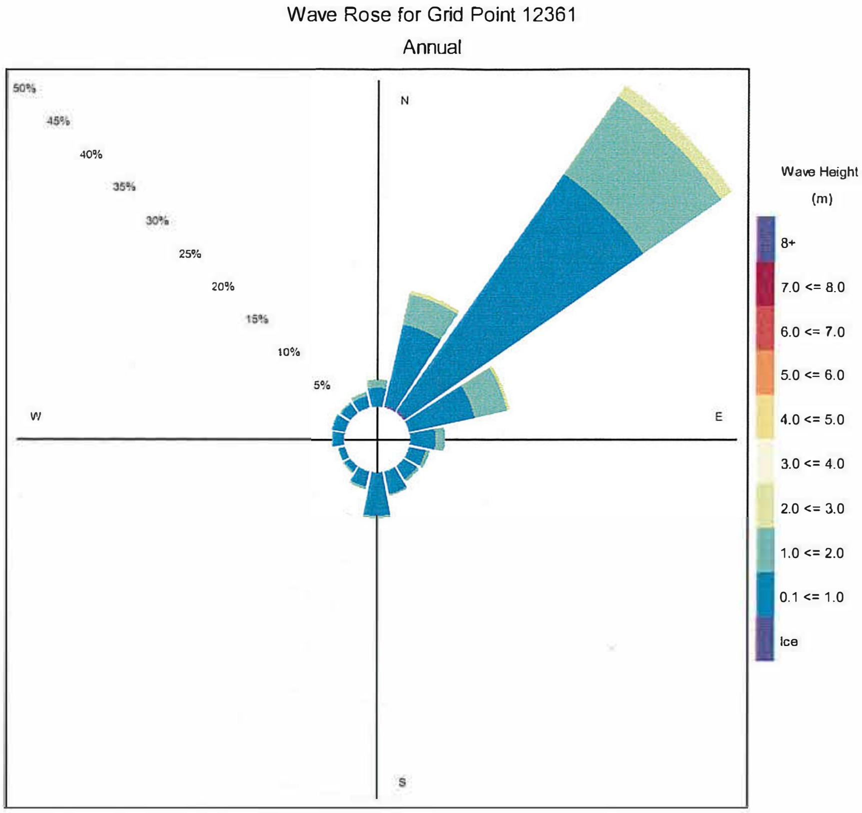
Wave heights were higher at grid point 12361, than the other two grid points. The SmartBay buoy recorded mean wave heights of 1.9 m during the months of January and February and a maximum wave height of 7.9 m in January. Maximum wave heights recorded at the MSC50 sites ranged from 1.3-5.4 m. It seems 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



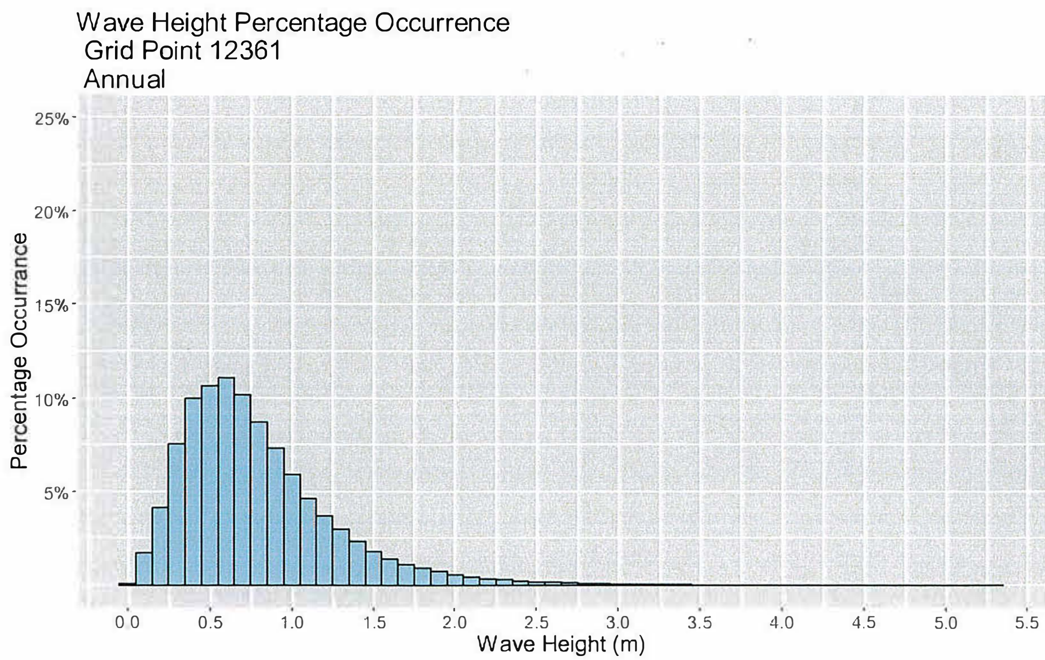


Figure 3.10 Wave Rose and Percentage Frequency Histogram for MSC50 Grid Point 12361 located at 47.4°N; 54.1W near Red Island

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.

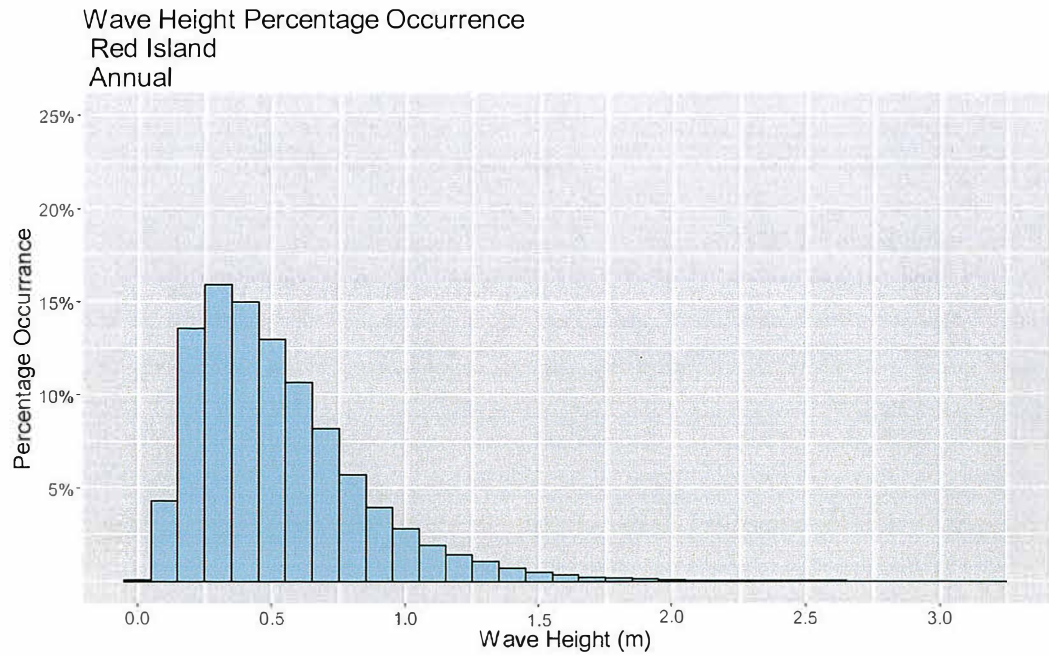


Figure 3.11 Red Island Shoal Percentage Frequency Histogram of Wave Heights.

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

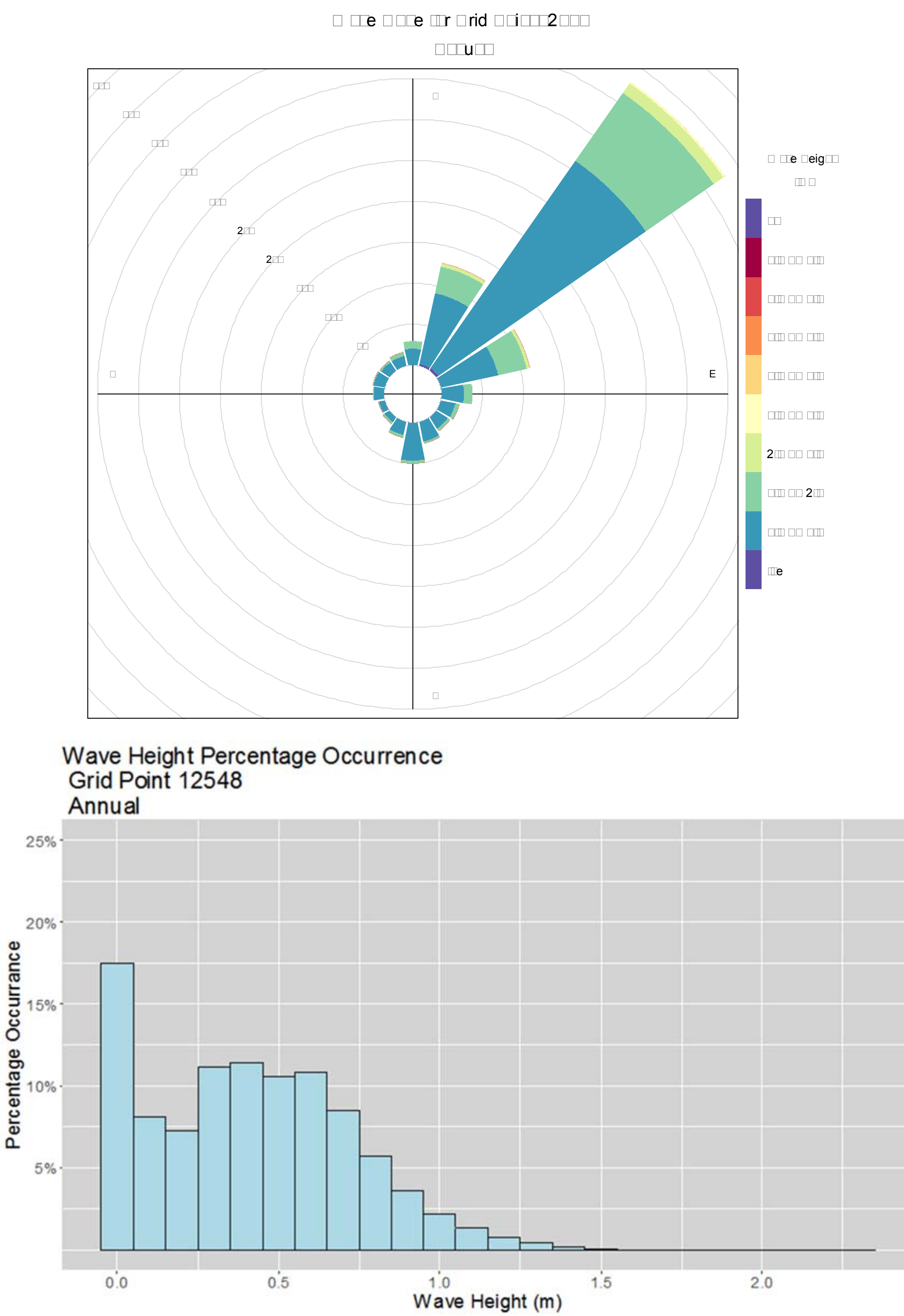


Figure 3.12 Wave Rose and Percentage Frequency Histogram for MSC50 Grid Point 12548 located at 47.5°N; 54.3W within the Merasheen BMA

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

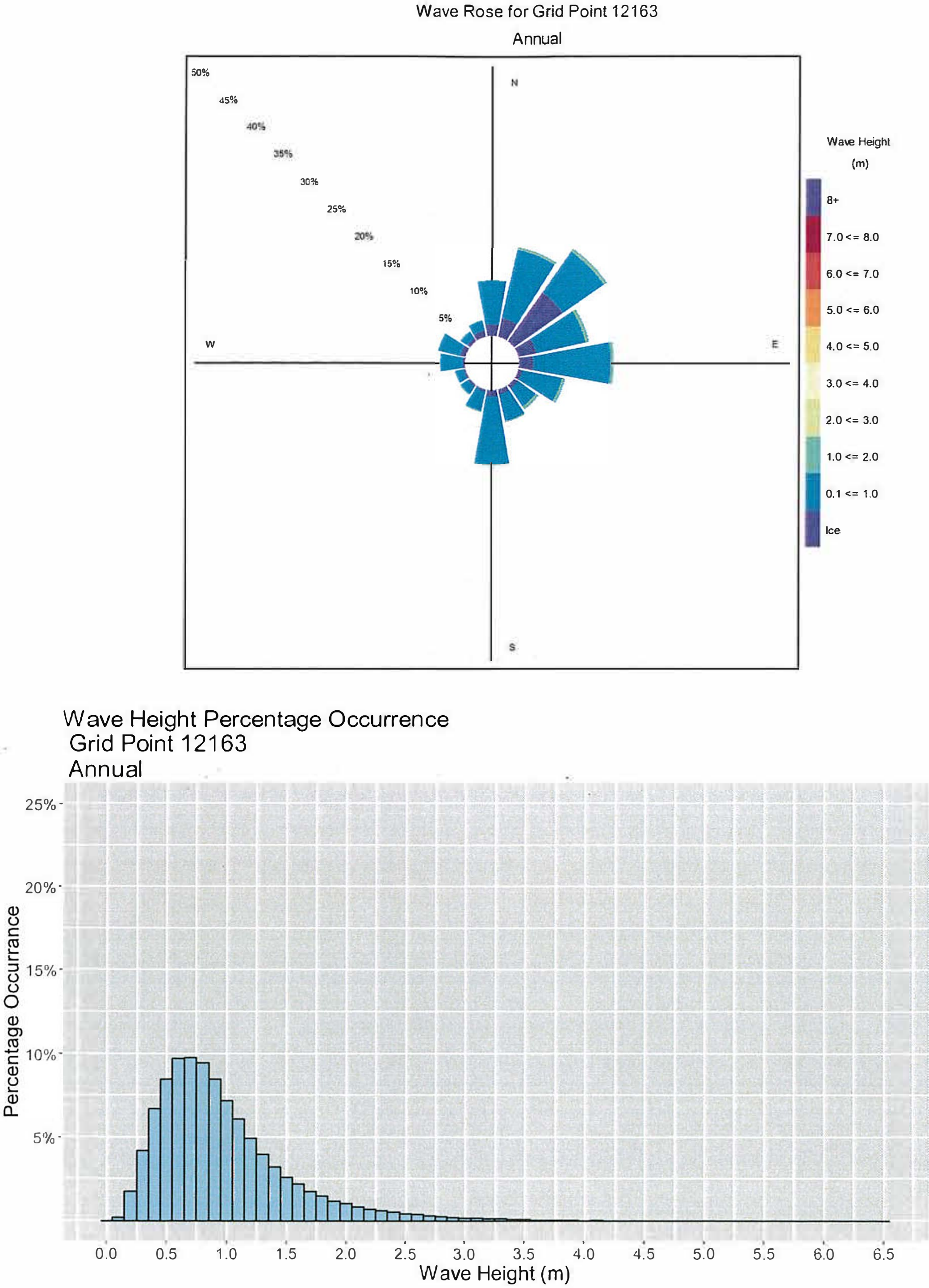


Figure 3.13 Wave Rose and Percentage Frequency Histogram for MSC50 Grid Point 12163 located at 47.3°N; 54.3W within the Rushoon BMA near Oderin Island Farm.

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%.

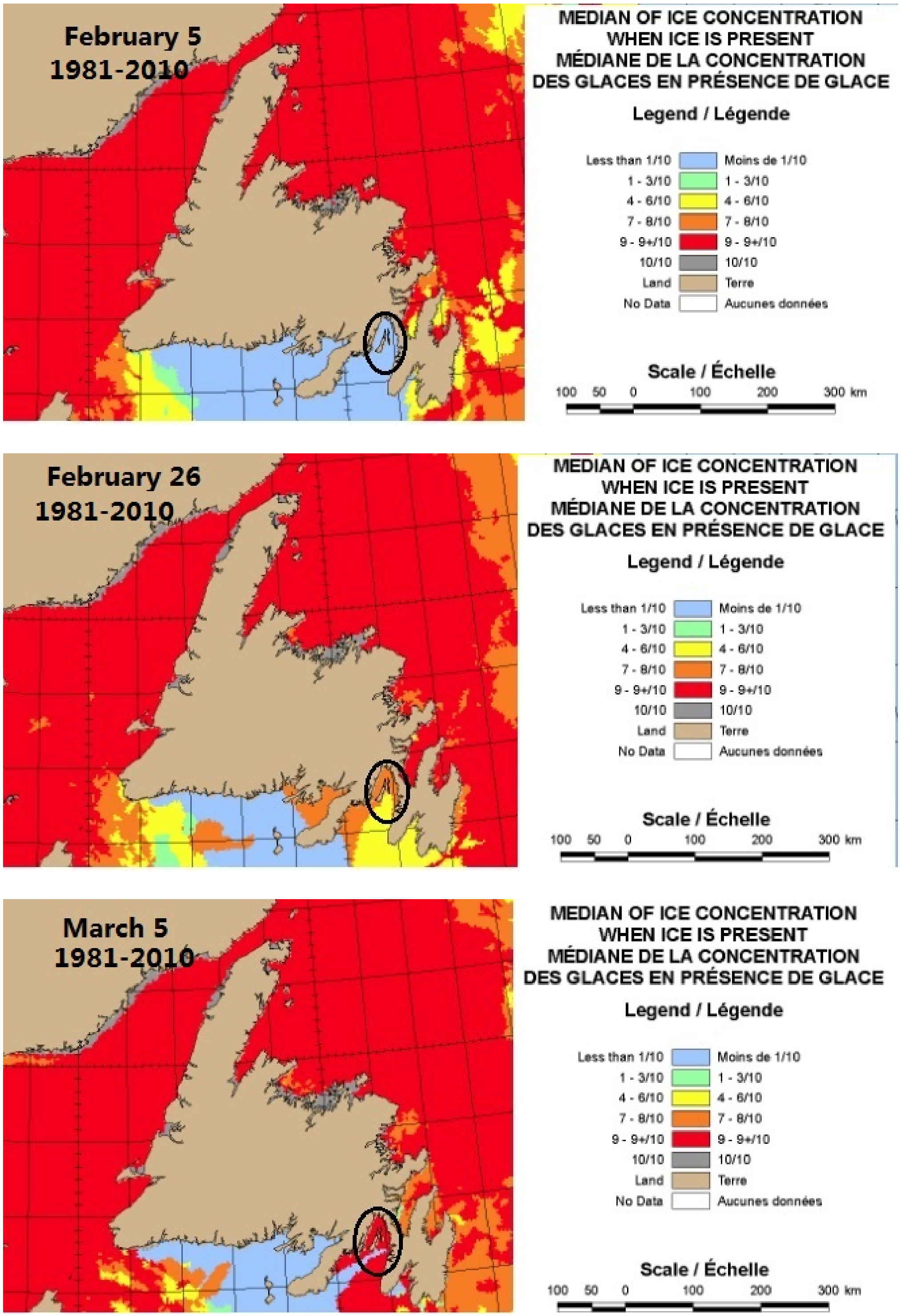


Figure 3.14 Weekly analysis of 30-year median of ice concentration when ice is present in Placentia Bay (black oval) from 1981 to 2010 (Canadian Ice Service).

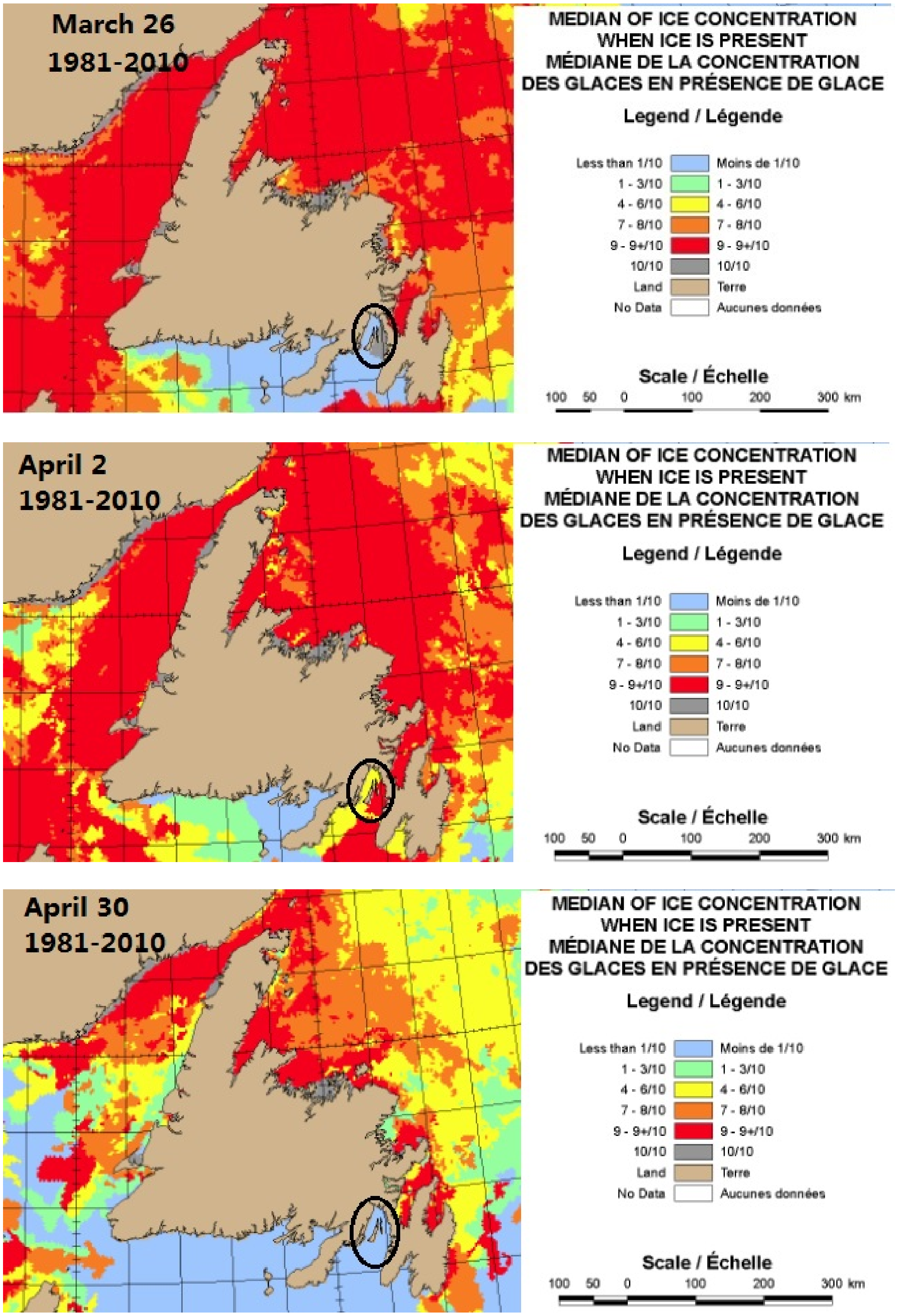


Figure 3.14 Weekly analysis of 30-year median of ice concentration when ice is present in Placentia Bay (black oval) from 1981 to 2010 (Canadian Ice Service) (Cont.).

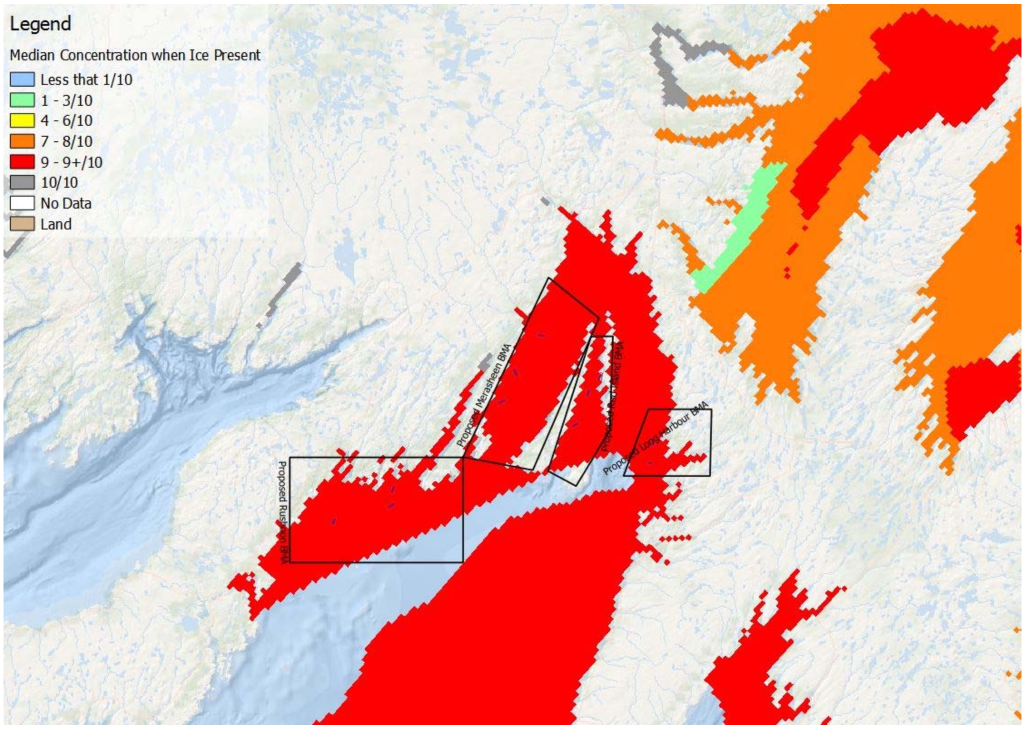


Figure 3.15 Weekly analysis of 30-year median of ice concentration when ice is present for the four BMA's in the week starting March 5, 1981-2010 (Canadian Ice Service).

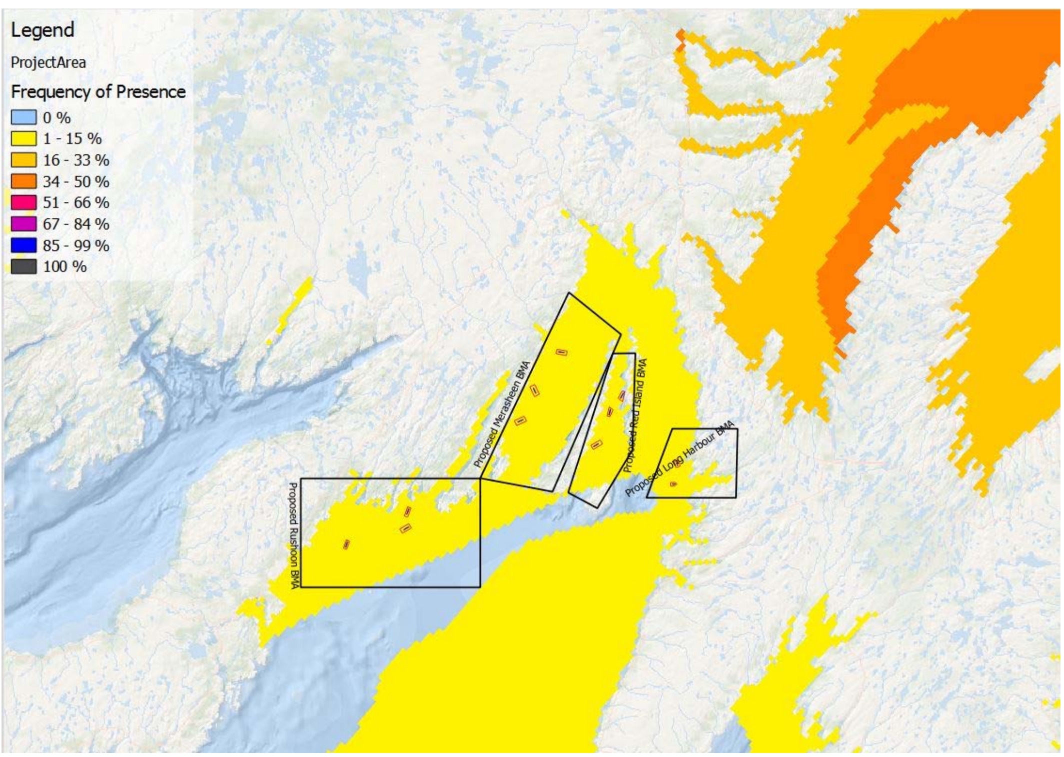


Figure 3.16 Weekly analysis of 30-year frequency of presence for the four BMA's in the week starting March 5, 1981-2010 (Canadian Ice Service).

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.

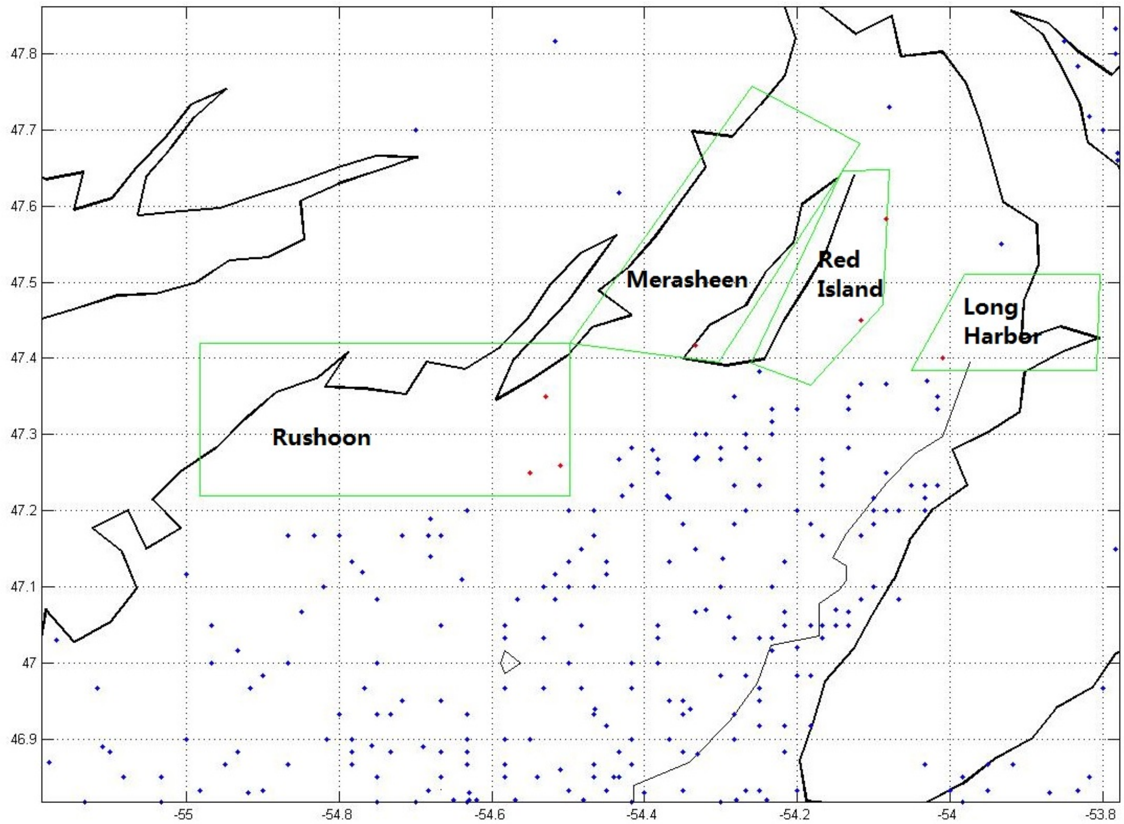


Figure 3.17 Iceberg sightings from 1960 to 2015. The green polygons are the four Bay Management Areas in Placentia Bay. The blue dots are icebergs sighted over 55 years within the farm fields. Some icebergs which were recorded at different coordinates due to drifting are shown.

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

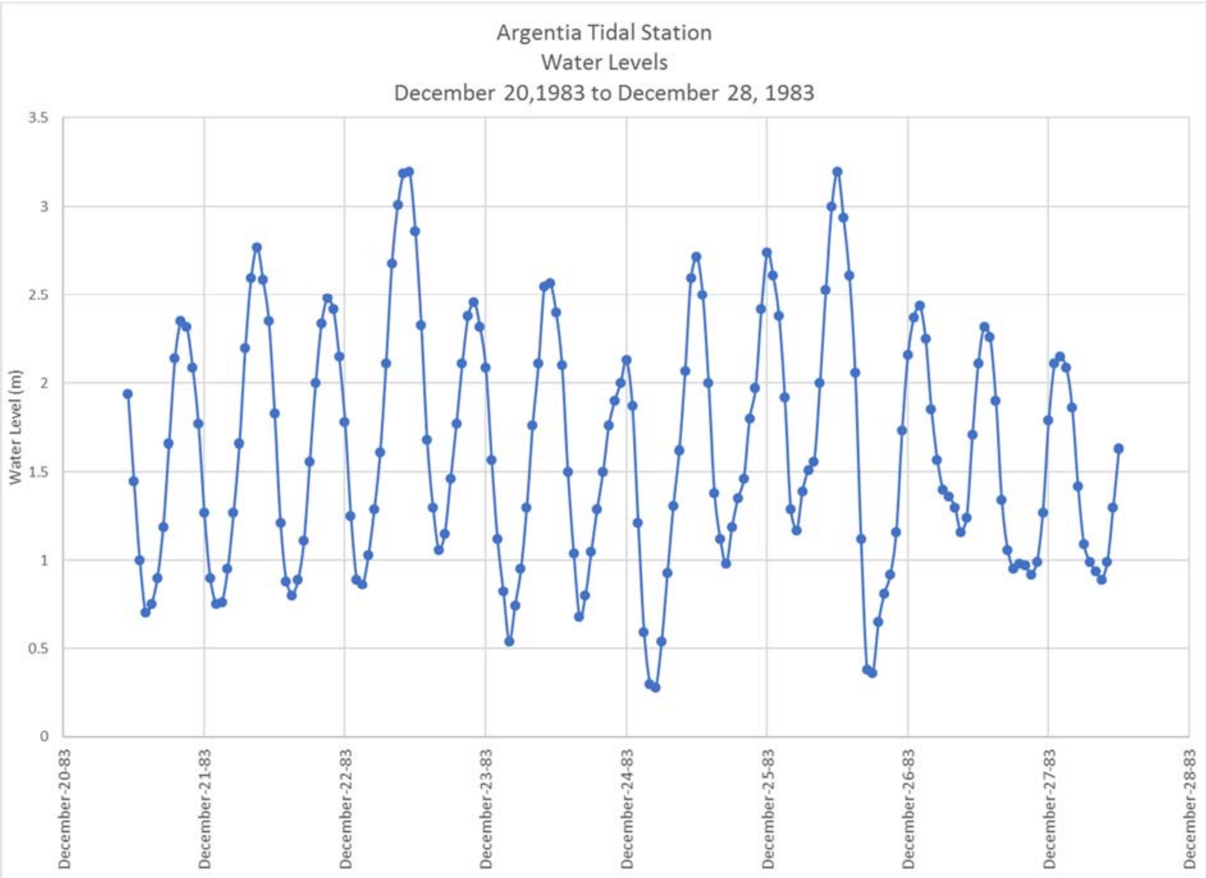


Figure 3.18 Argentia Tidal Station Water Levels (December 20, 1983 to December 28, 1983)

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

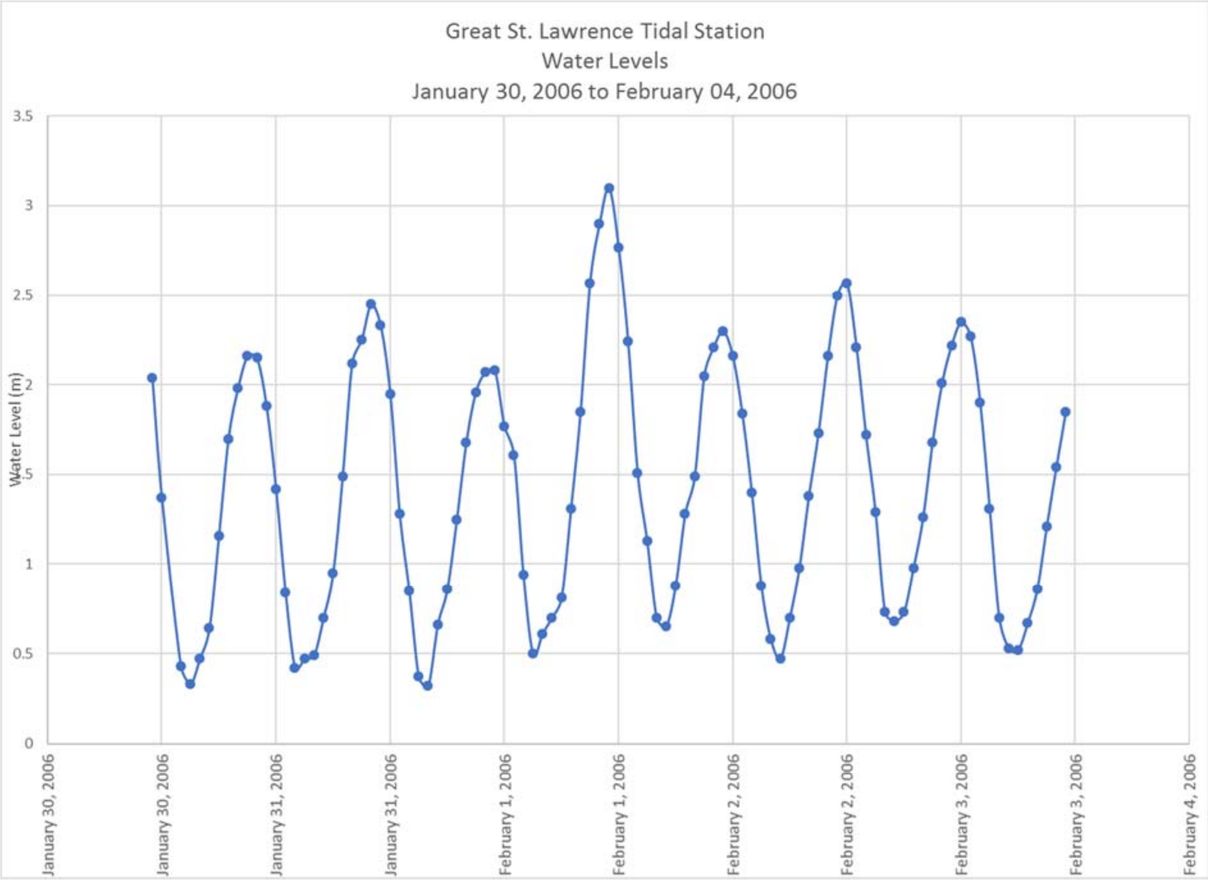


Figure 3.19 Great St. Lawrence Tidal Station Water Levels (January 30, 2006 to February 04, 2006)

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.

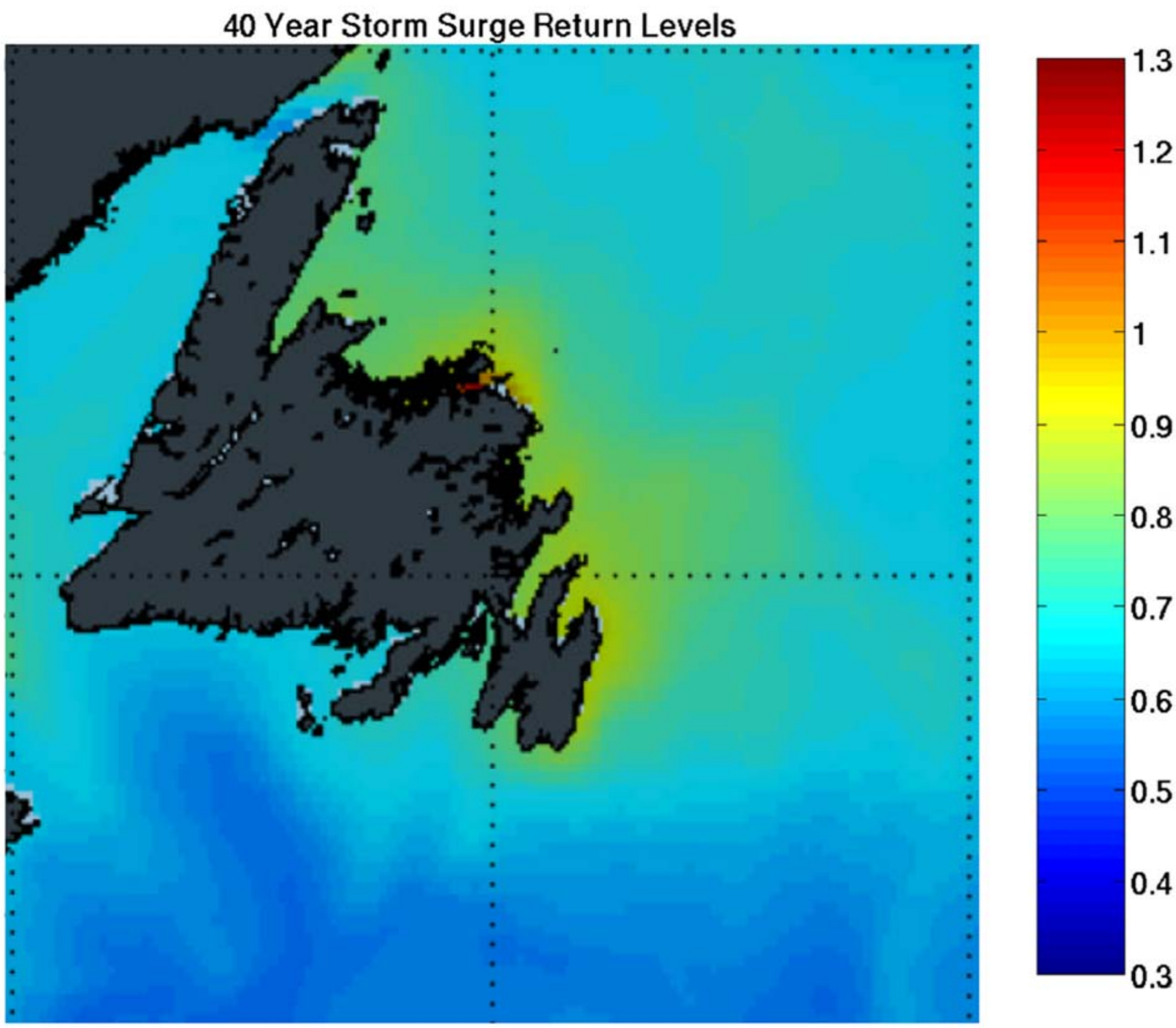


Figure 3.20 40-year return level of extreme storm surges based on the surge hindcast. Colorbar indicates the 40 return levels in metres. (Modified from (Bernier & Thompson, 2006))

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 C

Sea Cage Site Water Quality Data:

Water Temperature and Dissolved Oxygen

Appendix C-Sea Cage Site: Iona Island

Grieg NL Seafarms Ltd - Environmental Data													
Sea Cage Site: Iona Island													
Temperature							Dissolved Oxygen						
Date	Temperature (˚C) - Surfa	Temperature (˚C) - 3r	Temperature (˚C)- 10r	Temperature (˚C) - 25r	Temperature (˚C) - 35r	Temperature (˚C) - 50r	Date:2	DO (%L) - 3n	DO (mg/L)-3n	DO (%L) - 15n	DO (mg/L)-15n	DO (%L) - 35n	DO (mg/L)-35n
June 25,2016		8.40	8.40	8.40	8.10	1.10	June 25,2016	106.80	10.28	106.60	10.25	106.50	10.25
July 8,2016		10.00	5.20	5.00	3.00	1.10	July 8,2016	106.30	9.82	106.10	11.75	99.60	11.60
July 20,2016		12.20	12.20	10.90	7.40	1.40	July 20,2016	111.60	9.76	110.60	9.70	113.50	11.03
July 26,2016		13.70	13.30	12.90	2.70	1.10	July 26,2016	114.30	9.72	112.00	9.63	114.50	12.49
August 3,2016		15.90	13.90	5.20	3.80	1.60	Aug. 3,2016	111.80	9.17	114.60	10.32	116.50	12.34
August 10,2016	16.00	16.00	16.00	15.00	2.60	0.90	Aug. 10,2016	111.90	9.13	110.00	9.01	116.40	12.80
August 20,2016	16.30	16.30	13.90	6.40	4.90	2.30	Aug. 20,2016	109.10	8.94	122.90	11.57	117.70	12.22
September 4,2016	15.40	15.40	15.30	7.00	5.90	5.00	Sept 4,2016	108.20	8.93	113.00	10.18	115.50	11.78
September 8,2016	14.50	14.50	14.30	13.00	8.90	2.30	Sept 9,2016	112.60	9.45	114.10	9.73	116.70	10.97
September 23,2016	13.00	13.00	13.00	13.00	10.70	5.40	Sept 23,2016	104.60	9.05	103.30	8.93	103.10	9.36
September 27,2016	12.80	12.80	12.80	11.70	10.00	5.60	Sept 27,2016	102.10	8.79	99.90	8.62	101.60	9.30
September 30,2016	12.20	12.20	11.60	8.20	5.10	4.00	Sept 30,2016	102.20	9.06	101.40	9.26	103.20	10.65
October 6,2016	11.70	11.70	11.70	11.10	8.70	5.80	Oct 6,2016	105.80	9.45	102.50	9.17	100.00	9.34
October 12,2016	11.40	11.30	11.20	11.10	10.60	8.00	Oct 12,2016	107.00	9.70	105.10	9.53	103.10	9.49
October 16,2016	10.60	10.60	10.50	8.00	6.80	5.40	Oct 16,2016	110.60	10.08	106.70	9.78	108.10	10.71
October 21,2016	10.60	10.60	10.60	10.60	10.60	7.80	Oct 21,2016	99.60	9.19	99.20	9.15	98.90	9.13
October 26,2016	10.00	10.00	10.00	10.00	10.00	9.70	Oct 26,2016	107.20	9.87	106.40	9.79	104.90	9.66
October 31,2016	9.90	9.90	9.90	10.00	9.90	9.10							
November 4,2016	9.60	9.60	9.60	9.00	8.70	8.50							
November 8,2016	9.60	9.60	9.60	9.50	9.30	8.60							
November 15,2016	8.90	8.90	8.90	9.00	9.00	5.70	Nov 15,2016	91.90	8.75	92.20	8.78	91.00	8.66
November 23,2016	8.80	8.80	8.70	8.40	8.20	7.40	Nov 23,2016	97.30	9.13	96.60	9.12	95.20	9.04
November 30,2016	7.20	7.20	7.20	6.70	6.40	6.10	Nov 30,2016	95.20	9.36	92.40	9.12	92.70	9.27
December 8,2016	6.30	6.20	6.20	5.90	5.90	5.80	Dec 8,2016	98.90	9.81	97.60	9.74	95.90	9.64
December 14,2016	4.70	4.70	4.70	4.60	4.50	3.20							
December 31,2016	2.00	2.00	2.00	1.90	1.90	1.90	Dec 31,2016	101.50	11.22	99.80	11.03	88.10	10.86
May 23,2017	2.70	2.60	2.40	1.20	0.70	0.40	May 23,2017	99.00	13.50	102.00	14.30	101.00	14.60
June 3,2017	4.10	4.10	4.00	3.70	3.40	2.80	June 3,2017	104.00	13.60	103.00	13.40	104.00	13.80
June 7,2017	5.10	5.00	4.50	3.60	2.60	1.40	June 7,2017	107.00	13.70	105.00	13.70	105.00	14.20
June 16,2017	6.60	6.40	6.10	2.90	1.10	0.40	June 16,2017	104.00	12.90	105.00	13.60	102.00	14.50
June 23, 2017	6.40	6.40	6.40	6.30	5.80	5.00	June 23, 2017	96.00	11.90	96.00	11.80	96.00	11.90
June 30, 2017	8.00	7.90	7.90	6.90	6.30	5.60	June 30, 2017	110.00	13.20	108.00	13.10	109.00	13.60
July 21, 2017	12.80	12.80	12.80	7.70	3.50	2.50	July 21, 2017	105.00	11.10	104.00	11.10	108.00	14.30
July 27, 2017	11.90	11.90	11.30	5.50	3.50	1.90	July 27, 2017	105.00	11.40	107.00	11.80	104.00	12.60
August 3, 2017	15.90	15.90	15.40	6.10	4.30	3.10	August 3, 2017	109.00	10.90	117.00	13.30	115.00	15.20
August 11, 2017	16.10	16.10	15.90	11.10	6.30	3.40	August 11, 2017	106.00	10.50	106.00	10.50	116.00	14.40
August 19, 2017	14.90	14.80	6.80	1.40	0.80	0.20	August 19, 2017	95.00	9.70	104.00	14.00	96.00	13.80
August 26, 2017	15.70	15.20	14.50	12.20	2.60	1.90							
September 3, 2017	13.80	13.60	12.10	11.10	8.30	2.40							
September 9, 2017	13.50	13.40	13.40	13.30	12.50	1.00	September 9, 2017	100.00	10.50	98.00	10.30	98.00	10.50
September 15, 2017	13.70	13.70	13.10	12.30	10.90	3.60	September 15, 2017	104.00	10.90	101.00	10.70	99.00	11.00
September 22, 2017	14.00	14.00	13.80	13.50	7.50	3.00	September 22, 2017	99.00	10.30	98.00	10.20	101.00	12.50
September 30, 2017	13.20	13.10	13.00	10.00	4.40	1.50	September 30, 2017	93.00	9.90	93.00	10.10	98.00	12.80
October 7, 2017	12.00	12.00	12.00	11.90	9.90	8.10	October 7, 2017	97.00	10.50	96.00	10.40	95.00	10.80
October 13, 2017	11.60	11.60	11.60	10.90	7.00	4.10	October 13, 2017	96.00	10.60	94.00	10.40	96.00	11.90
October 19, 2017	11.00	11.00	11.00	11.00	10.90	6.70	October 19, 2017	97.00	10.80	96.00	10.70	96.00	10.70
October 28, 2017	10.30	10.30	10.30	9.60	8.30	6.60	October 28, 2017	97.00	10.90	96.00	10.80	95.00	11.20
November 2, 2017	9.90	9.90	9.90	9.80	9.60	8.10	November 2, 2017	99.00	11.50	99.00	11.50	98.00	11.50
November 13, 2017	8.50	8.50	8.50	7.80	6.90	5.80	November 13, 2017	92.00	11.00	92.00	11.00	91.00	11.30
November 19, 2017	7.90	7.90	7.90	7.70	7.00	5.80	November 19, 2017	88.00	10.60	88.00	10.50	87.00	10.40
November 29, 2017	6.40	6.40	6.40	6.50	6.60	6.30	November 29, 2017	94.00	11.70	92.00	11.50	92.00	11.30
December 6, 2017	5.90	5.90	6.00	6.10	6.00	5.30	December 6, 2017	94.00	11.70	94.00	11.70	89.00	11.20
December 11, 2017	5.50	5.50	5.50	5.50	5.50	5.50	December 11, 2017	99.00	12.60	99.00	12.60	99.00	12.50
January 4, 2018	2.40	2.50	2.60	3.50	3.60	2.90	January 4, 2018						

Appendix C-Sea Cage Site: Brine Island

Grieg NL Seafarms Ltd - Environmental Data

Sea Cage Site: Brine Island

Temperature							Dissolved Oxygen						
Date	Temperature (˚C) - Surface	Temperature (˚C) - 3m	Temperature (˚C)- 10m	Temperature (˚C) - 25m	Temperature (˚C) - 35m	Temperature (˚C) - 50m	Date:2	DO (%L) - 3m	DO (mg/L)-3m	DO (%L) - 15m	DO (mg/L)-15m	DO (%L) - 35m	DO (mg/L)-35m
June 25,2016		8.40	8.40	8.40	8.40	1.60	June 25,2016	111.90	10.74	109.40	10.53	107.80	10.38
July 8,2016		9.60	6.20	6.00	3.00	1.20	July 8,2016	112.50	10.49	108.90	12.08	102.30	11.90
July 20,2016		12.10	12.00	11.50	5.40	2.00	July 20,2016	111.90	9.81	110.00	9.67	115.80	11.81
July 26,2016		13.60	12.40	8.10	2.50	1.20	July 26,2016	113.00	9.63	110.50	9.47	113.00	12.39
August 3,2016		15.70	14.20	5.60	3.50	2.00	Aug. 3,2016	114.50	9.43	115.20	10.44	116.30	12.46
August 10,2016	16.05	16.05	16.00	14.80	2.75	0.50	Aug. 10,2016	109.70	8.95	108.70	8.87	116.50	12.75
August 20,2016	16.40	16.40	13.50	6.60	4.00	3.00	Aug. 20,2016	113.90	9.14	125.00	12.21	117.80	12.54
September 4,2016	15.40	15.40	13.00	6.70	5.30	4.80	Sept 4,2016	107.20	8.88	112.40	10.00	114.80	11.86
September 8,2016	14.60	14.60	14.40	12.00	8.20	2.20	Sept 8,2016	114.40	9.61	112.30	9.54	115.50	11.05
September 23,2016	13.20	13.20	13.20	13.00	9.90	5.50	Sept 23,2016	103.80	8.92	100.90	8.69	101.70	9.38
September 27,2016	13.00	13.00	13.00	11.70	9.80	6.40	Sept 27,2016	102.10	8.78	100.10	8.60	102.00	9.39
September 30,2016	11.30	11.30	11.00	7.80	6.10	4.00	Sept 30,2016	109.20	9.41	100.20	9.19	103.30	10.51
October 6,2016	11.70	11.70	11.50	11.60	10.00	6.40	Oct 6,2016	105.80	9.45	102.50	9.17	100.00	9.34
October 12,2016	11.40	11.40	11.40	11.00	10.20	7.00	Oct 12,2016	105.00	9.52	103.80	9.42	102.80	9.56
October 16,2016	10.90	10.90	11.00	8.00	6.80	6.60							
October 21,216	10.50	10.50	10.60	10.60	10.40	8.80	Oct 21,2016	104.40	9.65	102.00	9.39	100.40	9.31
October 26,2016	10.00	10.10	10.10	10.10	10.20	9.10	Oct 26,2016	102.40	9.42	101.70	9.36	101.40	9.30
October 31,2016	9.90	9.90	9.80	9.80	9.60	8.80							
November 4,2016	9.70	9.70	9.80	9.80	9.70	9.10							
November 8,2016	9.50	9.50	9.50	9.40	9.40	8.80							
November 15,2016	9.00	9.00	9.00	9.00	9.00	9.00	Nov 15,2016	90.70	8.63	90.10	8.57	90.90	8.64
November 23,2016	9.40	9.10	8.90	8.70	8.60	7.40	Nov 23,2016	97.00	9.03	94.80	8.87	93.20	8.78
November 30,2016	7.60	7.60	7.60	7.10	6.70	6.70	Nov 30,2016	94.20	9.18	93.40	9.11	93.60	9.33
December 8,2016	6.10	6.10	6.10	6.00	5.90	5.70	Dec 8,2016	98.10	9.79	97.10	9.68	96.10	9.64
December 14,2016	4.80	4.80	4.80	4.80	4.10	3.40	Dec 14,2016	97.30	10.16	95.60	9.99	94.10	9.99
December 31,2016	2.00	2.10	2.00	2.00	2.00	2.00	Dec 31,2016	102.10	11.26	101.40	11.19	99.40	10.98
May 23,2017	2.70	2.70	2.60	1.10	0.40	0.20	May 23,2017	100.00	13.60	101.00	14.00	99.00	14.40
June 3,2017	4.10	4.10	4.10	3.58	3.60	2.10	June 3,2017	103.00	13.50	102.00	13.40	103.00	13.60
June 7,2017	5.20	5.00	4.30	3.00	2.30	1.60	June 7,2017	108.00	13.80	107.00	14.00	106.00	14.50
June 16,2017	6.30	6.30	5.70	5.20	5.30	5.30	June 16,2017	104.00	12.90	105.00	13.40	103.00	13.30
June 23, 2017	7.00	7.00	6.70	6.40	6.30	4.70	June 23, 2017	96.00	11.60	95.00	11.70	95.00	11.80
June 30, 2017	8.20	8.10	7.90	6.70	6.30	5.50	June 30, 2017	108.00	12.90	108.00	13.00	107.00	13.30
July 21, 2017	13.00	13.00	12.50	8.20	3.60	2.00	July 21, 2017	105.00	11.00	104.00	11.20	105.00	14.00
July 27, 2017	12.00	11.90	11.50	5.50	3.40	2.00	July 27, 2017	111.00	12.00	113.00	13.20	110.00	14.60
August 3, 2017	15.90	15.90	14.60	7.00	4.70	2.90	August 3, 2017	108.00	10.80	114.00	12.60	115.00	15.00
August 11, 2017	16.10	16.00	15.90	13.10	6.10	3.30	August 11, 2017	106.00	10.50	106.00	10.60	117.00	14.70
August 19, 2017	15.10	15.10	6.80	2.80	1.50	0.90	August 19, 2017	96.00	9.70	107.00	14.20	100.00	14.20
August 26, 2017	16.00	15.70	14.30	11.10	2.10	1.70							
September 3, 2017	14.20	14.20	12.90	10.60	9.00	3.20							
September 9, 2017	13.60	13.50	13.50	13.20	11.30	1.90	September 9, 2017	100.00	10.60	96.00	10.10	99.00	10.90
September 15, 2017	13.40	13.40	12.90	12.20	9.50	4.20	September 15, 2017	103.00	10.80	100.00	10.70	100.00	11.40
September 22, 2017	13.80	13.80	13.80	13.00	10.00	2.70	September 22, 2017	99.00	10.30	98.00	10.30	97.00	11.00
September 30, 2017	13.10	13.10	13.10	9.40	3.70	1.70	September 30, 2017	93.00	9.80	93.00	9.80	99.00	13.10
October 7, 2017	12.00	12.00	12.00	12.10	11.20	8.30	October 7, 2017	97.00	10.50	96.00	10.40	95.00	10.40
October 13, 2017	11.80	11.80	11.60	11.10	7.60	7.00	October 13, 2017	94.00	10.40	94.00	10.40	95.00	11.60
October 19, 2017	11.00	11.00	11.00	11.00	10.70	6.60	October 19, 2017	98.00	10.80	95.00	10.60	94.00	10.90
October 28, 2017	10.30	10.30	10.10	9.50	9.20	9.10	October 28, 2017	97.00	10.90	96.00	11.00	94.00	10.90
November 2, 2017	10.00	10.00	10.00	9.90	8.90	7.40	November 2, 2017	100.00	11.60	99.00	11.50	97.00	11.50
November 13, 2017	8.60	8.60	8.60	7.70	6.60	5.20	Noveber 13, 2017	92.00	11.00	91.00	10.80	92.00	11.50
November 19, 2017	7.90	7.90	8.00	7.70	7.20	6.80	November 19, 2017	87.00	10.30	88.00	10.40	89.00	10.60
November 29, 2017	6.60	6.60	6.60	6.60	6.60	6.10	November 29, 2017	92.00	11.40	92.00	11.40	92.00	11.40
December 6, 2017	6.00	6.00	6.10	6.10	6.10	5.40	December 6, 2017	94.00	11.80	92.00	11.60	90.00	11.40
December 11, 2017	5.50	5.50	5.50	5.60	5.50	5.50	December 11, 2017	100.00	12.70	97.00	112.20	99.00	12.50
January 4, 2018	2.60	2.60	2.60	3.40	3.60	3.10	January 4, 2018						

Appendix C-Sea Cage Site: Ship Island

Grieg NL Seafarms Ltd - Environmental Data													
Sea Cage Site: Ship Island													
Temperature							Dissolved Oxygen						
Date	Temperature (˚C) - Surface	Temperature (˚C) - 3m	Temperature (˚C) - 10m	Temperature (˚C) - 25m	Temperature (˚C) - 35m	Temperature (˚C) - 50m	Date:2	DO (%L) - 3m	DO (mg/L)-3m	DO (%L) - 15m	DO (mg/L)-15m	DO (%L) - 35m	DO (mg/L)-35m
Feb. 24, 2016		0.10	0.70	0.90	0.90	1.00	Feb. 24, 2016	107.60	12.88	103.20	12.15	102.70	12.03
Mar. 7, 2016		0.30	0.60	0.60	0.70	0.80	Mar. 7, 2016	n/a	n/a	n/a	n/a	n/a	n/a
Mar.16, 2016		0.20	0.40	0.40	0.50	0.80	Mar.16, 2016	118.20	13.64	113.50	13.12	111.60	12.88
Mar. 27, 2016		0.50	0.30	0.30	0.30	0.40	Mar. 27, 2016	111.50	13.08	108.00	12.70	106.90	12.48
Apr. 12, 2016		1.20	0.90	0.90	0.90	0.60	Apr. 12, 2016	114.00	13.07	107.40	12.51	104.60	12.22
Apr. 17, 2016		3.90	1.80	0.90	0.50	0.40	Apr. 17, 2016	118.90	12.76	122.40	13.86	105.30	12.23
Apr. 28, 2016		1.90	1.50	0.60	0.40	0.30	Apr. 28, 2016	123.50	13.64	116.30	13.12	107.10	12.30
May 5, 2016		3.30	2.10	1.70	1.40	1.30	May 5, 2016	120.50	12.87	121.70	13.66	117.00	13.23
May 12,2016		3.80	3.30	2.40	2.00	1.00	May 12,2016	116.70	12.18	113.60	12.24	112.00	12.24
May 20,2016		5.40	4.80	3.50	2.50	1.60	May 20,2016	115.20	11.85	113.60	11.95	115.30	12.71
May 26,2016		5.40	3.50	2.20	1.20	0.50	May 26,2016	117.40	12.00	117.10	12.61	109.00	12.64
June 3,2016		6.70	6.20	3.20	1.60	0.80	June 3,2016	111.30	11.15	111.60	11.34	108.80	12.24
June 11,2016		7.90	7.40	1.90	1.40	0.90	June 11,2016	113.80	10.87	113.70	11.26	106.30	11.90
June 25,2016		9.60	9.00	7.50	4.30	0.80	June 25,2016	109.50	10.30	109.50	10.57	119.10	12.11
July 8,2016		11.10	10.80	7.50	4.70	0.10	July 8,2016	108.50	9.77	108.30	9.85	103.50	11.92
July 20,2016		9.90	9.40	7.50	5.20	2.30	July 20,2016	116.20	10.70	113.30	10.50	113.00	11.55
July 26,2016		13.10	12.60	11.50	3.50	1.00	July 26,2016	114.50	9.87	109.30	9.54	111.60	11.94
August 3,2016		16.00	15.20	12.20	3.10	1.90	Aug. 3,2016	112.30	9.21	115.20	10.02	108.70	11.78
August 10,2016	16.60	16.50	16.10	5.20	2.50	1.70	Aug. 10,2016	112.00	9.05	111.50	9.21	113.00	12.47
August 20,2016	17.30	17.30	17.10	3.90	2.40	1.10	Aug. 20,2016	109.90	8.78	116.80	10.18	110.60	12.25
September 4,2016	15.70	15.40	15.40	5.10	3.10	1.90	Sept 4,2016	105.40	8.77	105.10	8.75	111.80	12.21
September 9,2016	16.00	16.00	16.00	10.70	6.30	5.00	Sept 9,2016	110.30	8.99	105.90	8.97	115.40	11.56
September 23,2016	14.00	14.00	14.10	13.80	12.80	6.10	Sept 23,2016	101.90	8.64	102.90	8.72	100.10	8.71
September 27,2016	13.50	13.50	13.60	13.60	12.90	7.80	Sept 27,2016	99.00	8.44	97.80	8.30	96.20	8.29
October 1,2016	12.40	13.00	13.00	12.10	6.60	4.90	Oct 1,2016	101.20	8.83	98.70	8.60	104.00	10.44
October 6,2016	12.60	12.60	12.40	12.30	11.90	10.40	Oct 6,2016	109.70	9.56	106.40	9.34	102.00	9.06
October 13,2016	11.70	11.80	11.90	12.00	12.00	11.20	Oct 13,2016	102.20	9.18	100.70	9.03	99.50	8.91
October 16,2016	11.30	11.30	11.50	11.60	11.30	5.90	Oct 16,2016	104.00	9.21	104.20	9.27	103.50	9.24
October 21,2016	10.90	10.90	10.90	11.00	11.10	11.00	Oct 21,2016	100.20	9.20	100.20	9.19	99.80	9.13
October 25,2016	10.80	10.80	10.90	10.90	10.80	10.20	Oct 25,2016	108.20	9.77	105.10	9.47	103.40	9.33
October 31,2016	10.30	10.30	10.20	10.20	10.20	10.00							
November 4,2016	10.10	10.00	10.00	9.90	9.90	7.80							
November 8,2016	9.80	9.80	9.80	9.40	9.20	8.30							
November 15,2016	9.20	9.20	9.20	9.30	9.30	9.00	Nov 15,2016	90.00	8.50	90.10	8.50	87.20	8.22
November 23,2016	9.60	9.20	9.10	9.00	8.90	7.70	Nov 23,2016	95.30	88.20	93.10	8.63	91.60	8.54
November 30,2016	7.50	7.60	7.60	8.10	8.20	8.00	Nov 30,2016	93.90	9.18	93.20	9.09	91.60	8.92
December 8,2016	6.00	6.00	6.70	6.60	6.40	5.40	Dec 8,2016	98.30	9.88	95.20	9.44	92.40	9.20
December 14,2016	5.20	5.20	5.20	5.20	5.20	5.50	Dec 14,2016	92.40	9.57	91.20	9.44	89.70	9.27
December 23, 2016	4.30	4.30	4.30	4.30	4.10	3.90	Dec 22,2016	91.40	9.90	90.10	9.58	89.90	9.55
December 31,2016	2.50	3.10	3.20	3.30	3.30	3.40	Dec 31,2016	96.70	10.46	96.50	10.41	96.10	10.55
January 6,2017	3.00	3.00	3.00	3.30	3.40	3.30	Jan 6,2017	100.30	10.89	98.60	10.62	96.20	10.33
January 31,2017	1.00	1.00	1.00	1.10	1.10	1..4							
February 4,2017	0.20	0.20	0.50	1.20	1.40	1.40							
February 19,2017	0.80	0.70	0.70	0.80	0.90	0.80	Feb 19,2017	91.00	12.90	91.00	12.90	90.00	12.70
February 25,2017	0.60	0.60	0.50	0.50	0.30	0.20	Feb 25,2017	93.00	13.40	92.00	13.30	92.00	13.40
March 8,2017	-0.20	-0.20	0.00	0.10	0.10	0.40	Mar 8,2017	95.00	14.10	94.00	13.90	93.00	13.80
March 14,2017	-0.10	0.00	0.00	0.10	0.10	0.20	Mar 14,2017	96.00	14.40	96.00	14.30	95.00	14.20
March 19,2017	-0.20	-0.10	0.20	0.10	0.10	0.10	Mar 19,2017	99.00	14.80	97.00	14.40	95.00	14.20
March 25,2017	-0.20	-0.10	0.20	0.10	0.10	0.10	Mar 25,2017	93.00	13.70	92.00	13.50	90.00	13.20
April 6,2017	0.00	0.00	0.00	-0.10	-0.10	-0.10	Apr 6,2017	87.00	13.00	87.00	12.90	87.00	12.90
April 12,2017	0.70	0.70	0.40	0.00	0.00	-0.10	Apr 12,2017	91.00	13.20	92.00	13.60	91.00	13.40
April 23,2017	1.20	1.20	1.00	0.70	0.60	0.00	Apr 23,2017	90.00	12.80	90.00	12.90	90.00	12.90
April 26,2017	0.70	0.70	0.50	0.00	-0.10	-0.20	Apr 26,2017	90.00	13.10	88.00	13.10	85.00	12.80
May 3,2017	2.10	2.10	1.50	0.80	0.70	0.30	May 4,2017	112.00	15.30	110.00	15.40	105.00	15.00
May 13,2017	3.90	3.90	3.00	0.60	0.30	-0.10	May 13,2017	102.00	13.50	102.00	13.80	93.00	13.60
May 18,2017	3.00	3.00	1.60	0.40	0.20	0.00	May 18,2017	98.00	13.20	100.00	14.10	92.00	13.40
May 23,2017	3.60	3.50	2.80	2.50	1.60	0.10	May 23,2017	100.00	13.30	99.00	13.60	98.00	13.50
June 3,2017	5.10	4.70	4.60	3.00	2.60	1.80	June 3,2017	102.00	13.20	103.00	13.40	102.00	13.90
June 7,2017	6.90	6.30	5.10	3.60	2.20	1.30	June 7,2017	109.00	13.30	109.00	14.00	107.00	14.60
June 16,2017	7.10	6.90	6.80	4.90	2.80	1.20	June 16,2017	106.00	13.00	104.00	12.80	105.00	14.40
June 23, 2017	7.70	7.70	7.60	6.20	5.20	1.50	June 23, 2017	95.00	11.30	97.00	11.70	97.00	112.30
June 30, 2017	9.10	9.10	8.10	7.60	6.40	3.10	June 30, 2017	107.00	12.40	107.00	12.80	106.00	13.20
July 8, 2017	10.30	10.30	9.30	8.50	7.40	3.50	July 8, 2017	98.00	10.90	98.00	11.40	97.00	11.70
July 21, 2017	13.70	13.60	12.20	8.10	4.20	2.10	July 21, 2017	105.00	10.80	106.00	11.70	105.00	13.60
July 27, 2017	13.50	13.50	11.90	5.20	2.90	1.60	July 27, 2017	110.00	11.50	111.00	12.30	106.00	14.30
August 3, 2017	16.40	16.40	16.30	9.30	2.50	1.40	August 3, 2017	105.00	10.40	108.00	11.10	109.00	15.10
August 11, 2017	17.10	17.10	16.50	9.80	4.80	2.80	August 11, 2017	105.00	10.20	106.00	10.40	113.00	14.60
August 19, 2017	16.40	16.30	16.10	2.40	1.20	0.60	August 19, 2017	89.00	8.80	91.00	9.10	100.00	14.30
August 26, 2017	15.40	15.40	15.40	9.30	2.30	1.30							
September 3, 2017	14.40	14.50	14.30	9.40	7.00	2.00							
September 9, 2017	14.70	14.70	14.50	13.90	13.90	5.30	September 9, 2017	98.00	10.10	97.00	10.00	95.00	10.00
September 15, 2017	14.70	14.60	13.90	11.60	10.30	7.30	September 15, 2017	99.00	10.20	97.00	10.10	98.00	11.10
September 22, 2017	14.10	14.10	14.10	12.80	10.10	5.10	September 22, 2017	100.00	10.30	98.00	10.20	100.00	10.50
September 30, 2017	13.50	13.50	13.50	13.40	12.30	4.30	Septmeber 30, 2017	95.00	10.00	93.00	9.70	91.00	9.80
October 7, 2017	12.10	12.10	12.00	11.20	10.70	8.60	October 7, 2017	97.00	10.50	94.00	10.30	94.00	10.50
October 13, 2017	11.80	11.80	11.80	11.70	11.10	6.30	October 13, 2017	95.00	10.50	94.00	10.30	91.00	10.20
October 19, 2017	11.20	11.10	11.10	10.70	8.40	5.30	October 19, 2017	95.00	10.60	95.00	10.50	94.00	11.20
October 28, 2017	10.70	10.50	10.50	10.40	9.80	6.10	October 28, 2017	99.00	11.20	96.00	10.80	92.00	10.50
November 2, 2017	10.30	10.30	10.30	10.30	9.90	7.10	November 2, 2017	99.00	11.40	98.00	11.20	95.00	11.00
November 13, 2017	8.70	8.80	8.80	9.10	9.10	8.50	November 13, 2017	90.00	10.70	90.00	10.60	89.00	10.50
November 17, 2017	8.20	8.20	8.40	8.40	8.40	4.50	November 17, 2017	96.00	11.30	95.00	11.10	95.00	11.10
November 24, 2017	7.00	7.00	7.10	6.90	6.50	5.50	November 24, 2017	88.00	10.80	87.00	10.50	88.00	10.80
December 2, 2017	6.20	6.40	6.60	6.70	6.70	6.40	December 2, 2017	92.00	11.40	89.00	10.90	89.00	11.00
December 12, 2017	5.60	5.60	5.70	5.70	5.70	5.40	December 12, 2017	98.00	12.40	98.00	12.30	97.00	12.20
January 3, 2018	3.10	3.10	3.20	3.20	3.40	3.50	January 3, 2018	91.00	12.50	91.00	12.50	90.00	12.20
January 17, 2018	1.60	1.60	1.90	2.20	2.30	2.50	January 17, 2018	93.00	13.20	91.00	12.80	90.00	12.60
January 27, 2018	1.00	1.00	1.00	1.80	2.00	2.10	January 27, 2018	76.00	11.00	75.00	10.90	76.00	10.80
February 15, 2018	1.60	1.70	1.60	1.70	1.70	1.70	February 15, 2018	90.00	12.60	89.00	12.40	87.00	12.10
February 26, 2018	0.60	0.60	0.50	1.00	1.20	1.20	February 26, 2018	94.00	13.80	94.00	13.70	92.00	13.20

Appendix C-Sea Cage Site: Chamber's Island

Grieg NL Seafarms Ltd - Environmental Data

Sea Cage Site: Chamber's Island

Temperature							Dissolved Oxygen						
Date	Temperature (˚C) - Surface	Temperature (˚C) - 3m	Temperature (˚C) - 10m	Temperature (˚C) - 25m	Temperature (˚C) - 35m	Temperature (˚C) - 50m	Date:2	DO (%L) - 3m	DO (mg/L)-3m	DO (%L) - 15m	DO (mg/L)-15m	DO (%L) - 35m	DO (mg/L)-35m
Feb. 24, 2016		0.30	0.60	0.90	0.90	0.80	Feb. 24, 2016	104.10	12.26	101.20	11.86	108.60	12.86
Mar. 7, 2016		0.30	0.60	0.60	0.70	0.80	Mar. 7, 2016	n/a	n/a	n/a	n/a	n/a	n/a
Mar. 16, 2016		0.30	0.30	0.60	0.70	0.60	Mar. 16, 2016	118.20	13.64	113.50	13.12	111.60	12.88
Mar. 27, 2016		0.80	0.30	0.40	0.30	0.40	Mar. 27, 2016	113.50	13.17	108.20	12.72	105.20	12.39
Apr. 12, 2016		1.20	1.00	0.80	0.70	0.50	Apr. 12, 2016	115.80	13.34	109.70	12.77	104.30	12.22
Apr. 17, 2016		3.60	2.10	0.90	0.70	0.60	Apr. 17, 2016	122.70	13.16	121.50	13.86	108.20	12.51
Apr. 28, 2016		1.70	1.30	0.70	0.30	0.20	Apr. 28, 2016	127.30	13.96	120.50	13.50	108.50	12.47
May 5, 2016		3.40	2.50	1.80	1.20	1.10	May 5, 2016	125.20	13.37	122.30	13.76	112.90	12.90
May 12,2016		3.30	2.80	2.10	1.80	1.30	May 12,2016	114.30	12.11	112.70	12.24	111.20	12.28
May 20,2016		4.80	4.30	3.10	2.80	1.30	May 20,2016	118.40	12.33	115.30	12.25	115.40	12.65
May 26,2016		4.80	3.30	2.00	1.20	0.60	May 26,2016	120.50	12.53	116.40	12.61	109.90	12.46
June 3,2016		6.70	6.30	4.40	2.40	1.00	June 3,2016	119.50	11.99	114.10	11.55	114.20	12.67
June 11,2016		8.00	7.90	2.10	1.60	0.90	June 11,2016	115.90	11.07	111.10	10.96	106.60	11.87
June 25,2016		9.40	8.50	6.90	5.30	1.80	June 25,2016	110.60	10.41	110.70	10.66	111.80	11.58
July 8,2016		10.80	10.50	5.60	4.70	1.00	July 8,2016	111.80	10.17	108.90	9.95	103.10	11.87
July 20,2016		10.20	8.40	7.20	4.00	1.10	July 20,2016	113.70	10.34	111.20	10.61	108.90	11.45
July 26,2016		13.30	12.60	11.90	4.10	1.00	July 26,2016	114.80	9.85	111.40	9.75	103.70	11.42
August 3,2016		16.40	16.10	11.80	5.20	1.50	Aug. 3,2016	114.50	9.31	115.60	9.92	110.90	11.47
August 10,2016	16.20	16.10	14.80	5.50	2.70	1.70	Aug. 10,2016	13.50	9.47	13.70	9.74	108.50	11.90
August 20,2016	17.10	17.10	16.90	4.20	2.60	1.30	Aug. 20,2016	111.40	8.91	109.00	8.71	109.90	12.10
September 4,2016	15.30	15.30	15.20	4.70	3.10	1.70	Sept 4,2016	105.20	8.76	105.20	8.78	105.50	11.83
September 9,2016	15.60	15.60	15.50	11.10	7.10	5.10	Sept 9,2016	109.60	9.00	109.30	9.03	117.30	11.52
September 23,2016	14.10	14.00	13.90	13.70	13.10	7.10	Sept 23,2016	102.50	8.70	99.00	8.42	97.10	8.39
September 27,2016	13.50	13.50	13.50	13.60	12.50	8.00	Sept 27,2016	99.70	8.99	97.90	8.33	96.60	8.40
October 1,2016	13.10	13.00	13.10	13.10	7.90	3.40	Oct 1,2016	100.90	8.79	98.20	8.53	98.60	9.62
October 6,2016	12.50	12.40	12.20	11.90	11.00	10.40	Oct 6,2016	106.20	9.31	101.80	8.98	102.50	9.24
October 13,2016	11.90	11.90	12.00	11.90	11.80	11.10	Oct 13,2016	100.70	9.04	100.20	8.97	99.10	8.91
October 16,20164	11.30	11.50	11.60	11.50	11.50	8.20	Oct 16,2016	107.60	9.58	105.50	9.37	104.90	9.35
Octobe 21,2016	10.80	10.90	11.00	11.30	11.20	10.80	Oct 21,2016	101.70	9.34	100.20	9.16		
October 25,2016	10.90	10.90	10.90	10.90	10.80	10.50	Oct 25,2016	107.60	9.70	105.30	9.48	103.40	9.33
October 31,2016	10.20	10.20	10.10	10.00	9.80	9.40							
November 4,2016	10.00	10.10	10.00	10.00	9.80	7.90							
November 8,2016	9.60	9.60	9.60	9.30	8.90	7.50							
November 15,2016	9.10	9.10	9.10	9.00	9.00	8.90	Nov 15,2016	92.60	8.76	90.10	8.53	90.20	8.55
November 23,2016	9.20	9.20	9.10	9.00	8.90	8.40	Nov 23,2016	94.10	8.71	93.70	8.71	93.00	8.65
November 30,2016	7.40	7.40	7.60	8.20	8.20	8.20	Nov 30,2016	93.00	9.11	93.00	9.06	92.50	8.90
December 8,2016	6.40	6.40	6.40	6.40	6.50	5.40	Dec 8,2016	93.40	9.31	93.90	9.35	90.80	9.03
December 14,2016	5.30	5.30	5.30	5.30	5.30	5.50	Dec 14,2016	97.00	9.94	95.10	9.81	93.90	9.71
December 22,2016	4.30	4.30	4.30	4.20	4.20	4.40	Dec 22,2016	94.00	9.91	91.40	9.68	91.00	9.63
December 31,2016	2.90	3.00	3.30	3.30	3.30	3.30	Dec 31,2016	95.30	10.37	93.10	10.03	93.50	10.09
January 6,2017	3.00	3.00	3.00	3.00	3.30	3.20	Jan 6,2017	102.20	11.09	99.20	10.77	94.50	10.16
January 31,2017	1.00	1.10	1.10	1.40	1.50	1.50							
February 4,2017	0.30	0.30	0.40	1.00	1.40	1.60							
February 19,2017	0.70	0.70	0.70	0.80	0.80	0.70	Feb 19,2017	93.00	13.20	92.00	13.00	91.00	12.80
February 25,2017	0.60	0.60	0.60	0.60	0.50	0.80	Feb 25,2017	92.00	13.30	91.00	13.20	90.00	13.10
March 8,2017	0.00	0.10	0.30	0.30	0.30	0.30	Mar 8,2017	96.00	14.20	94.00	13.90	94.00	13.80
March 14,2017	-0.10	-0.10	0.00	0.10	0.10	0.10	Mar 14,2017	97.00	14.60	95.00	14.20	94.00	14.10
March 19,2017	0.00	0.00	0.10	0.10	0.10	0.10	Mar 19,2017	95.00	14.20	94.00	14.00	93.00	13.80
March 25,2017	0.00	0.10	0.20	0.10	0.10	0.00	Mar 25,2017	95.00	14.00	91.00	13.50	89.00	13.20
April 6,2017	0.10	0.10	0.10	0.00	0.00	-0.10	Apr 6,2017	89.00	13.10	87.00	12.90	87.00	12.90
April 12,2017	0.30	0.30	0.30	0.20	0.10	-0.10	Apr 12,2017	92.00	13.50	92.00	13.60	92.00	13.60
April 23,2017	1.60	1.50	0.90	0.60	0.40	0.00	Apr 23,2017	92.00	12.90	90.00	12.90	88.00	12.80
April 26,2017	1.20	1.10	0.50	0.10	0.00	-0.20	Apr 26,2017	95.00	13.80	90.00	13.30	87.00	13.10
May 3,2017	2.10	2.00	1.40	0.60	0.30	0.10	May 3,2017	113.00	15.50	108.00	15.30	101.00	14.60
May 13, 2017	4.30	4.30	3.30	1.20	0.50	0.10	May 13,2017	101.00	13.20	102.00	13.90	95.00	13.80
May 18,2017	2.40	2.40	1.80	0.70	0.20	-0.10	May 18,2017	101.00	13.80	100.00	14.00	94.00	13.60
May 23.2017	4.20	4.10	3.20	2.60	2.30	0.60	May 23,2017	100.00	13.20	99.00	13.60	98.00	13.50
June 3,2017	4.60	4.40	3.90	2.80	2.20	1.70	June 3,2017	103.00	13.40	104.00	13.80	102.00	14.00
June 7,2017	6.50	6.50	5.30	3.20	2.50	1.20	June 7,2017	108.00	13.30	108.00	13.90	107.00	14.50
June 16,2017	7.40	7.30	7.30	4.60	2.70	2.20	June 16,2017	105.00	12.90	102.00	12.60	104.00	14.40
June 23, 2017	7.40	7.20	6.90	5.90	5.10	1.60	June 23, 2017	97.00	11.80	97.00	11.90	98.00	12.40
June 30, 2017	8.00	8.00	7.60	7.00	6.30	2.10	June 30, 2017	108.00	12.90	106.00	12.90	105.00	13.20
July 8, 2017	9.40	9.40	9.10	7.70	6.40	4.20	July 8, 2017	99.00	11.40	98.00	11.50	97.00	12.00
July 21, 2017	13.80	13.00	10.60	8.20	4.10	2.90	July 21, 2017	105.00	11.10	104.00	11.70	104.00	13.60
July 27, 2017	12.80	12.80	11.40	4.80	2.40	1.30	July 27, 2017	111.00	11.80	111.00	12.20	106.00	14.50
August 3, 2017	15.90	15.90	15.30	5.40	1.90	1.00	August 3, 2017	106.00	10.60	108.00	11.20	108.00	15.20
August 11, 2017	16.30	16.30	15.30	9.90	4.30	3.30	August 11, 2017	106.00	10.50	110.00	11.70	111.00	14.50
August 19, 2017	16.60	16.20	15.90	3.30	1.90	1.30	August 19, 2017	86.00	8.50	86.00	8.60	99.00	13.80
August 26, 2017	15.30	15.30	15.10	14.80	3.50	1.20							
September 3, 2017	14.80	14.80	14.70	10.10	6.20	2.20							
September 9, 2017	14.60	14.60	14.50	14.40	14.20	9.80	September 9, 2017	98.00	10.00	97.00	10.00	97.00	10.00
September 15, 2017	14.60	14.60	14.00	12.00	9.20	4.80	September 15, 2017	98.00	10.00	97.00	10.10	99.00	11.40
September 22, 2017	14.10	14.10	13.80	12.60	11.40	5.20	September 22, 2017	100.00	10.30	98.00	10.20	96.00	10.50
September 30, 2017	13.60	13.60	13.50	13.50	13.50	3.40	September 30, 2017	93.00	9.80	92.00	9.60	92.00	9.60
October 7, 2017	12.30	12.30	12.30	11.70	10.90	8.30	October 7, 2017	96.00	10.10	93.00	10.00	94.00	10.40
October 13, 2017	11.70	11.70	11.70	11.60	10.60	6.70	October 13, 2017	95.00	10.50	94.00	10.40	91.00	10.30
October 19, 2017	11.30	11.30	11.20	11.00	8.70	4.80	October 19, 2017	96.00	10.70	95.00	10.60	95.00	11.20
October 28, 2017	10.60	10.50	10.50	10.40	9.60	6.80	October 28, 2017	98.00	11.10	94.00	10.60	91.00	10.50
November 2, 2017	10.50	10.30	10.20	10.30	9.90	9.50	November 2, 2017	100.00	11.60	97.00	11.20	96.00	11.00
November 13, 2017	8.90	8.90	8.90	9.00	9.00	9.10	November 13, 2017	91.00	10.80	89.00	10.50	88.00	10.40
November 17, 2017	8.20	8.20	8.30	8.30	8.30	8.50	November 17, 2017	95.00	11.20	95.00	11.20	95.00	11.20
November 24, 2017	7.00	7.00	6.90	6.40	6.20	5.50	November 24, 2017	89.00	10.60	88.00	10.70	88.00	10.90
December 2, 2017	6.30	6.30	6.60	6.60	6.70	6.80	December 2, 2017	90.00	11.20	90.00	11.10	89.00	11.00
December 12, 2017	5.70	5.70	5.70	5.80	5.80	5.50	December 12, 2017	98.00	12.30	97.00	12.20	97.00	12.20
January 3, 2018	3.30	3.30	3.30	3.50	3.60	3.50	January 3, 2018	89.00	12.10	84.00	11.40	78.00	10.60
January 17, 2018	1.80	1.90	2.20	2.30	2.30	2.50	January 17, 2018	92.00	12.10	90.00	12.60	89.00	12.50
January 27, 2018	1.10	1.00	1.30	2.00	2.00	2.10	January 27, 2018	80.00	11.60	79.00	11.20	77.00	10.80
February 15, 2018	1.40	1.40	1.50	1.70	1.50	1.70	February 15, 2018	91.00	12.60	89.00	12.40	88.00	12.40
February 26, 2018	0.40	0.40	0.40	1.00	1.50	1.50	February 26, 2018	96.00	14.10	94.00	13.60	91.00	13.00

Appendix C-Sea Cage Site: Valen Island

Grieg NL Seafarms Ltd - Environmental Data

Sea Cage Site: Valen Island

Temperature							Dissolved Oxygen						
Date	Temperature (˚C) - Surface	Temperature (˚C) - 3m	Temperature (˚C) - 10m	Temperature (˚C) - 25m	Temperature (˚C) - 35m	Temperature (˚C) - 50m	Date:2	DO (%L) - 3m	DO (mg/L)-3m	DO (%L) - 15m	DO (mg/L)-15m	DO (%L) - 35m	DO (mg/L)-35m
Feb. 24, 2016		0.50	0.60	0.80	0.70	0.60	Feb. 24, 2016	107.60	12.76	103.90	12.30	102.70	12.10
Mar. 7, 2016		0.10	0.70	0.60	0.70	0.70	Mar. 7, 2016	n/a	n/a	n/a	n/a	n/a	n/a
Mar. 16, 2016		0.40	0.30	0.50	0.50	0.60	Mar. 16, 2016	119.10	13.74	115.00	13.32	112.00	12.92
Mar. 27, 2016		0.40	0.30	0.30	0.20	0.30	Mar. 27, 2016	115.20	13.23	107.50	12.66	105.00	12.36
Apr. 12, 2016		1.30	0.90	0.80	0.80	0.50	Apr. 12, 2016	114.30	13.15	107.50	12.56	103.80	12.14
Apr. 17, 2016		2.50	2.00	0.90	0.70	0.60	Apr. 17, 2016	122.50	13.25	122.70	13.88	105.90	12.29
Apr. 28, 2016		1.60	1.40	0.60	0.40	0.20	Apr. 28, 2016	125.00	13.71	117.90	13.36	108.40	12.45
May 5, 2016		3.20	1.90	1.40	1.00	0.80	May 5, 2016	129.00	13.46	122.60	13.78	111.00	12.74
May 12,2016		3.40	2.40	1.70	1.50	1.40	May 12,2016	114.60	12.19	112.80	12.39	109.10	12.19
May 20,2016		5.10	3.90	2.90	2.30	1.70	May 20,2016	115.40	11.93	114.60	12.24	113.30	12.53
May 26,2016		4.40	3.30	1.80	1.20	0.50	May 26,2016	118.80	12.50	114.40	12.38	109.00	12.34
June 3,2016		6.50	6.10	5.50	2.00	0.40	June 3,2016	112.80	11.89	114.30	11.61	111.90	12.46
June 11,2016		7.70	7.40	2.00	1.40	0.90	June 11,2016	113.20	10.88	112.80	11.14	107.70	12.03
June 25,2016		9.80	9.00	7.00	6.10	1.60	June 25,2016	113.40	10.58	111.30	10.78	111.60	11.33
July 8,2016		10.70	10.40	7.80	5.30	1.20	July 8,2016	114.50	10.41	107.20	9.83	104.10	11.79
July 20,2016		10.70	9.70	7.30	4.50	1.90	July 20,2016	115.10	10.39	112.20	10.74	109.70	11.42
July 26,2016		13.20	12.70	10.80	6.00	4.00	July 26,2016	114.40	9.84	110.70	9.87	109.70	11.05
August 3,2016		16.40	15.60	11.80	6.10	1.70	Aug. 3,2016	112.4	9.18	114.3	9.58	112	11.34
August 10,2016	16.20	16.00	15.10	8.50	2.90	1.80	Aug. 10,2016	113.1	9.17	114.6	9.9	111.3	12.17
August 20,2016	17.10	17.00	16.70	3.80	2.20	1.10	Aug. 20,2016	112.3	9.01	109.8	8.87	111	12.3
September 4,2014	15.30	15.30	15.20	5.40	3.40	2.10	Sept 4,2016	107.5	8.97	105.4	8.84	111.5	12.07
September 9,2016	15.80	15.80	15.80	11.60	7.70	5.20	Sept 9,2016	110.5	9.03	110.6	9.22	116.3	11.26
September 23,2016	14.40	14.20	14.00	13.90	12.60	7.70	Sept 23,2016	100.8	8.51	98	8.29	97.2	8.46
September 27,2016	13.80	13.80	13.70	13.60	11.80	6.30	Sept 27,2016	98.2	8.29	95.6	8.11	96.2	8.5
October 1,2016	13.10	13.40	13.10	13.00	10.20	5.80	Oct 1,2016	101.3	8.82	95.9	8.35	96.7	8.99
October 6,2016	12.50	12.50	12.40	11.90	11.20	9.10	Oct 6,2016	106.7	9.34	103.2	9.08	102.4	9.2
October 13,2016	11.80	11.80	11.80	11.60	11.60	11.60	Oct 13,2016	100.9	9.06	98.8	8.97	98.5	8.89
October 16,2016	11.40	11.40	11.40	11.40	11.50	7.10	Oct 16,2016	105.8	9.43	103.7	9.23	103	9.18
October 21,2016	10.90	11.00	11.00	11.10	11.00	10.90	Oct 21,2016	104.1	9.55	101.3	9.29	100.5	9.22
October 25,2016	10.70	10.70	10.80	10.80	10.50	10.40	Oct 25,2016	99.2	8.97	98.4	8.88	99	8.98
October 31,2016	10.20	10.20	10.20	9.60	9.50	9.60							
November 4,2016	9.90	10.00	9.90	9.90	9.80	8.70							
November 8,2016	9.20	9.20	9.50	9.20	8.90	7.80							
November 15,2016	8.90	8.90	8.90	8.90	8.90	8.20	Nov 15,2016	89.3	8.5	89.7	8.51	89.6	8.51
November 23,2016	9.30	9.20	9.10	9.00	8.90	8.20	Nov 23,2016	92.1	8.51	90.7	8.42	91	8.47
November 30,2016	7.50	7.50	7.60	7.90	8.10	8.10	Nov 30,2016	94	9.2	93.6	9.11	92.7	8.94
December 8,2016	6.30	6.30	6.50	6.60	6.40	5.00	Dec 9,2016	94.3	9.41	93.5	9.28	91.9	9.14
December 14,2016	5.30	5.30	5.30	5.30	5.40	5.50	Dec 14,2016	93.2	9.6	91.6	9.43	90.3	9.28
December 22,2016	4.30	4.30	4.30	4.30	4.00	3.70							
December 31,2016	3.00	3.00	3.30	3.30	3.40	3.20	Dec 31,2016	97.9	10.65	95.4	10.3	94.1	10.15
January 6,2017	2.50	2.60	2.60	2.50	2.70	2.70	Jan 6,2017	99.7	10.89	100.1	10.98	98.7	10.77
January 31,2017	1.00	1.00	1.00	1.10	1.30	1.60							
February 4,2017	0.50	0.60	0.70	0.70	1.30	1.60							
February 19,2017	0.60	0.60	0.60	0.70	0.80	0.60	Feb 19,2017	96	13.6	94	13.3	92	12.9
February 25,2017	0.60	0.60	0.70	0.70	0.60	0.50	Feb 25,2017	93	13.4	92	13.3	90	13.1
March 8,2017	0.20	0.20	0.20	0.30	0.30	0.30	Mar 8,2017	96	14.1	93	13.7	93	13.6
March 14,2017	-0.10	-0.10	0.00	0.00	0.10	0.10	Mar 14,2017	97	14.5	95	14.2	95	14.1
March 19,2017	0.00	0.00	0.20	0.10	0.10	0.10	Mar 19,2017	97	14.4	95	14.1	93	13.8
March 25,2017	0.00	0.00	0.20	0.10	0.10	0.00	Mar 25,2017	93	13.8	91	13.5	90	13.2
April 6,2017	0.20	0.10	0.10	0.00	0.00	-0.10	Apr 6,2017	90	13.3	88	13	88	13
April 12,2017	0.30	0.30	0.20	0.00	-0.10	-0.10	Apr 12,2017	92	13.6	92	13.6	91	13.5
April 23,2017	1.40	1.40	1.20	1.00	0.20	-0.10	Apr 23,2017	91	12.9	92	12.9	88	12.9
April 26,2017	1.50	1.40	0.70	0.10	-0.10	-0.20	Apr 26,2017	96	13.8	92	13.6	86	13
May 3,2017	2.30	2.50	1.60	0.60	0.40	0.20	May 3,2017	116	15.7	111	15.5	103	14.7
May 13,2017	4.60	4.60	3.60	1.00	0.50	0.10	May 13,2017	100	13.9	101	13.6	93	13.6
May 18,2017	2.80	2.80	1.80	0.20	0.00	0.00	May 18,2017	102	13.7	104	14.6	91	13.3
May 23,2017	4.10	3.90	3.10	3.00	2.40	0.70	May 23,2017	100	13.2	98	13.3	99	13.6
June 3,2017	4.20	3.80	3.60	2.40	1.90	1.50	June 3,2017	103	13.6	102	13.6	101	14
June 7,2017	7.00	5.80	5.20	2.70	2.00	1.80	June 7,2017	108	13.6	107	13.7	105	14.4
June 16,2017	7.40	7.40	6.60	4.80	3.20	1.60	June 16,2017	105	12.7	104	12.9	105	14.3
June 23, 2017	7.50	7.40	7.20	5.40	5.10	2.40	June 23, 2017	97	11.7	98	11.9	98	12.5
June 30, 2017	9.00	8.20	7.80	6.80	6.80	6.70	June 30, 2017	107	12.7	107	13	105	13
July 8, 2017	9.10	9.10	8.30	6.70	6.00	3.70	July 8, 2017	97	11.2	97	11.5	95	12
July 21, 2017	13.50	12.50	10.60	8.80	4.90	2.00	July 21, 2017	109	11.4	105	11.9	106	13.6
July 27, 2017	13.80	13.80	12.10	6.20	2.90	1.60	July 27, 2017	111	11.5	112	12.8	107	14.4
August 3, 2017	15.60	15.60	15.40	4.00	1.90	1.10	August 3, 2017	106	10.8	107	11.2	107	15.1
August 11, 2017	16.20	16.20	14.80	7.70	5.20	2.80	August 11, 2017	108	10.7	110	11.7	109	14.1
August 19, 2017	16.20	16.10	15.60	8.90	2.00	0.90	August 19, 2017	83	8.2	87	8.8	103	19.3
August 26, 2017	15.50	15.50	15.30	14.30	8.30	2.10							
September 3, 2017	15.00	15.00	14.90	9.00	4.90	2.90							
September 9, 2017	14.60	14.40	14.20	13.90	13.50	11.30	September 9, 2017	100	10.3	97	10.1	97	10.2
September 15, 2017	14.50	14.30	14.20	12.80	10.50	9.70	September 15, 2017	98	10.1	95	9.9	98	11
September 22, 2017	14.00	14.00	14.00	13.10	10.90	3.30	September 22, 2017	100	10.4	99	10.2	96	10.6
September 30, 2017	13.60	13.60	13.60	13.50	13.00	3.60	September 30, 2017	94	9.8	89	9.3	90	9.5
October 7, 2017	12.40	12.40	12.40	12.20	11.80	8.00	October 7, 2017	95	10.2	94	10.1	92	10
October 13, 2017	11.80	11.80	11.70	11.60	11.00	5.50	October 13, 2017	93	10.2	94	10.3	92	10.3
October 19, 2017	11.40	11.20	11.20	11.10	8.20	4.40	October 19, 2017	97	10.8	96	10.6	95	11.3
October 28, 2017	10.40	10.30	10.40	10.40	9.00	6.60	October 28, 2017	97	10.9	94	10.6	93	10.8
November 2, 2017	10.50	10.50	10.40	10.20	9.70	8.90	November 2, 2017	98	11.2	98	11.2	96	11.1
November 13, 2017	8.60	8.60	8.60	9.00	9.00	8.30	November 13, 2017	90	10.7	90	10.6	89	10.5
November 17, 2017	8.30	8.30	8.30	8.30	8.30	7.10	November 17, 2017	95	11.2	95	11.2	95	11.2
November 24, 2017	6.90	6.90	6.90	6.50	6.00	5.40	November 24, 2017	88	10.7	88	10.7	88	11
December 2, 2017	6.50	6.50	6.50	6.50	6.60	6.60	December 2, 2017	87	10.8	88	10.9	89	10.7
December 12, 2017	5.70	5.70	5.70	5.70	5.70	5.40	December 12, 2017	100	12.6	98	12.3	97	12.2
January 3, 2018	3.30	3.40	3.40	3.50	3.60	3.60	January 3, 2018	92	12.6	92	12.5	91	12.3
Janurary 17, 2018	1.90	2.00	2.20	2.30	2.30	2.40	January 17, 2018	91	12.9	90	12.6	89	12.4
January 27, 2018	1.20	1.20	1.50	2.20	2.20	2.80	January 27, 2018	81	11.6	77	10.9	76	10.6
February 15, 2018	1.40	1.50	1.50	1.60	1.50	1.60	February 15, 2018	91	12.7	89	12.5	88	12.3
February 26, 2018	0.50	0.50	0.60	0.90	1.20	1.60	February 26, 2018	96	14.1	93	13.5	92	13.2

Appendix C-Sea Cage Site: Darby Harbour

Grieg NL Seafarms Ltd - Environmental Data

Sea Cage Site: Darby Harbour

Temperature							Dissolved Oxygen						
Date	Temperature (˚C) - Surface	Temperature (˚C) - 3m	Temperature (˚C)- 10m	Temperature (˚C) - 25n	mperature (˚C) -	Temperature (˚C) - 50m	Date:2	DO (%L) - 3m	DO (mg/L)-3m	DO (%L) - 15m	DO (mg/L)-15m	DO (%L) - 35m	DO (mg/L)-35m
Mar. 11, 2016		0.40	0.40	0.50	0.50	0.40	Mar. 11, 2016	115.4	13.36	113.40	13.10	109.10	12.59
Mar. 16, 2016		0.30	0.20	0.20	0.20	0.30	Mar. 16, 2016	118.8	13.80	116.60	13.62	114.60	13.36
Mar. 27, 2016		0.20	0.30	0.20	0.20	0.20	Mar. 27, 2016	112.2	13.12	108.80	12.84	107.00	12.65
Apr. 12, 2016		1.10	1.10	1.00	0.80	0.50	Apr. 12, 2016	117.4	13.57	113.70	13.17	109.20	12.70
Apr. 17, 2016		2.50	2.40	1.20	0.80	0.40	Apr. 17, 2016	123.1	13.74	122.80	13.69	108.50	12.55
Apr. 28, 2016		1.40	1.00	0.90	0.80	0.30	Apr. 28, 2016	122.3	13.67	117.00	13.28	111.20	12.70
May 5, 2016		3.00	2.10	1.20	0.90	0.50	May 5, 2016	124.8	13.33	123.10	13.64	109.60	12.57
May 12, 2016		2.90	2.60	2.30	1.90	1.20	May 12,2016	116.3	12.50	114.80	12.49	113.60	12.50
May 20,2016		5.30	4.50	3.80	3.00	1.60	May 20,2016	115.3	11.83	113.70	11.20	115.30	12.57
May 26,2016		6.20	5.10	2.80	1.80	0.60	May 26,2016	115.6	11.60	115.60	12.05	114.00	12.74
June 3,2016		5.90	5.70	4.70	2.20	1.10	June 3,2016	113.3	11.57	111.30	11.44	111.70	12.40
June 11,2016		7.70	7.60	3.30	1.70	1.00	June 11,2016	113.6	11.22	110.80	10.94	112.40	12.44
June 25,2016		7.40	7.20	6.10	3.80	1.80	June 25,2016	116.0	11.40	112.20	11.17	111.20	11.95
July 8,2016		11.00	10.90	5.00	3.20	1.60	July 8,2016	111.9	10.00	109.60	10.01	103.30	12.05
July 20,2016		10.20	9.50	6.90	4.30	1.60	July 20,2016	114.8	10.50	114.80	10.97	115.70	12.02
July 26,2016		12.80	11.70	9.90	4.40	1.30	July 26,2016	113.5	9.85	113.00	10.08	115.90	12.08
August 3,2016		15.20	15.00	10.90	3.50	1.40	Aug. 3,2016	113.6	9.46	113.50	9.58	115.50	12.43
August 10,2016	14.00	13.90	13.80	6.70	3.30	1.40	Aug. 10,2016	112.4	9.58	112.00	9.66	110.00	11.91
August 20,2016	17.00	17.00	16.90	6.00	3.00	1.30	Aug. 20,2016	112.3	9.00	110.70	8.92	115.50	12.57
September 4,2016	15.30	15.40	15.40	9.90	3.30	1.70	Sept 4,2016	106.6	8.86	105.20	8.74	112.20	12.20
September 9,2016	15.60	15.60	15.60	10.90	8.50	5.00	Sept 9,2016	109.0	8.95	109.60	9.05	112.50	10.71
September 23,2016	13.20	13.20	13.20	13.00	11.80	5.90	Sept 23,2016	102.3	8.81	99.30	8.59	98.20	8.73
September 27,2016	13.20	13.20	13.20	13.10	12.90	7.10	Sept 27,2016	103.8	8.88	9.99	8.56	97.00	8.35
October 1,2016	12.30	12.30	12.30	12.10	8.50	4.50	Oct 1,2016	102.0	9.03	101.20	8.95	103.60	9.95
October 6,2016	11.90	11.90	11.70	11.70	11.70	11.00	Oct 6,2016	110.5	9.80	104.70	9.33	102.00	9.08
October 12,2016	11.60	11.50	11.50	11.60	11.60	11.20	Oct 12,2016	103.9	9.39	102.90	9.29	100.50	9.08
October 16,2016	11.30	11.30	11.40	11.40	11.40	6.80	Oct 16,2016	109.2	9.77	106.90	9.56	105.80	9.46
October 21,2016	10.90	10.90	10.90	10.90	10.80	10.80	Oct 21,2016	103.6	9.51	102.50	9.41	102.00	9.38
October 25,2016	10.40	10.50	10.60	10.70	10.70	9.80	Oct 25,2016	105.1	9.55	104.10	9.46	102.00	9.25
October 31,2016	10.10	10.10	9.70	9.60	9.60	9.20							
November 4,2016	10.00	10.00	9.90	9.80	9.60	9.50							
November 8,2016	9.50	9.40	9.40	9.30	9.10	8.70							
November 15,2016	9.00	9.00	9.10	9.00	9.00	7.90	Nov 15,2016	91.7	8.71	88.20	8.35	88.90	8.44
November 23,2016	9.20	9.30	9.10	8.90	8.80	7.40	Nov 23,2016	96.4	8.94	93.90	8.75	92.90	8.70
November 30,2016	8.10	8.10	8.10	8.10	8.00	6.70	Nov 30,2016	91.1	8.79	89.80	8.66	91.20	8.82
December 8,2016	6.60	6.60	6.60	6.60	6.60	6.60	Dec 8,2016	93.4	9.24	92.80	9.18	93.30	9.22
December 14,2016	5.50	5.40	5.40	5.40	5.40	5.50	Dec 14,2016	93.9	9.67	93.10	9.59	92.40	9.52
December 26,2016	3.70	3.70	3.70	3.70	3.80	3.80	Dec 26,2016	90.7	9.78	89.70	9.66	89.80	9.66
December 31,2016	3.10	3.00	3.30	3.30	3.80	2.50	Dec 31,2016	101.2	10.41	98.40	10.54	96.90	10.49
January 6,2017	2.50	2.50	2.50	2.50	2.50	2.60	Jan 6,2017	101.6	11.18	100.40	11.05	98.60	10.83
January 30,2017	1.30	1.40	1.40	1.40	1.40	1.50							
February 4,2017	0.60	0.60	0.70	0.90	1.00	1.20							
February 19,2017	0.60	0.60	0.60	0.60	0.60	0.30	Feb 19,2017	92.0	13.10	90.00	12.90	90.00	12.60
February 25,2017	0.40	0.40	0.20	0.00	0.00	0.00	Feb 25,2017	94.0	13.60	93.00	13.50	91.00	13.40
March 8,2017	0.10	0.20	0.20	0.10	0.00	0.00	Mar 8,2017	95.0	14.10	95.00	13.90	94.00	13.80
March 14,2017	-0.20	-0.20	-0.10	-0.10	-0.10	-0.10	Mar 14,2017	99.0	14.90	99.00	14.80	98.00	14.60
March 19,2017	0.00	0.00	0.10	0.10	0.00	-0.10	Mar 19,2017	95.0	14.20	95.00	14.10	94.00	14.00
March 24,2017	0.20	0.20	0.20	0.10	-0.10	-0.20	Mar 24,2017	95.0	13.90	94.00	13.90	91.00	13.60
April 6,3017	-0.10	-0.10	-0.10	-0.10	-0.20	-0.20	Apr 6,2017	91.0	13.50	90.00	13.40	89.00	13.20
April 12,2017	0.10	0.10	0.10	-0.10	-0.10	-0.20	Apr 12,2017	94.0	13.80	94.00	13.80	92.00	13.60
April 22,2017	1.00	1.00	1.00	0.70	0.70	0.00	Apr 22,2017	98.0	14.00	97.00	13.90	93.00	13.30
April 26,2017	0.70	0.70	0.50	0.00	-0.20	-0.40	Apri 26,2017	95.0	13.90	91.00	13.50	86.00	13.00
May 3,2017	1.50	1.50	1.40	1.00	0.90	0.10	May 3,2017	112.0	15.70	108.00	15.30	107.00	15.20
May 13,2017	3.40	3.40	3.30	3.10	0.40	0.20	May 13,2017	104.0	14.00	104.00	14.00	104.00	15.10
May 19,2017	2.00	1.90	1.50	0.60	0.30	0.10	May 19,2017	104.0	14.40	105.00	14.90	100.00	14.40
May 23,2017	3.50	3.40	3.40	2.90	2.40	1.70	May 23,2017	100.0	13.40	99.00	13.40	99.00	13.70
June 3,2017	3.80	3.60	3.40	2.80	2.20	1.40	June 3,2017	103.0	13.70	102.00	13.70	102.00	14.00
June 7,2017	5.80	5.00	4.40	2.20	1.40	1.00	June 7,2017	107.0	13.70	107.00	14.00	102.00	14.50
June 16,2017	6.60	6.60	6.50	4.60	2.90	1.70	June 16,2017	106.0	13.10	104.00	13.10	103.00	14.10
June 23, 2017	5.80	5.80	5.40	4.50	3.90	2.70	June 23, 2017	97.0	12.10	98.00	12.40	98.00	12.80
July 1, 2017	7.70	7.70	6.40	5.80	5.30	3.10	July 1, 2017	109.0	13.10	109.00	13.70	108.00	13.90
July 9, 2017	8.30	8.30	7.80	6.90	6.40	4.60	July 9, 2017	98.0	11.60	98.00	11.60	98.00	12.10
July 21, 2017	11.70	10.90	10.40	7.50	4.30	2.20	July 21, 2017	108.0	11.90	107.00	12.20	105.00	13.60
July 27, 2017	12.20	12.20	10.20	4.90	2.30	1.20	July 27, 2017	111.0	11.90	113.00	12.90	105.00	14.50
August 3, 2017	15.70	15.70	15.10	6.00	2.50	1.50	August 3, 2017	108.0	10.80	111.00	11.70	109.00	15.00
August 11, 2017	16.70	16.70	15.50	10.20	4.80	2.90	August 11, 2017	105.0	10.30	111.00	11.60	110.00	14.20
August 19, 2017	15.80	15.80	15.60	6.60	1.60	1.10	August 19, 2017	95.0	9.50	97.00	9.70	105.00	15.10
August 26, 2017	15.70	15.20	14.60	9.60	3.00	2.20							
September 3, 2017	13.90	13.90	13.70	13.30	7.50	2.50							
September 9, 2017	13.20	13.10	13.00	12.80	11.80	4.70	September 9, 2017	100.0	10.60	98.00	10.40	96.00	10.50
September 16, 2017	13.60	13.60	13.00	11.80	9.70	5.70	September 16, 2017	101.0	10.50	99.00	10.50	99.00	11.30
September 22, 2017	13.40	13.40	13.40	12.00	9.90	4.20	September 22, 2017	99.0	10.40	98.00	10.30	96.00	11.00
September 30, 2017	13.20	13.20	13.10	13.10	9.60	3.10	September 30, 2017	95.0	10.10	93.00	9.90	93.00	10.70
October 7, 2017	12.10	12.10	11.90	10.00	8.40	5.30	October 7, 2017	94.0	10.20	94.00	10.30	96.00	11.30
October 13, 2017	11.80	11.80	11.60	11.50	10.60	6.10	October 13, 2017	94.0	10.40	94.00	10.40	91.00	10.30
October 19, 2017	11.00	11.00	11.00	10.70	8.90	5.30	October 19, 2017	95.0	10.60	96.00	10.60	95.00	11.10
October 28, 2017	10.30	10.30	10.30	10.10	8.20	4.80	October 28, 2017	97.0	10.90	93.00	10.60	95.00	11.20
November 2, 2017	10.20	10.20	10.20	10.10	9.10	6.70	November 2, 2017	98.0	11.30	97.00	11.20	96.00	11.30
November 13, 2017	8.70	8.70	8.70	8.70	8.70	8.50	November 13, 2017	92.0	10.90	92.00	10.90	91.00	10.80
November 19, 2017	7.80	7.90	7.90	7.80	7.20	6.80	November 19, 2017	89.0	10.60	88.00	10.40	88.00	10.70
November 28, 2017	6.80	6.80	6.80	6.80	6.70	6.50	November 28, 2017	92.0	11.40	92.00	11.30	89.00	11.00
December 6, 2017	6.00	6.00	6.10	6.10	6.10	5.50	December 6, 2017	95.0	11.90	92.00	11.50	92.00	11.50
December 12, 2017	5.70	5.70	5.80	5.80	5.80	5.70	December 12, 2017	99.0	12.50	99.00	12.40	98.00	12.30
January 4, 2018	2.90	2.90	3.00	3.60	3.70	3.30	January 4, 2018						
January 17, 2018	1.90	2.00	2.10	2.20	2.20	2.10	January 17, 2018	90.0	12.70	90.00	12.70	89.00	12.60
January 27, 2018	1.30	1.30	1.30	1.50	1.50	1.80	January 27, 2018	79.0	11.30	78.00	11.30	78.00	11.10
February 15, 2018	1.10	1.10	1.00	1.20	1.30	1.30	February 15, 2018	93.0	13.20	92.00	13.00	90.00	12.80
February 26, 2018	0.40	0.40	0.40	0.40	0.50	0.60	February 26, 2018	93.0	13.60	92.00	13.60	92.00	13.30

Appendix C-Sea Cage Site: Red Island

Grieg NL Seafarms Ltd - Environmental Data

Sea Cage Site: Red Island

Temperature								Dissolved Oxygen					
Date	Temperature (˚C) - Surface	Temperature (˚C) - 3m	Temperature (˚C)- 10m	Temperature (˚C) - 25m	Temperature (˚C) - 35m	Temperature (˚C) - 50m	Date:2	DO (%L) - 3m	DO (mg/L)-3m	DO (%L) - 15m	DO (mg/L)-15m	DO (%L) - 35m	DO (mg/L)-35m
Mar.11, 2016		0.30	0.40	0.50	0.50	0.50	Mar. 11, 2016	113.20	13.09	110.50	12.78	106.30	12.24
Mar. 16, 2016		0.20	0.30	0.30	0.30	0.30	Mar. 16, 2016	123.00	14.30	118.50	13.74	115.20	13.39
Mar. 27, 2016		0.20	0.20	0.30	0.30	0.30	Mar. 27, 2016	113.50	13.37	109.60	12.95	105.60	12.40
Apr. 12, 2016		1.30	1.20	1.10	0.90	0.30	Apr. 12, 2016	118.40	13.56	113.30	13.02	107.50	12.54
Apr. 17, 2016		2.30	1.80	0.70	0.50	0.30	Apr. 17, 2016	126.00	14.12	120.30	13.77	104.60	12.25
Apr. 28, 2016		2.00	1.90	1.00	0.50	0.20	Apr. 28, 2016	125.50	13.87	123.00	13.67	106.90	12.27
May 5, 2016		2.90	2.20	1.00	0.80	0.40	May 5, 2016	124.80	13.52	122.80	13.82	114.40	12.62
May 12,2016		3.80	3.30	2.80	2.10	0.50	May12,2016	115.00	12.20	114.90	12.33	113.90	12.52
May 20,2016		5.30	5.40	4.30	1.90	0.90	May 20,2016	114.10	11.71	112.50	11.72	113.90	12.69
May 26,2016		6.90	6.00	3.20	1.80	0.50	May 26,2016	117.40	11.51	116.50	12.01	111.50	12.43
June 3,2016		6.20	6.10	2.80	1.70	0.90	June 3,2016	117.00	11.87	118.30	11.70	111.20	12.60
June 11,2016		8.00	8.00	2.70	1.80	0.90	June 11,2016	113.60	10.85	110.80	10.59	111.70	12.38
June 25,2016		8.50	8.10	6.00	3.50	1.80	June 25,2016	114.40	11.00	111.70	10.95	111.30	12.02
July 8,2016		11.00	10.50	4.60	3.50	1.20	July 8,2016	109.00	9.85	109.40	10.10	106.50	12.03
July 20,2016		11.20	10.60	6.00	3.50	1.20	July 20,2016	113.90	10.19	112.50	10.51	111.40	11.88
July 26,2016		12.80	12.20	11.40	5.10	2.20	July 26,2016	114.10	9.87	112.80	10.01	115.10	11.83
August 3,2016		15.30	15.30	7.20	2.70	1.40	Aug. 3,2016	115.20	9.57	117.30	10.12	111.40	12.26
August 10,2016	15.50	15.30	14.70	9.20	2.50	1.10	Aug. 10,2016	113.50	9.40	111.60	9.38	110.30	12.17
August 20,2016	17.20	17.20	17.20	5.10	2.60	1.00	Aug. 20,2016	112.50	8.98	110.30	10.05	111.60	12.27
September 4,2016	15.40	15.40	15.40	6.30	2.80	1.60	Sept 4,2016	107.40	8.92	105.80	8.78	109.10	11.97
September 9,2016	15.80	15.90	15.90	10.20	6.70	4.70	Sept 9,2016	106.50	8.95	110.00	8.99	116.20	11.54
September 23,2016	13.70	13.70	13.70	13.30	13.00	6.00	Sept 23,2016	102.90	8.76	100.60	8.62	98.50	8.53
September 27,2016	13.50	13.50	13.50	13.50	11.40	5.30	Sept 27,2016	98.50	8.38	97.90	8.33	97.70	8.62
October 1,2016	13.00	13.00	12.90	12.70	8.20	3.10	Oct 1,2016	101.70	8.88	97.90	8.57	101.80	9.83
October 6,2016	12.20	12.20	11.90	11.90	11.90	11.30	Oct 6,2016	107.00	9.43	103.40	9.17	101.00	8.95
October 12,2016	11.90	11.90	11.90	11.80	11.50	7.30	Oct 12,2016	104.50	9.37	102.00	9.17	100.30	9.07
October 16,2016	11.50	11.50	11.50	11.60	9.70	5.80	Oct 16,2016	106.30	9.48	105.70	9.42	104.30	9.64
October 21,2016	11.00	11.00	11.00	11.10	11.10	11.00	Oct 21,2016	103.40	9.47	101.30	9.26	100.20	9.17
October 25,2016	10.80	10.80	10.80	10.90	10.80	10.30	Oct 25,2016	106.90	9.66	102.90	9.30	99.60	9.00
October 31,2016	10.00	10.00	9.90	9.90	9.80	9.20							
November 4,2016	10.10	10.00	9.90	9.80	9.70	9.10							
November 8,2016	9.30	9.30	9.50	9.50	9.50	8.80							
November 15,2016	9.00	9.00	9.00	9.00	9.10	6.80	Nov 15,2016	92.40	8.77	88.30	8.38	86.50	8.20
November 23,2016	9.20	9.20	9.20	9.00	8.80	7.50	Nov 23,2016	94.40	8.75	91.40	8.51	90.00	8.42
November 30,2016	8.00	7.90	8.00	8.00	7.90	5.90	Nov 30,2016	94.10	9.12	92.10	8.91	90.70	8.79
December 8,2016	6.60	6.60	6.60	6.70	6.80	6.70	Dec 8,2016	93.50	9.25	92.50	9.14	92.10	9.08
December 14,2016	5.50	5.50	5.50	5.50	5.40	5.10	Dec 14,2016	91.70	9.44	89.00	9.17	90.60	9.33
December 26,2016	3.60	3.60	3.60	3.70	3.70	3.70	Dec 26,2016	90.10	9.72	88.90	9.58	88.50	9.53
December 31,2016	2.90	3.00	3.20	3.30	3.10	3.10	Dec 31,2016	96.70	10.46	97.40	10.45	95.70	10.32
January 6,2017	2.60	2.60	2.60	2.60	2.60	2.60	Jan 6,2017	100.80	11.07	99.30	10.90	99.10	10.88
January 30,2017	1.20	1.20	1.20	1.20	1.30	1.60							
February 4,2017	0.30	0.40	0.50	0.60	1.30	1.20							
February 19,2017	0.50	0.50	0.50	0.50	0.50	0.70	Feb 19,2017	93.00	13.20	92.00	13.00	91.00	12.80
February 25,2017	0.50	0.50	0.50	0.30	0.20	0.30	Feb 25,2017	94.00	13.60	91.00	13.30	91.00	13.30
March 8,2017	0.10	0.10	0.20	0.20	0.10	0.10	Mar 8,2017	93.00	13.70	93.00	13.70	92.00	13.60
March 14,2017	-0.10	-0.10	0.00	0.00	0.00	0.00	Mar 14,2017	97.00	14.50	97.00	14.40	97.00	14.50
March 19,2017	0.00	0.00	0.10	0.10	0.10	-0.20	Mar 19,2017	96.00	14.40	95.00	14.10	95.00	14.20
March 24,2017	0.20	0.20	0.30	0.00	-0.20	-0.20	Mar 24,2017	93.00	13.90	91.00	13.50	90.00	13.40
April 6,2017	-0.10	-0.10	-0.10	-0.10	-0.20	-0.20	Apr 6,2017	88.00	13.20	88.00	13.00	88.00	13.10
April 12,2017	0.80	0.60	0.60	0.40	0.10	-0.20	Apr 12,2017	93.00	13.60	92.00	13.40	91.00	13.50
April 22,2017	0.70	0.70	0.60	0.60	0.40	-0.30	Apr 22,2017	92.00	13.30	91.00	13.20	91.00	13.20
April 26,2017	1.40	1.40	0.80	0.30	0.20	-0.30	Apr 26,2017	95.00	13.60	93.00	13.70	90.00	13.30
May 3,2017	1.50	1.50	1.30	1.00	0.80	0.20	May 3,2017	114.00	15.90	107.00	15.20	107.00	15.20
May 13,2017	3.00	3.00	2.90	2.10	0.50	0.20	May 13,2017	106.00	14.40	105.00	14.30	100.00	14.60
May 19.2017	2.80	2.70	2.70	1.20	0.60	0.10	May 19,2017	103.00	13.90	105.00	14.30	103.00	14.80
May 23,2017	3.30	2.80	2.70	1.80	1.40	0.90	May 23,2017	102.00	13.80	101.00	13.80	101.00	14.20
June 3,2017	4.30	4.30	4.20	3.00	1.90	1.30	June 3,2017	103.00	13.50	102.00	13.50	102.00	14.30
June 7,2017	6.50	5.60	4.70	2.10	1.40	1.10	June 7,2017	112.00	14.00	110.00	14.20	107.00	14.90
June 16,2017	7.20	7.00	6.80	3.50	2.20	1.60	June 16,2017	105.00	12.90	105.00	13.20	105.00	14.50
June 23, 2017	6.40	6.40	6.40	5.30	3.60	1.90	June 23,2 017	99.00	12.20	97.00	12.10	98.00	13.00
July 1, 2017	7.80	7.80	7.60	6.10	5.60	3.00	July 1, 2017	109.00	13.10	108.00	13.30	108.00	13.70
July 9, 2017	9.00	9.00	8.10	7.80	6.20	3.30	July 9, 2017	98.00	11.30	99.00	11.70	99.00	12.20
July 21, 2017	12.50	12.50	10.40	7.50	7.10	2.10	July 21, 2017	106.00	11.30	108.00	12.10	105.00	12.70
July 27, 2017	14.50	14.50	12.30	5.80	2.70	0.80	July 27, 2017	110.00	11.20	114.00	12.80	106.00	14.40
August 3, 2017	16.00	16.00	14.60	5.40	2.50	1.60	August 3, 2017	106.00	10.60	113.00	12.40	108.00	15.00
August 11, 2017	17.30	17.20	16.50	11.40	4.80	2.90	August 11, 2017	105.00	10.30	111.00	11.60	110.00	14.20
August 19, 2017	15.80	15.70	15.50	6.60	2.60	1.90	August 19, 2017	97.00	9.70	99.00	10.10	101.00	13.90
August 26, 2017	15.00	15.00	14.70	9.50	4.80	2.20							
September 3, 2017	15.20	15.20	14.90	14.00	6.70	2.70							
September 9, 2017	13.30	13.20	13.20	13.30	13.20	4.60	September 9, 2017	99.00	10.50	97.00	10.30	94.00	9.90
September 16, 2017	13.80	13.60	13.30	11.60	10.70	4.30	September 16, 2017	101.00	10.50	99.00	10.50	98.00	11.00
September 22, 2017	13.80	13.80	13.70	12.40	10.00	4.90	September 22, 2017	100.00	10.40	99.00	10.30	96.00	11.00
September 30, 2017	13.40	13.30	13.30	13.20	6.40	2.80	September 30, 2017	94.00	9.90	93.00	9.80	96.00	11.90
October 7, 2017	12.10	12.10	12.10	12.10	10.40	7.30	October 7, 2017	96.00	10.40	94.00	10.60		
October 13, 2017	12.00	12.00	11.90	11.80	8.30	5.30	October 13, 2017	94.00	10.40	94.00	10.30	95.00	11.30
October 19, 2017	11.30	11.30	11.30	11.30	8.30	5.40	October 19, 2017	98.00	10.80	95.00	10.50	95.00	11.20
October 28, 2017	10.40	10.30	10.30	10.30	10.10	5.90	October 28, 2017	98.00	11.00	93.00	10.50	92.00	10.50
November 2, 2017	10.40	10.40	10.30	10.30	9.60	9.60	November 2, 2017	99.00	11.40	98.00	11.20	95.00	11.10
November 13, 2017	8.80	8.80	8.80	8.80	8.90	6.50	November 13, 2017	91.00	10.80	91.00	10.70	89.00	10.50
November 19, 2017	8.00	8.00	8.00	8.00	7.90	6.40	November 19, 2017	99.00	10.60	98.00	10.40	95.00	10.40
November 28, 2017	6.90	6.90	6.90	6.90	6.90	6.90	November 28, 2017	90.00	11.10	91.00	11.10	90.00	11.10
December 6, 2017	6.00	6.00	6.00	6.00	6.00	5.30	December 6, 2017	94.00	11.90	91.00	11.40	90.00	11.40
December 12, 2017	5.80	5.80	5.80	5.80	5.70	5.80	December 12, 2107	100.00	12.60	98.00	12.30	98.00	12.30
January 4, 2018	2.90	2.90	3.00	3.80	3.80	3.40	January 4, 2018						
January 17, 2018	2.00	2.00	2.10	2.20	2.20	2.20	January 17, 2018	92.00	13.00	91.00	12.80	89.00	12.50
January 27, 2018	1.40	1.40	1.40	1.40	1.60	2.10	January 27, 2018	80.00	11.50	78.00	11.20	77.00	11.10
February 15, 2018	1.20	1.10	1.00	1.20	1.30	1.40	February 15, 2018	93.00	13.10	91.00	12.00	90.00	12.70
February 26, 2018	0.30	0.40	0.40	0.40	0.80	1.00	February 26, 2018	93.00	13.60	92.00	13.60	92.00	13.30

Appendix C-Sea Cage Site: Butler Island

Grieg NL Seafarms Ltd - Environmental Data													
Sea Cage Site: Butler Island													
Temperature							Dissolved Oxygen						
Date	Temperature (˚C) - Surface	Temperature (˚C) - 3m	Temperature (˚C)- 10m	Temperature (˚C) - 25m	Temperature (˚C) - 35m	Temperature (˚C) - 50m	Date:	DO (%L) - 3m	DO (mg/L)-3m	DO (%L) - 15m	DO (mg/L)-15m	DO (%L) - 35m	DO (mg/L)-35m
Mar.11, 2016		0.40	0.50	0.50	0.50	0.50	Mar. 11, 2016	115.90	13.38	114.60	13.23	107.80	12.47
Mar. 16, 2016		0.20	0.30	0.40	0.40	0.30	Mar. 16, 2016	1118.10	13.70	115.10	13.38	113.20	13.14
Mar. 27, 2016		0.10	0.20	0.20	0.20	0.20	Mar. 27, 2016	112.90	13.27	110.30	12.90	106.60	12.56
Apr. 12, 2016		1.40	1.00	0.50	0.40	0.40	Apr. 12, 2016	117.10	13.46	108.30	12.63	103.50	12.22
Apr. 17, 2016		2.10	1.70	1.00	0.70	0.30	Apr. 17, 2016	126.30	14.17	120.20	14.72	107.30	12.48
Apri. 28, 2016		2.10	1.90	0.80	0.40	0.20	Apr. 28, 2016	127.20	14.03	125.70	13.89	108.40	12.43
May 5, 2016		2.60	2.30	1.20	0.90	0.40	May 5, 2016	125.70	13.80	123.20	13.86	110.80	12.70
May 12,2016		4.20	3.10	2.40	1.80	0.90	May 12,2016	116.80	12.21	116.00	12.46	113.10	12.50
May 20,2016		5.20	4.50	3.10	2.30	1.40	May 20,2016	117.50	11.97	114.70	12.20	113.70	12.60
May 26,2016		7.20	7.10	2.80	1.70	0.70	May 26,2016	115.40	11.32	118.20	12.47	112.90	12.64
June 3,2016		6.00	5.60	4.10	1.50	0.90	June 3,2016	113.70	11.60	112.30	11.61	110.30	12.55
June 11,2016		6.60	5.50	3.30	1.80	1.00	June 11,2016	116.00	11.41	115.80	11.83	111.40	12.84
June 25,2016		8.70	8.30	6.20	4.70	1.60	June 25,2016	112.10	10.71	110.20	10.70	111.90	11.83
July 8,2016		10.60	10.10	6.90	4.10	1.30	July 8,2016	110.30	10.06	108.70	10.07	106.40	12.04
July 20,2016		11.40	11.00	6.00	3.30	1.40	July 20,2016	110.90	9.85	109.70	9.86	110.00	11.77
July 26,2016		13.10	12.60	10.00	5.40	2.00	July 26,2016	114.20	9.84	111.00	9.73	113.50	11.62
August 3,2016		15.00	14.00	7.20	2.90	1.20	Aug. 3,2016	114.6	9.59	115.5	10.02	112.6	12.32
August 10,2016	16.00	15.90	15.70	7.90	2.80	1.20	Aug. 10,2016	113.8	9.32	113.1	9.67	111.9	12.23
August 20,2016	17.20	17.20	16.40	4.80	2.50	1.00	Aug. 20,2016	110.5	8.82	115	9.49	112.4	12.38
September 4,2016	15.30	15.30	15.30	6.50	2.80	1.50	Sept 4,2016	106.4	8.85	106	8.92	112.5	12.36
September 9,2016	16.00	16.00	15.60	10.40	7.10	5.60	Sept 9,2016	108.9	8.88	112.5	9.66	114.8	11.27
September 23,2016	13.90	13.90	13.50	13.00	12.60	6.20	Sept 23,2016	101.1	8.59	98.6	8.47	97.1	8.48
September 27,2016	13.50	13.50	13.40	13.10	11.70	6.10	Sept 27,2016	98.2	8.38	96.3	8.22	96.4	8.52
October 1,2016	12.80	12.80	12.80	12.50	8.70	4.70	Oct 1,2016	101	8.84	98.8	8.66	102.4	9.79
October 6,2016	12.40	12.30	12.20	12.10	11.80	11.30	Oct 6,2016	106.2	9.32	102.3	9.01	100.7	8.93
October 12,2016	11.90	11.90	11.90	11.90	11.30	7.00	Oct 13,2016	104.3	9.36	102.8	9.22	100.4	9.12
October 16,2016	11.40	11.40	11.40	11.40	9.70	5.70	Oct 16,2016	105.7	9.44	104.7	9.36	104.6	9.7
October 21,2016	11.00	11.00	11.10	11.10	11.00	10.90	Oct 21,2016	100.7	9.23	100.8	9.21	99.8	9.14
October 25,2016	10.70	10.70	10.50	10.60	10.60	9.50	Oct 25,2016	106.3	9.63	104.8	9.53	102.8	9.34
October 31,2016	10.00	10.00	9.90	9.90	9.80	9.20							
November 4,2016	10.00	10.00	9.80	9.70	9.50	8.90							
November 8,2016	9.50	9.50	9.50	9.50	9.50	9.50							
November 15,2016	9.00	9.00	9.00	9.10	9.10	7.30	Nov 15,2016	91.9	8.73	89.2	8.47		
November 23,2016	9.40	9.40	9.40	9.20	8.80	7.40							
November 30,2016	7.70	7.80	7.90	8.10	8.00	7.20	Nov 30,2016	93	9.04	92	8.88	92.9	9
December 8,2016	6.60	6.60	6.60	6.60	6.60	6.70	Dec 8,2016	97	9.6	94.8	9.37	93.7	9.27
December 14,2016	5.30	5.30	5.30	5.30	5.40	5.10	Dec 14,2016	92	9.51	92.6	9.57	91.9	9.47
December 26,2016	3.60	3.60	3.70	3.70	3.70	3.70	Dec 26,2016	91	9.81	90	9.7	89.2	9.61
December 31,2016	2.90	3.10	3.30	3.10	3.10	2.70	Dec 31,2016	97.1	10.42	95.5	10.28	94.9	10.24
January 30,2017	1.10	1.10	1.10	1.20	1.30	1.00							
February 4,2017	0.30	0.40	0.50	1.00	1.00	1.00							
Febraury 19,2017	0.50	0.50	0.40	0.50	0.30	0.00	Feb 19,2017	92	13.2	91	13.1	90	13
Febraury 25,3017	0.50	0.50	0.50	0.40	0.40	0.10	Feb 25,2017	93	13.5	92	13.3	92	13.3
March 8,2017	0.00	0.00	1.00	1.00	1.00	1.00	Mar 8,2017	97	14.3	94	13.8	93	13.8
March 14,2017	-0.20	-0.10	-0.10	0.00	0.10	-0.20	Mar 14,2017	99	14.8	97	14.5	95	14.1
March 19,2017	0.00	0.00	0.20	0.00	-0.10	-0.20	Mar 19,2017	99	14.3	95	14.1	94	14
March 24,2017	0.20	0.20	0.20	-0.10	-0.10	-0.20	Mar 24,2017	93	13.8	92	13.6	90	13.4
April 6,2017	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	Apr 6,2017	88	13.2	88	13.1	88	13.2
April 12,2017	0.80	0.80	0.80	0.60	0.10	-0.10	Apr 12,2017	93	13.5	93	13.5	92	13.6
April 22,2017	0.40	0.40	0.40	0.30	0.10	-0.20	Apr 22,2017	88	12.8	89	12.9	88	12.9
April 26,2017	1.40	1.50	0.90	-0.10	-0.30	-0.50	Apr 26,2017	94	13.4	92	13.8	87	13.7
May 3,2016	1.50	1.50	1.40	1.00	0.90	0.10	May 3,2017	112	15.7	108	15.3	107	15.2
May 13,2017	1.70	1.70	1.70	0.60	0.40	0.20	May 13,2017	106	14.8	105	14.8	102	14.8
May 19,2017	3.50	3.50	3.40	0.90	0.30	0.10	May 19,2017	101	13.4	102	13.5	99	14.4
May 23,2017	3.20	2.60	2.60	2.60	2.50	1.40	May 23,2017	101	13.8	99	13.6	99	13.6
June 3,2017	4.60	4.60	4.40	2.60	1.80	1.40	June 3,2017	104	13.5	102	13.3	102	14.3
June 7,2017	7.80	5.50	4.70	3.00	1.70	1.10	June 7,2017	110	13.8	110	14.3	107	14.8
June 16,2017	6.50	6.30	5.00	4.40	3.40	1.80	June 16,2017	104	13	105	13.6	104	14
June 23, 2017	6.40	6.40	6.40	5.80	3.70	2.40	June 23, 2017	97	11.9	97	11.9	98	12.9
June 30, 2017	8.70	8.70	8.70	6.20	5.70	3.90	June 30, 2017	107	12.6	107	12.6	108	13.9
July 9, 2017	9.30	9.30	9.30	8.90	7.70	5.20	July 9, 2017	97	11.1	97	11.3	98	11.5
July 21, 2017	13.40	13.30	11.30	7.00	4.10	1.70	July 21, 2017	104	10.8	109	12.2	108	14.1
July 27, 2017	14.80	14.80	14.70	4.60	2.60	1.40	July 27, 2017	108	11	108	11	106	14.4
August 3, 2017	15.60	15.60	15.10	7.30	3.00	1.20	August 3, 2017	108	10.9	110	11.5	107	14.6
August 11, 2017	17.40	17.30	16.80	9.80	4.40	2.10	August 11, 2017	106	10.3	105	10.4	111	14.5
August 19, 2017	16.00	15.70	14.50	10.40	3.20	2.00	August 19, 2017	97	9.7	99	10.2	107	14.5
August 26, 2017	14.60	14.60	14.20	11.30	5.80	2.20							
September 3, 2017	15.20	15.10	14.70	12.40	6.60	2.50							
September 9, 2017	13.30	13.30	13.20	13.20	13.20	5.00	September 9, 2017	100	10.6	98	10.4	96	10.2
September 16, 2017	13.60	13.50	13.20	12.30	9.40	4.60	September 16, 2017	101	10.5	99	10.4	100	11.5
September 22, 2017	13.90	13.90	13.70	12.30	10.90	4.50	September 22, 2017	100	10.3	98	10.3	95	10.5
September 30, 2017	13.50	13.50	13.40	12.60	9.50	7.90	September 30, 2017	95	10	93	9.8	93	10.7
October 7, 2017	12.20	12.20	12.20	11.90	9.80	5.70	October 7, 2017	92	9.9	93	10.1	94	10.7
October 13, 2017	11.90	11.90	11.70	11.50	10.20	5.40	October 13, 2017	95	10.4	94	10.3	93	10.6
October 19, 2017	11.30	11.30	11.30	11.30	8.40	5.50	October 19, 2017	97	10.7	96	10.6	96	11.3
October 28, 2017	10.50	10.50	10.50	10.20	8.70	6.10	October 28, 2017	98	11	94	10.6	94	11
November 2, 2017	10.50	10.40	10.30	10.10	8.90	6.90	November 2, 2017	99	11.3	98	11.2	95	11.4
November 13, 2017	8.80	8.80	8.80	8.80	8.80	8.80	November 13, 2017	91	10.8	90	10.7	90	10.6
November 19, 2017	8.00	8.00	8.00	7.80	7.10	6.90	November 19, 2017	8	8	8	7.8	7.1	6.9
November 28, 2017	6.80	6.80	6.80	6.38	6.70	6.50	November 28, 2017	91	11.2	90	11.1	91	11.2
December 6, 2017	5.70	5.80	5.80	5.90	5.90	5.90	December 6, 2017	81	10.3	83	10.5	80	10.11
December 12, 2017	5.80	5.80	5.80	5.80	5.70	5.60	December 12, 2017	100	12.5	99	12.4	98	12.3
January 4, 2018	2.30	3.00	3.00	3.40	3.50	3.20	January 4, 2018						
January 17, 2018	2.00	2.00	2.20	2.20	2.20	2.20	January 17, 2018	91	12.8	90	12.6	89	12.5
January 27, 2018	1.30	1.30	1.30	1.60	2.00	2.10	January 27, 2018	82	11.7	79	11.3	77	10.8
February 15, 2018	0.80	0.80	0.90	1.30	1.40	1.40	February 15, 2018	93	13.3	91	13	90	12.6
February 26, 2018	0.40	0.40	0.40	0.70	0.80	0.90	February 26, 2018	93	13.7	92	13.6	92	13.4

Appendix C-Sea Cage Site: Oderin Island

Grieg NL Seafarms Ltd - Environmental Data

Sea Cage Site: Oderin Island

Temperature							Dissolved Oxygen Readings						
Date	Temperature (˚C) - Surface	Temperature (˚C) - 3m	Temperature (˚C) - 10m	Temperature (˚C) - 25m	Temperature (˚C) - 35m	Temperature (˚C) - 50m	Date:2	DO (%L) - 3m	DO (mg/L)-3m	DO (%L) - 15m	DO (mg/L)-15m	DO (%L) - 35m	DO (mg/L)-35m
Feb. 5, 2016		1.3	1.2	1.1	1.2	1.2	Feb. 5	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 7, 2016		1.2	1.2	1.2	1.2	1.0	Feb. 7	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 11, 2016		1.0	1.0	1.0	1.0	1.0	Feb. 11	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 14, 2016		0.7	0.7	0.7	0.8	0.9	Feb. 14	n/a	n/a	n/a	n/a	n/a	n/a
Feb.18, 2016		0.8	0.7	0.7	0.7	0.8	Feb. 18	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 20, 2016		0.6	0.7	0.7	0.7	0.7	Feb. 20	105.50	12.20	102.90	11.92	101.00	11.68
Feb. 24, 2016		0.3	0.6	0.6	0.8	0.8	Feb. 24	100.40	11.91	97.10	11.43	94.00	11.04
Feb. 29, 2016		0.6	0.6	0.5	0.6	0.6	Feb. 29	103.30	11.89	99.80	11.46	97.00	11.18
Mar. 2, 2016		0.7	0.6	0.7	0.7	0.6	Mar. 2	113.00	13.01	109.70	12.76	105.80	12.28
Mar. 7, 2016		0.1	0.5	0.4	0.5	0.5	Mar. 7	n/a	n/a	n/a	n/a	n/a	n/a
Mar. 9, 2016		0.4	0.5	0.5	0.5	0.5	Mar. 9	111.50	12.99	107.30	12.47	103.50	12.01
Mar. 15, 2016		0.3	0.3	0.3	0.3	0.5	Mar. 15	117.00	13.54	111.70	13.10	110.00	12.89
Mar. 21, 2016		0.3	0.4	0.4	0.5	0.5	Mar. 21	115.30	13.22	109.80	12.70	106.40	12.26
Mar. 25, 2016		0.2	0.1	0.0	0.0	0.0	Mar. 25	114.40	13.35	110.30	12.95	108.00	12.74
Mar. 27, 2016		0.6	0.3	0.1	0.2	0.1	Mar. 27	115.90	13.37	109.70	12.91	105.80	12.49
Apr. 1, 2016		0.7	0.4	0.2	0.1	0.1	Apr. 1	113.10	12.95	107.60	12.43	103.60	12.04
Apr. 12, 2016		0.9	0.8	0.7	0.2	0.1	Apr. 12	114.90	13.13	107.50	12.59	102.10	12.16
Apr. 17, 2016		1.5	1.1	0.6	0.3	0.4	Apr. 17	105.50	12.08	103.00	11.91	99.60	11.66
Apr. 21, 2016		1.4	1.4	1.3	1.3	1.2	Apr. 21	121.80	13.50	118.40	13.16	116.00	12.90
Apr. 28, 2016		2.3	2.2	1.7	0.7	0.5	Apr. 28	124.10	13.51	122.10	13.30	109.20	12.41
May 5, 2016		2.2	2.1	1.4	0.7	0.4	May 5, 2016	126.20	13.98	124.70	14.02	111.20	12.83
May 9, 2016		3.6	2.8	1.2	1.0	0.5	May 9, 2016	108.50	11.50	108.90	11.91	101.30	11.48
May 12, 2016		3.6	2.2	1.3	0.7	0.5	May 12, 2016	118.20	12.50	115.80	12.77	103.40	12.76
May 20,2016		4.1	2.3	1.1	0.9	0.5	May 20,2016	120.70	12.78	119.00	13.27	110.80	12.71
May 26,2016		7.3	4.6	1.9	1.4	1.0	May 26,2016	117.40	11.53	117.40	12.81	112.10	12.64
June 3,2016		6.9	6.3	2.4	1.9	1.3	June 3,2016	117.80	11.71	116.40	11.87	111.40	12.49
June 11,2016		8.2	8.0	5.4	3.7	1.0	June 11,2016	113.00	10.68	112.00	11.05	113.40	11.96
June 19,2016		8.7	7.9	4.0	2.5	0.9	June 19,2016	112.20	10.69	114.20	11.38	111.10	12.26
June 25, 2016		9.1	8.0	2.5	1.6	0.8	June 25,2016	115.40	10.96	112.30	11.43	107.70	12.20
July 8,2016		10.8	9.9	8.5	5.2	2.4	July 8,2016	113.10	10.27	112.00	10.48	114.40	11.78
July 20,2016		12.6	10.1	6.7	3.8	0.6	July 20,2016	113.50	9.82	115.00	10.78	109.70	11.61
July 26,2016		12.8	10.5	7.5	6.2	3.2	July 26,2016	118.40	10.27	116.70	10.76	114.00	11.43
August 3,2016		14.7	14.4	10.1	7.7	2.2	Aug 3,2016	118.5	9.95	118.3	10.2	112.6	11
August 20,2016	17.2	17.0	15.6	11.2	4.3	1.4	Aug 20.2016	112.3	9.06	112.6	9.31	106.8	11.26
September 4,2016	14.70	14.6	14.3	12.1	6.6	2.4	Sept 4,2016	114.5	9.65	110.6	9.4	110.8	11.13
September 9,2016	14.60	14.5	14.5	11.7	8.8	4.2	Sept 9,2016	114.5	9.57	112.5	9.42	113.2	10.69
September 17,2016	12.90	12.9	12.8	9.3	7.7	5.3	Sept 17,2016	107.3	9.33	105	9.19	105	10.24
September 23,2016	12.40	12.4	12.1	11	9.5	5.2	Sept 23,2016	102.4	8.96	101	8.9	99.2	9.25
September 27,2016	12.50	12.5	12.4	12	10.8	4.7	Sept 27,2016	101.7	8.84	100.4	8.79	96.7	8.71
October 1,2016	12.50	12.5	12.5	12.3	12.1	7	Oct 1,2016	103.1	9.08	99.8	8.79		
October 6, 2016	12.10	12.1	12.1	11.2	10.8	6.5	Oct 6,2016	103.9	9.18	100.6	8.9	97.5	8.85
October 13,2016	11.60	11.6	11.4	11	11	10.3	Oct 13,2016			101.3	9.24	99.4	9.09
October 17,2016	10.60	10.6	10.9	10.9	10.8	10.2	Oct 17,2016	106.9	9.63	105.8	9.51	104.1	9.37
October 21,2016	10.50	10.5	10.4	10.4	10.3	10.1	Oct 21,2016	106.6	9.76	103.4	9.59	100.9	9.38
October 26,2016	10.10	10.1	10.2	10	10.1	9.3	Oct 26,2016	101.7	9.38	100.2	9.24	101.1	9.34
November 2,2016	9.40	9.4	9.3	9.3	9.3	9.3							
November 4,2016	9.60	9.5	9.5	9.3	9.3	9.3							
November 8,2016	9.20	9.2	9.3	9.3	9	9							
November 15,2016	8.70	8.6	8.6	8.7	7.7	6.3	Nov 15,2016	92.1	8.84	90.4	8.66	86.9	8.52
November 23,2016	9.40	9.1	9	8.8	8.7	7.6	Nov 23,2016	96.4	8.44	93.4	8.68	92.6	8.64
December 1,2016	7.90	7.9	8	8	8.1	8	Dec 1,2016	94.8	9.21	93.2	8.99	91.8	8.89
December 8,2016	6.70	6.7	6.7	6.9	6.8	6.8	Dec 8,2016	93.4	9.26	93.7	9.27	92.6	9.15
December 15,2016	5.10	5.1	5.1	5.1	5.1	5.1	Dec 15,2016	100.1	10.19	100.1	10.17	99.4	10.12
December 27,2016	2.90	2.9	3.3	3.5	3.2	3.2	Dec 27,2016	90.8	98.9	89.2	9.7	86.3	9.38
Janurary 31,2017	1.00	1	1	1	1.3	1.7							
February 4,2017	0.30	0.3	0.4	0.9	1.3	1.4							
February 16,2017	0.40	0.3	0.4	0.4	0.4	0.4	Feb 16,2017	95	13.5	94	13.6	95	13.6
February 20,2017	0.20	0.2	0.2	0.3	0.3	0.3	Feb 20,2017	93	13.4	92	13.3	91	13.2
February 25,2017	0.70	0.5	0.4	0.4	0.5	0.3	Feb 25,2017	96	14	94	13.7	92	13.3
March 8,2017	0.50	0.4	0.3	0.1	0.1	0.1	Mar 8,2017	97	14.3	93	13.7	91	13.4
March 14,2017	-0.20	-0.2	-0.2	-0.5	-0.5	-0.4	Mar 14,2017	100	15	98	14.8	98	14.8
March 19,2017	0.70	0	-0.2	-0.3	-0.3	-0.2	Mar 19,2107	98	14.6	97	14.4	96	14.3
March 29,2017	0.50	0.4	0.1	-0.1	-0.1	-0.1	Mar 29,2017	91	13.2	89	13.1	87	12.9
April 6,2017	0.40	0.4	0.3	0.1	0	0	Apr 6,2017	92	13.5	91	13.4	90	13.3
April 12,2017	1.10	1.1	0.5	0	0	0	Apr 12,2017	96	13.9	94	13.9	92	13.7
April 23,2017	0.80	0.8	0.8	0.3	0.1	0	Apr 23,2017	92	13.2	92	13.1	89	13
April 26,2017	1.20	1.2	1.1	0.3	0.2	-0.1	Apr 26,2017	95	13.7	95	13.9	92	13.6
May 4,2017	1.90	1.8	1.6	0.2	-0.1	-0.2	May 4,2017	112	15.4	111	15.6	101	14.7
May 14,2017	3.90	4	3.5	3	0.6	0.1	May 14,2017	100	13.2	101	13.6	99	14.3
May 18,2017	5.00	4.9	3	0.9	0.2	0.1	May 18,2017	104	13.5	103	14.4	94	13.6
May 23,2017	3.40	3.4	2.6	1.8	1.1	0.6	May 23,2017	101	13.4	99	13.7	96	13.7
June 3,2017	5.40	5.1	4.3	2.9	1.6	0.9	June 3,2017	108	13.7	107	14	101	14.2
June 8,2017	6.10	6.1	6	3.2	2.5	1.8	June 8,2017	108	13.4	107	13.8	105	14.4
June 16,2017	6.40	6.4	6	3.6	3.3	2.1	June 16, 2017	105	13.1	104	13.4	105	14.1
June 23, 2017	7.20	7	4.5	2.5	1.9	1.6	June 23, 2017	103	12.4	102	13.5	98	13.7
July 1, 2017	10.00	9.8	6.5	3.9	2.7	1.6	July 1, 2017	109	12.5	112	14.2	109	15
July 9, 2017	11.40	10.9	7.6	5.6	4.4	2	July 9, 2017	96	10.6	101	12.3	100	13
July 20, 2017	14.40	14.4	9.2	6.8	5.6	4.2	July 20, 2017	109	11.1	115	13.7	114	13.9
July 28, 2017	12.40	12.2	8.2	5.2	3.5	1.9	July 28, 2017	110	11.8	113	13.7	104	13.8
August 4, 2017	14.50	14.5	10.8	7.3	3.5	1.9	August 4, 2017	105	10.8	114	13.4	108	14.5
August 11, 2017	15.70	15.7	14.2	6.6	2.8	1.5	August 11, 2017	105	10.5	114	12.8	105	14.4
August 19, 2107	13.80	13.8	13.7	9.3	4.5	2.5	August 19, 2017	63	6.5	65	6.9	73	9.6
August 27, 2017	14.50	14.5	13.7	9.1	5.4	2.3							
September 3, 2017	14.70	14.7	14.5	5.5	2.6	0.8							
September 9, 2017	14.80	14.8	14.1	11.3	8.5	4.7	September 9, 2017	100	10.2	99	10.4	101	12
September 16, 2017	14.20	14.2	13.4	12	7.5	2.1	September 16, 2017	98	10.1	95	10	99	12
September 22, 2017	13.90	13.9	13.9	12	10.5	5.3	September 22, 2017	99	10.3	97	10.1	94	10.6
September 30, 2017	13.10	13.1	13	11.9	10.6	6.1	September 30, 2017	94	10	93	9.9	90	10.1
October 7, 2017	12.00	12.0	11.9	11.5	9.4	3.9	October 7, 2017	96	10.4	94	10.3	97	10.7
October 13, 2017	11.40	11.4	11.4	10.3	9.1	7.3	October 13, 2017	11.4	11.4	11.4	10.3	9.1	7.3
October 19, 2017	10.60	10.6	10.5	9.6	8.8	5.9	October 19, 2017	99	11.2	96	10.9	95	11.1
Ocotber 28, 2017	10.20	10.2	10	9.7	9.3	6.8	October 28, 2017	98	11.1	95	10.8	92	10.7
November 2, 2017	9.90	9.9	9.9	9.8	8.6	6.2	November 7, 2017	100	11.5	97	11.3	95	11.4
November 13, 2017	8.10	8.1	8	7.7	6.6	5.3	November 13, 2017	94	11.3	92	11	91	11.3
November 17, 2017	7.50	7.6	7.7	7.7	7.7	7.4	November 17, 2017	94	11.3	95	11.3	95	11.4
November 24, 2017	6.90	6.9	6.8	6.6	6	5.2	November 24, 2017	88	10.7	88	10.5	87	10.7
December 2nd, 2017	5.90	6	6	6.2	5.7	5.2	December 2, 2017	89	11.3	91	11.5	90	11.5
December 12, 2017	5.40	5.4	5.4	5.6	5.5	5.3							
January 4, 2018	2.50	2.5	2.6	2.8	2.8	2.5							
January 17, 2018	1.60	1.6	1.8	2.1	2	1.8	January 17, 2018	92	13.1	91	12.7	90	12.6
January 27, 2018	0.70	0.8	1.5	1.6	1.7	1.7	January 27, 2018	82	12.2	80	11.5	79	11.3
February 7, 2018	1.10	1.1	1.3	1.4	1.4	1.5	February 7, 2018	92	13.1	91	12.7	90	12.6
February 15, 2018	1.10	1.1	1.2	1.4	1.3	1.3	February 15, 2018	90	12.7	89	12.6	87	12.3
February 26, 2018	0.50	0.4	0.4	0.5	1.1	1.3	February 26, 2018	100	14.4	97	14.1	94	13.4

Appendix C-Sea Cage Site: Gallows Harbour

Grieg NL Seafarms Ltd - Environmental Data													
Sea Cage Site: Gallows Harbour													
Temperature							Dissolved Oxygen						
Date	Temperature (˚C) - Surface	Temperature (˚C) - 3m	Temperature (˚C) - 10m	Temperature (˚C) - 25m	Temperature (˚C) - 35m	Temperature (˚C) - 50m	Date:2	DO (%L) - 3m	DO (mg/L)-3m	DO (%L) - 15m	DO (mg/L)-15m	DO (%L) - 35m	DO (mg/L)-35m
Feb. 5, 2016		1.20	1.20	1.20	1.20	1.10	Feb. 5	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 7, 2016		1.00	1.20	1.20	1.20	1.10	Feb. 7	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 11, 2016		1.00	0.90	0.90	0.90	0.80	Feb. 11	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 14, 2016		0.80	0.70	0.80	0.80	0.80	Feb. 14	n/a	n/a	n/a	n/a	n/a	n/a
Feb.18, 2016		0.80	0.80	0.80	0.80	0.80	Feb. 18	120.10	14.02	122.00	14.05	119.10	13.72
Feb. 20, 2016		0.50	0.90	0.70	0.70	0.70	Feb. 20	110.20	13.00	103.90	11.97	104.30	12.06
Feb. 24, 2016		0.70	0.70	0.70	0.70	0.60	Feb. 24	111.20	13.11	108.30	12.80	105.20	12.38
Feb. 29, 2016		0.60	0.60	0.60	0.70	0.60	Feb. 29	107.20	12.36	104.70	12.09	102.00	11.77
Mar. 2, 2016		0.70	0.60	0.60	0.60	0.60	Mar. 2	103.70	12.09	102.60	11.95	101.40	11.80
Mar. 7, 2016		0.30	0.40	0.40	0.50	0.50	Mar. 7	n/a	n/a	n/a	n/a	n/a	n/a
Mar. 9, 2016		0.50	0.40	0.40	0.40	0.50	Mar. 9	106.90	12.37	105.00	12.22	102.90	11.97
Mar. 15, 2016		0.30	0.30	0.40	0.30	0.40	Mar. 15	118.30	13.75	113.00	13.32	111.20	12.97
Mar. 21, 2016		0.50	0.40	0.50	0.50	0.30	Mar. 21	109.00	12.59	104.50	12.05	104.30	12.07
Mar. 25, 2016		0.20	0.30	0.30	0.10	0.10	Mar. 25	117.90	13.69	110.30	12.94	109.50	12.87
Mar. 27, 2016		0.90	0.40	0.20	0.10	0.10	Mar. 27	112.80	12.87	107.40	12.59	105.30	12.46
Apr. 1, 2016		0.50	0.40	0.10	0.10	0.10	Apr. 1	101.30	11.69	101.30	11.70	94.10	11.56
Apr. 12, 2016		1.30	0.90	0.70	0.30	0.10	Apr. 12	111.90	12.78	107.60	12.56	103.60	12.26
Apr. 17, 2016		1.50	0.80	0.60	0.40	0.30	Apr. 17	112.00	12.70	109.20	12.63	104.30	12.22
Apr. 21, 2016		1.50	1.40	1.40	1.40	1.40	Apr. 21	113.30	12.52	113.00	12.52	111.20	12.33
Apr. 28, 2016		2.30	2.20	1.00	0.60	0.10	Apr. 28	121.30	13.24	120.40	13.24	108.20	2.34
May 5, 2016		2.50	2.30	1.80	0.80	0.40	May 5, 2016	124.10	13.70	122.30	13.63	110.10	12.70
May 9, 2016		3.10	2.60	1.50	1.30	1.00	May 9, 2016	98.40	10.53	101.20	11.16	97.10	10.94
May 12, 2016		3.90	3.20	1.80	1.00	0.30	May 12, 2016	114.10	12.41	115.30	12.57	105.30	12.89
May 20,2016		4.10	3.00	1.20	0.70	0.40	May 20,2016	118.10	12.51	118.20	13.10	107.20	12.38
May 26,2016		7.40	4.60	2.30	1.90	1.10	May 26,2016	119.70	11.63	117.80	12.37	116.80	12.92
June 3,2016		6.10	5.20	3.90	2.00	0.70	June 3,2016	115.70	11.78	113.80	11.87	113.00	12.63
June 11, 2016		7.90	7.00	4.50	3.10	1.60	June 11,2016	118.30	11.24	114.40	11.15	113.50	12.16
June 19, 2016		8.00	7.60	6.10	3.10	1.60	June 19,2016	106.40	10.30	106.80	10.58	106.80	11.63
June 25,2016		9.40	7.90	5.70	3.20	1.90	June 25,2016	116.20	10.97	114.60	11.38	112.80	12.30
July 8,2016		10.80	9.90	9.30	7.30	2.20	July 8,2016	114.90	10.44	111.50	10.32	111.90	10.99
July 20,2016		11.30	10.20	5.20	3.30	1.70	July 20,2016	116.10	10.34	115.20	10.99	109.10	11.67
July 26,2016		12.50	11.30	10.40	7.40	5.20	July 26,2016	115.80	10.10	114.30	10.30	112.90	11.02
August 3,2016		15.90	15.40	10.50	6.20	1.60	Aug. 3,2016	117.00	9.58	119.50	10.50	114.20	11.50
August 10,2016	15.30	15.30	13.60	10.80	6.30	3.10	Aug. 10,2016	115.40	9.54	116.90	10.20	119.70	12.07
August 20,2016	17.10	16.60	16.30	7.10	2.70	0.80	Aug 20,2016	109.90	8.88	110.80	9.23	112.10	12.31
September 4,2016	15.00	14.90	14.60	9.90	6.20	1.80	Sept 4,2016	110.90	9.30	110.40	9.53	110.50	11.20
September 9,2016	14.60	14.60	14.40	12.20	7.40	4.60	Sept 9,2016	113.90	9.53	112.30	9.42	116.10	11.33
September 17,2016	12.80	12.80	12.60	10.00	7.60	3.30	Sept 17,2016	99.10	8.71	99.40	8.87	101.90	9.99
September 23,2016	12.70	12.70	12.30	12.10	11.80	8.90	Sept 23,2016	104.90	9.13	104.00	9.14	100.90	8.94
September 27,2016	12.70	12.70	13.10	12.00	10.40	4.50	Sept 27,2016	101.80	8.82	99.80	8.66	97.50	8.87
October 1,2016	12.40	12.40	12.60	12.50	12.30	6.20	Oct 1,2016	99.70	8.80	99.00	8.71	96.40	8.53
October 6,2016	11.70	11.70	11.70	11.40	10.60	6.00	Oct 6,2016	104.50	9.30	103.00	9.18	100.90	9.19
October 13,2016	11.30	11.70	11.20	11.00	10.50	9.90	Oct 13,2016	101.80	9.18	100.00	9.14	99.50	9.19
October 17,2016	10.70	11.10	11.00	10.80	10.70	10.20	Oct 17,2016	104.50	9.36	103.70	9.28	102.20	9.23
October 21,2016	10.30	10.30	10.30	10.40	10.40	10.20	Oct 21,2016	108.80	10.11	104.10	9.69	101.50	9.43
October 26,2016	9.90	9.90	10.30	10.20	10.20	9.40	Oct 26,2016	104.90	9.69	104.20	9.57	103.10	9.49
November 2,2016	9.40	9.40	9.40	9.30	9.30	9.30							
November 4,2016	9.70	9.60	9.40	9.30	9.30	9.10							
November 8,2016	9.30	9.30	9.40	9.30	9.20	8.40							
November 15,2016	9.00	9.00	8.90	8.90	8.80	8.80	Nov 15,2016	93.00	8.86	91.50	8.73	89.90	8.58
November 23,2016	9.20	9.10	8.90	8.80	8.80	8.70	Nov 23,2016	96.40	8.93	96.00	8.95	95.10	8.87
December 1,2016	7.40	7.50	7.80	8.00	7.70	7.60	Dec 1,2016	92.30	9.24	92.80	8.99	94.80	9.22
December 8,2016	5.30	6.00	6.30	7.30	7.10	6.30	Dec 8,2016	93.00	9.34	91.00	8.98	88.40	8.66
December 15,2016	5.00	5.00	5.10	5.10	5.10	5.20	Dec 15,2016	103.70	10.43	101.60	10.34	99.20	10.08
December 27,2016	2.40	2.80	3.40	3.30	3.20	3.10	Dec 27,2016	89.10	9.81	88.00	9.57	86.70	9.40
January 1,2017	2.90	2.90	2.90	2.90	2.90	3.10	Jan 1,2017	97.70	10.70	97.30	10.64	96.10	10.51
January 31,2017	0.90	1.00	1.10	1.20	1.40	1.60							
February 4,2017	0.30	0.40	0.90	1.10	1.10	1.10							
February 16,2017	0.40	0.40	0.40	0.40	0.30	0.30	Feb 16,2017	96.00	13.70	95.00	13.60	95.00	13.60
February 20,2017	0.40	0.40	0.40	0.50	0.50	0.60	Feb 20,2017	92.00	13.20	92.00	13.20	91.00	12.90
February 25,2017	0.60	0.50	0.40	0.30	0.40	0.30	Feb 25,2017	96.00	13.90	94.00	13.70	93.00	13.50
March 8,2017	0.40	0.40	0.20	0.10	0.10	0.00	Mar 8,2017	96	14	94	13.9	93	13.8
March 14, 2017	0.40	0.40	0.10	0.00	-0.10	-0.10	Mar 14,2017	99.00	14.70	98.00	14.60	98.00	14.60
March 19,2017	0.80	0.40	0.10	0.10	0.10	0.10	Mar 19,2017	97.00	14.40	96.00	14.30	94.00	14.10
March 29,2017	0.60	0.50	0.30	0.10	0.00	-0.10	Mar 29,2017	92.00	13.30	90.00	13.10	89.00	13.10
April 6,2017	0.40	0.40	0.00	0.00	0.00	-0.10	Apr 6,2017	94.00	13.70	92.00	13.60	91.00	13.50
April 12,2017	1.60	1.20	1.10	0.10	0.00	-0.10	Apr 12,2017	95.00	13.70	94.00	13.90	93.00	14.10
April 23,2017	1.00	1.10	0.40	0.70	0.50	0.30	Apr 23,2017	89.00	12.70	90.00	12.80	90.00	13.00
April 26,2017	1.00	1.00	0.50	0.30	0.10	-0.10	Apr 26,2017	95.00	13.80	94.00	13.90	91.00	13.50
May 4,2017	1.90	1.70	1.10	0.70	0.40	0.30	May 4,2017	111.00	15.60	111.00	15.60	105.00	15.10
May 14,2017	3.70	3.60	3.40	2.10	0.80	0.10	May 14,2017	101.00	13.40	101.00	13.50	99.00	14.30
May 18,2017	4.70	4.10	2.50	0.60	-0.10	-0.30	May 18,2017	105.00	13.60	104.00	14.50	92.00	13.50
May 23,2017	3.20	3.20	2.50	2.20	1.90	1.90	May 23,2017	100.00	13.50	99.00	13.60	99.00	13.70
June 3,2017	5.80	5.00	3.80	2.30	1.60	1.30	June 3,2017	106.00	13.50	105.00	14.00	99.00	13.80
June 8,2017	6.20	6.10	4.80	3.90	2.60	1.80	June 8,2017	109.00	13.50	107.00	13.80	106.00	14.40
June 16,2017	7.10	7.10	5.90	4.60	3.30	2.70	June 16,2017	106.00	12.90	105.00	13.40	103.00	14.10
June 23,2 017	7.20	7.00	5.90	2.90	2.00	1.40	June 23, 2017	102.00	12.30	100.00	13.00	96.00	13.30
July 1, 2017	9.00	8.00	7.60	5.00	4.60	2.40	July 1, 2017	110.00	13.10	109.00	13.50	110.00	14.30
July 9, 2017	10.60	9.90	8.80	7.20	3.50	1.40	July 9, 2017	97.00	11.10	98.00	11.70	97.00	13.10
July 20, 2017	15.70	15.70	10.10	7.40	6.30	4.50	July 20, 2017	107.00	10.70	115.00	13.40	111.00	13.80
July 28, 2017	10.80	10.80	9.10	5.80	2.90	1.50	July 28, 2017	110.00	12.30	110.00	13.10	105.00	14.20
August 4, 2017	14.80	14.80	13.20	7.80	3.40	1.90	August 4, 2017	106.00	10.90	111.00	12.30	108.00	14.60
August 11, 2017	15.70	15.70	13.20	4.50	2.00	0.80	August 11, 2017	98.00	9.90	99.00	11.20	101.00	14.20
August 19, 2017	14.40	14.40	13.80	10.60	8.90	4.00	August 19, 2017	80.00	8.20	63.00	6.70	67.00	7.90
August 27, 2017	15.00	15.00	14.90	12.90	9.50	2.90							
September 3, 2017	14.60	14.60	13.80	6.20	2.30	1.10							
September 9, 2017	14.50	14.40	14.10	9.50	8.40	7.80	September 9, 2017	101.00	10.40	98.00	10.30	97.00	11.70
September 16, 2017	14.00	14.20	13.10	12.30	8.50	1.80	September 16, 2017	97.00	10.00	94.00	9.90	95.00	11.30
September 22, 2017	14.00	14.00	14.00	11.90	10.40	6.70	September 22, 2017	98.00	10.20	97.00	10.10	96.00	10.80
September 30, 2017	12.80	12.90	12.80	12.40	11.20	7.70	September 30, 2017	94.00	10.00	93.00	9.90	91.00	10.10
October 7, 2017	11.60	11.60	11.30	10.90	10.30	4.30	October 7, 2017	98.00	10.80	97.00	10.80	96.00	10.80
October 13, 2017	11.30	11.30	11.40	10.10	9.20	5.90	October 13, 2017	95.00	10.60	94.00	10.40	93.00	10.90
October 19, 2017	10.70	10.70	10.40	8.90	6.80	4.40	October 19, 2017	99.00	11.10	96.00	10.90	96.00	11.90
October 27, 2017	10.30	10.30	9.90	9.70	9.00	7.10	October 28, 2017	98.00	11.10	94.00	10.70	93.00	10.80
November 2, 2017	9.90	10.00	9.90	9.90	9.30	6.80	November 2, 2017	97.00	11.20	97.00	11.20	94.00	11.00
November 13, 2017	7.70	7.80	8.10	8.10	7.80	5.60	November 13, 2017	91.00	11.00	91.00	10.90	90.00	10.90
November 17, 2017	7.70	7.70	7.80	7.90	7.80	7.50	November 17, 2017	92.00	11.00	95.00	11.30	93.00	11.20
November 24, 2017	6.70	6.70	6.70	6.80	5.90	5.50	November 24, 2017	87.00	10.60	88.00	10.70	89.00	10.90
December 2, 2017	5.90	5.90	6.20	6.20	6.10	6.00	Decemebr 2, 2017	93.00	11.90	92.00	11.40	91.00	11.40
December 12, 2017	5.50	5.60	5.70	5.70	5.47	5.70	December 12, 2017	89.00	11.30	91.00	11.50	93.00	11.70
January 4, 2018	2.10	2.50	2.60	3.00	3.00	2.90							
January 17, 2018	1.90	1.90	2.20	2.10	1.90	2.00	Januray 17, 2018	94.00	13.20	91.00	12.80	90.00	12.70
Januay 27, 2018	1.40	1.50	1.70	1.70	1.80	1.80	January 27, 2018	85.00	12.30	83.00	11.70	81.00	11.40
February 7, 2018	1.30	1.30	1.50	1.50	1.60	1.60	February 7, 2018	100.00	14.50	98.00	14.20	95.00	13.60
Febraury 15, 2018	0.80	1.20	1.30	1.20	1.20	1.40	February 15, 2018	90.00	12.70	90.00	12.70	89.00	12.50
February 26, 2018	0.60	0.50	0.50	0.60	0.90	1.00	February 26, 2018	99.00	14.40	96.00	14.00	94.00	13.60

Appendix C-Sea Cage Site: Long Island

Grieg NL Seafarms Ltd - Environmental Data													
Sea Cage Site: Long Island													
Temperature							Dissolved Oxygen						
Date	Temperature (˚C) - Surface	Temperature (˚C) - 3m	Temperature (˚C) - 10m	Temperature (˚C) - 25	Temperature (˚C) - 35m	Temperature (˚C) - 50m	Date:2	DO (%L) - 3m	DO (mg/L)-3m	DO (%L) - 15m	DO (mg/L)-15m	DO (%L) - 35m	DO (mg/L)-35m
Feb. 5, 2016		1.20	1.20	1.10	1.00	0.80	Feb. 5	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 7, 2016		1.00	1.20	1.20	1.00	0.80	Feb. 7	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 11, 2016		0.90	0.90	0.90	0.80	0.80	Feb. 11	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 14, 2016		0.70	0.80	0.80	0.80	0.80	Feb. 14	n/a	n/a	n/a	n/a	n/a	n/a
Feb.18, 2016		0.70	0.70	0.70	0.70	0.70	Feb. 18	n/a	n/a	n/a	n/a	n/a	n/a
Feb. 20, 2016		0.70	0.80	0.80	0.80	0.80	Feb. 20	103.90	12.06	102.40	11.84	101.10	11.69
Feb. 24, 2016		0.60	0.60	0.60	0.50	0.50	Feb. 24	102.30	12.06	97.90	11.56	95.30	11.27
Feb. 29, 2016		0.60	0.60	0.60	0.50	0.60	Feb. 29	106.00	12.23	104.40	12.04	102.80	11.89
Mar. 2, 2016		0.60	0.60	0.50	0.50	0.40	Mar. 2	108.70	12.62	105.10	12.23	102.40	11.92
Mar. 7, 2016		0.40	0.40	0.40	0.40	0.40	Mar. 7	n/a	n/a	n/a	n/a	n/a	n/a
Mar.9, 2016		0.30	0.30	0.40	0.40	0.40	Mar. 9	102.40	11.97	101.70	11.83	101.50	11.78
Mar. 15, 2016		0.30	0.30	0.30	0.30	0.40	Mar. 15	116.70	13.62	113.00	13.27	111.30	13.05
Mar. 21, 2016		0.40	0.30	0.30	0.30	0.30	Mar. 21	114.00	13.21	109.50	12.73	105.20	12.22
Mar. 25, 2016		0.10	0.00	0.10	0.00	0.00	Mar. 25	114.40	13.43	110.30	13.02	107.00	12.52
Mar. 27, 2016		0.80	0.20	0.10	0.10	0.10	Mar. 27	111.70	12.86	108.40	12.80	105.90	12.52
Apr. 1, 2016		0.60	0.50	0.10	0.00	0.00	Apr. 1	101.30	11.64	100.60	11.57	99.80	11.63
Apr. 12, 2016		1.00	0.80	0.70	0.20	0.10	Apr. 12	114.90	13.13	107.50	12.59	102.10	12.16
Apr. 17, 2016		1.50	1.00	0.40	0.40	0.20	Apr. 17	113.30	12.87	109.80	12.70	105.00	12.27
Apr. 21, 2016		1.60	1.60	1.60	1.50	1.50	Apr. 21	124.20	13.61	119.60	13.17	117.10	12.85
Apr. 28, 2016		2.40	2.10	1.20	0.70	0.30	Apr. 28	120.80	13.14	119.10	13.15	107.80	12.23
May 5, 2016		2.40	1.90	1.20	0.80	0.50	May 5, 2016	126.60	13.94	124.80	14.02	113.20	13.01
May 9, 2016		3.00	2.60	1.70	1.30	0.60	May 9, 2016	99.00	10.65	101.10	11.09	96.50	10.81
May 12, 2016		3.70	3.30	1.10	0.90	0.50	may 12,2016	114.60	12.19	114.00	12.61	105.20	11.92
May 20,2016		4.20	3.80	1.00	0.90	0.80	May 20,2016	120.20	12.74	118.50	13.37	109.70	12.60
May 26,2016		5.20	3.90	2.20	1.60	1.00	May 26,2016	119.20	12.29	118.60	12.73	113.20	12.70
June 3,2016		6.40	6.20	3.20	1.90	1.00	June 3,2016	116.70	11.75	113.90	11.61	112.10	12.63
June 11,2016		7.80	6.90	6.50	4.80	1.00	June 11,2016	116.60	11.16	113.20	11.13	113.10	11.62
June 19,2016		7.90	7.90	7.50	4.40	2.10	June 19,2016	110.90	10.76	109.50	10.67	110.60	11.63
June 25,2016		8.30	8.20	5.10	3.90	2.00	June 25,2016	115.90	11.21	112.00	10.91	113.90	12.18
July 8,2016		10.40	10.10	9.40	7.80	1.50	July 8,2016	114.20	10.45	111.60	10.30	111.80	10.83
July 20,2016		12.40	8.30	5.20	4.10	0.60	July 20,2016	115.60	10.12	114.90	10.99	113.50	11.90
July 26,2016		12.30	10.90	9.80	8.90	8.90	July 26,2016	116.80	10.25	114.40	10.47	111.80	10.55
August 3,2016		14.80	14.70	10.00	5.80	1.60	Aug. 3,2016	117.60	9.85	116.80	10.06	112.60	11.47
August 10,2016	14.70	14.80	13.50	10.40	5.70	2.90	Aug. 10,2016	110.30	9.26	115.90	10.17	117.30	11.92
August 20,2016	16.70	16.40	16.00	9.50	2.60	0.70	Aug.20,2016	110.70	8.99	113.20	9.38	109.30	12.02
September 4,2016	14.80	14.80	14.70	10.70	4.50	1.60	Sept 4,2016	115.00	9.66	110.40	9.42	112.30	11.83
September 9,2016	14.90	14.90	14.40	11.70	7.00	4.60	Sept 9,2016	116.10	9.63	115.40	9.74	118.90	11.71
September 17,2016	12.90	12.90	12.90	10.00	6.50	3.60	Sept 17,2016	99.40	8.67	99.70	8.69	101.30	10.17
September 23,2016	12.60	12.60	12.30	12.20	10.70	7.50	Sept 23,2016	105.50	9.20	102.80	9.01	100.30	9.11
September 27,2016	12.80	12.80	12.80	12.40	11.20	5.30	Sept 27,2016	100.80	8.72	100.10	8.66	96.30	8.60
October 1,2016	12.50	12.50	12.50	12.50	12.50	5.50	Oct 1,2016	106.50	9.38	101.90	8.87	98.30	8.67
October 6,2016	12.00	12.00	12.00	11.40	10.10	6.40	Oct 6,2016	108.00	9.56	104.60	9.25	101.70	9.37
October 13,2016	11.10	11.10	10.90	10.90	11.00	10.70	Oct 13,2016	102.40	9.34	100.90	9.25	99.80	9.12
October 17,2016	10.60	10.60	10.80	10.70	10.10	10.30	Oct 17,2016	106.00	9.59	105.70	9.54	105.30	9.61
Octobre 21,2016	10.40	10.40	10.40	10.50	10.50	9.70	Oct 21,2016	104.10	9.67	102.60	9.63	100.40	9.32
October 26,2016	10.10	10.10	10.30	10.00	9.70	9.30	Oct 26,2016	102.90	9.50	104.60	9.60	104.80	9.76
November 2,2016	9.30	9.30	9.30	9.30	9.30	9.30							
November 4,2016	9.50	9.50	9.40	9.40	9.40	9.40							
November 8,2016	9.20	9.20	9.20	9.30	9.20	9.30							
November 15,2016	8.80	8.80	8.80	8.80	8.50	6.90							
November 23,2016	9.10	9.10	8.90	8.80	8.70	8.50	Nov 23,2016	97.40	9.04	96.60	9.01	96.60	9.02
December 1,2016	7.60	7.60	7.70	7.70	7.80	7.60	Dec 1,2016	95.20	9.30	93.50	9.12	93.80	9.14
December 8,2016	5.70	5.70	7.00	6.80	6.70	5.80	Dec 8,2016	92.30	9.36	91.90	9.04	90.50	8.98
December 15,2016	5.00	5.00	5.00	5.00	5.00	4.20	Dec 15,2016	105.30	10.53	103.90	10.56	102.20	10.40
December 27,2016	2.80	2.80	3.30	3.30	3.20	3.10	Dec 27,2016	91.60	10.07	89.90	9.77	86.10	9.48
January 31, 2017	0.80	0.80	1.00	0.90	1.40	0.90							
February 4,2017	0.30	0.30	0.40	0.90	0.90	1.00							
February 16,2017	0.30	0.30	0.30	0.40	0.40	0.30	Feb 16,2017	96.00	13.50	95.00	13.60		
February 20,2017	0.40	0.40	0.30	0.30	0.30	0.60	Feb 20,2017	93.00	13.40	92.00	13.20	91.00	13.20
February 25,2017	0.50	0.50	0.40	0.40	0.30	0.20	feb. 25,2017	96.00	13.90	94.00	13.70	93.00	13.60
March 8,2017	0.50	0.50	0.20	0.10	0.10	0.10	Mar 8,2017	96.00	14.00	94.00	13.80	93.00	13.70
March 14,2017	0.20	0.20	-0.10	-0.20	-0.20	-0.10	Mar 14,2017	100.00	14.80	96.00	14.60	97.00	14.60
March 19,2017	0.80	0.30	0.10	0.00	-0.10	-0.20	Mar 19,2017	98.00	14.50	96.00	14.30	94.00	14.10
March 29,2017	0.30	0.20	0.10	-0.10	-0.10	-0.10	Mar 29,2017	93.00	13.60	92.00	13.50	91.00	13.40
April 6,2017	0.30	0.30	0.00	-0.10	-0.10	-0.10	Apr 6,2017	93.00	13.70	90.00	13.40	90.00	13.40
April 12,2017	0.70	0.70	0.40	0.00	-0.10	-0.10	Apr 12,2017	96.00	13.90	94.00	13.90	92.00	13.70
April 23,2017	1.00	1.00	0.90	0.80	0.50	0.50	Apr 23,2017	92.00	13.10	92.00	13.20	92.00	13.30
April 26,2017	1.20	1.20	1.00	0.40	0.10	-0.10	Apr 26,2017	98.00	14.10	96.00	14.10	92.00	13.70
May 4,2017	1.10	1.10	1.10	1.00	0.90	0.20	May 4,2017	110.00	15.50	111.00	15.60	110.00	15.60
May 14,2017	3.40	3.40	3.40	2.90	1.60	0.20	May 14,2017	101.00	13.50	101.00	13.60	100.00	14.00
May 18,2017	4.80	4.80	2.90	0.80	0.20	0.00	May 18,2017	104.00	13.60	103.00	14.20	93.00	13.50
May 23,2017	3.30	3.30	3.10	2.80	2.70	2.70	May 23,2017	101.00	13.50	100.00	13.50	100.00	13.60
June 3,2017	5.40	5.10	3.40	2.70	2.00	1.60	June 3,2017	106.00	13.60	105.00	14.00	100.00	13.70
June 8,2017	5.80	5.80	5.40	4.30	3.30	2.20	June 8,2017	108.00	13.50	107.00	13.80	106.00	14.20
June 16,2017	6.40	6.40	5.90	5.10	4.60	3.40	June 16,2017	105.00	13.10	105.00	13.40	104.00	13.50
June 23, 2017	7.20	7.10	5.60	3.60	2.20	1.60	June 23, 2017	101.00	12.20	100.00	12.50	97.00	13.30
July 1, 2017	9.90	9.00	7.30	5.50	4.00	2.30	July 1, 2017	110.00	12.80	111.00	13.70	111.00	14.70
July 9, 2017	11.80	10.90	7.10	5.50	3.90	1.70	July 9, 2017	96.00	10.50	99.00	12.30	97.00	12.70
July 20, 2017	14.90	14.90	9.80	8.00	6.20	3.70	July 20, 2017	107.00	10.80	113.00	13.10	112.00	13.80
July 28, 2017	12.50	12.40	8.70	5.90	3.20	0.90	July 28, 2017	110.00	11.70	113.00	13.40	105.00	14.10
August 4, 2017	14.90	14.90	14.80	6.60	3.50	1.50	August 4, 2017	106.00	10.90	111.00	12.00	107.00	14.60
August 11, 2017	16.20	16.20	14.00	6.80	3.70	1.00	August 11, 2017	103.00	10.30	113.00	13.10	107.00	14.60
August 19, 2017	14.00	13.80	13.50	13.10	8.00	2.60	August 19, 2017	71.00	7.50	71.00	7.60	78.00	9.30
August 27, 2017	14.30	14.30	14.30	13.00	8.00	2.70							
September 3, 2017	14.60	14.60	14.60	7.10	2.70	1.10							
September 9, 2017	14.60	14.60	14.10	10.30	8.50	5.10	September 9, 2017	99.00	10.30	98.00	10.40	100.00	11.90
September 16, 2017	14.40	14.20	13.60	12.70	7.30	2.00	September 16, 2017	99.00	10.20	96.00	10.10	99.00	12.00
September 22, 2017	14.00	14.00	14.00	11.80	8.40	5.70	September 22, 2017	99.00	10.30	98.00	10.20	99.00	11.80
September 30, 2017	12.90	12.90	12.60	12.30	11.80	9.30	September 30, 2017	94.00	10.00	93.00	9.90	91.00	9.90
October 7, 2017	12.00	12.00	11.90	11.60	9.60	3.70	October 7, 2017	98.00	10.60	95.00	10.30	94.00	10.80
October 13, 2017	11.50	11.50	11.50	11.00	9.70	8.00	October 13, 2017	96.00	10.60	94.00	10.50	93.00	10.70
October 19, 2017	10.60	10.60	10.60	9.10	8.00	5.20	October 19, 2017	100.00	11.20	98.00	10.00	97.00	11.60
October 28, 2017	10.10	10.10	10.00	9.80	9.40	6.80	October 28, 2017	99.00	11.30	94.00	10.70	93.00	10.70
November 2, 2017	10.00	10.00	9.90	9.90	9.10	6.80	November 2, 2017	100.00	11.60	98.00	11.40	94.00	11.20
November 13, 2017	8.20	8.10	8.00	7.80	7.60	6.20	November 13, 2017	93.00	11.20	91.00	11.00	91.00	11.00
November 17, 2017	7.80	7.80	7.80	7.80	7.80	7.80	November 17, 2017	98.00	11.70	96.00	11.50	96.00	11.40
November 24, 2017	6.90	6.90	6.90	6.30	6.00	5.10	November 24, 2017	88.00	10.80	88.00	10.70	89.00	10.90
December 2, 2017	5.90	6.00	6.00	6.00	6.00	6.00	December 2, 2017	89.00	11.20	88.00	11.00	90.00	11.30
December 12, 2017	5.60	5.60	5.60	5.70	5.70	4.90	December 12, 2017	95.00	12.10	95.00	12.50	96.00	12.20
Januray 4, 2018	2.50	2.50	2.50	3.00	2.90	2.90							
January 17, 2018	1.90	1.80	2.10	2.20	2.20	2.20	January 17, 2018	94.00	13.30	92.00	12.80	91.00	12.70
January 27, 2018	0.80	1.60	1.70	1.60	1.80	1.80	January 27, 2018	83.00	11.80	81.00	11.40	79.00	11.10
February 7, 2018	1.10	1.10	1.30	1.50	1.60	1.40	February 7, 2018	99.00	14.30	98.00	14.20	95.00	13.70
February 15, 2018	1.00	1.00	1.10	1.20	1.30	1.30	February 15, 2018	91.00	12.90	90.00	12.70	88.00	12.40
Febraury 26, 2018	0.80	0.80	0.70	0.60	0.70	0.80	February 26, 2018	98.00	14.20	96.00	13.90	94.00	13.60

Appendix D
Benthic Depositional Modelling
for
Grieg Seafarms in Placentia Bay

FINAL

Benthic Depositional Modelling for Grieg Seafarms in Placentia Bay

Submitted to:

Grieg NL Seafarms Ltd.

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709-279-7226

Submitted by:

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29 July 2016

Amec Foster Wheeler Project #: TF1691501

IMPORTANT NOTICE

This report was prepared exclusively for Grieg by Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler). The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in Amec Foster Wheeler's services and based on: i) information available at the time of preparation, ii) data supplied by outside sources and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by Grieg only, subject to the terms and conditions of its contract with Amec Foster Wheeler. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

EXECUTIVE SUMMARY

To address the federal Department of Fisheries and Oceans (DFO) Aquaculture Activities Regulations (AAR) permitting requirements condition 8.1a the 1, 5 and 10 grams of carbon per meter squared per day depositional contours are calculated for each marine production site using a specified daily quantity of feed usage. Overall the majority of depositional contours predicted from the model will not exceed 1g C/ m2 /day with minimal exceptions at shallower sites.

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APPENDIX A: DHI HYDROGRAPHIC REPORT

1.0 INTRODUCTION

Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler) is pleased to provide the required Benthic Depositional Modeling at the proposed marine production sites in Placentia Bay for the purpose of satisfying the federal Department of Fisheries and Oceans (DFO) Aquaculture Activities Regulations (AAR) permitting requirements specific to:

"Predicted Contours [AAR paragraph 8(1)(a)]

1. (1) Calculate the rate of deposition of biochemical oxygen demanding (BOD) matter from the facility during maximum daily quantity of feed usage, using an aquaculture waste deposition model, and map the 1, 5, and 10 g C/m^2/day depositional contours."

This work was conducted using the commercially available aquaculture industry benthic depositional modeling software DEPOMOD (version 2.4.1) (Cromey et al 2002) using the methods and settings defined in "DEPOMOD Canada Methods and Settings v1.6" and provided by DFO (DFO 2016), and the output calculations were plotted using MATLAB (version 7.12.0.635 R2011a) software.

2.0 INPUT DATA

Information regarding the locations and production capacity of Grieg NL Seafarms Ltd. marine sites was obtained from the "Placentia Bay Atlantic Salmon Aquaculture Project" Environmental Assessment Registration (Grieg NL 2016) and in consultation with Grieg NL Seafarms Ltd. personnel.

2.1 Bathymetry

A 2400x2400 m bathymetric grid was created around each farm site using data obtained from the Canadian Hydrographic service.

2.2 Currents

Current data was recorded at the 11 sites of interest during the winter of 2015-2016 by DHI (see Appendix A). The deployments ranged from ~12 hours to several days. The 20-minute averaged data was looped on itself to create 1-month long timeseries for each site.

Other assumptions used for setting up the current velocity data:

- ADCP moored ~3m above anchor (seafloor)
- No magnetic correction applied to raw data, we apply this inside DEPOMOD
- Use the same 3 depth layers defined in the DHI report (Appendix A)
- Mean tidal range is 1m above chart datum

2.3 DEPOMOD Inputs

Grid Generation Module (values set by user)	
Major grid cell dimensions	40 x 40 m
Number of major grid cells	60
Minor grid cell dimensions	25 x 25 m
Number of minor grid cells	90
Particle Tracking Module	
Material type	Carbon
Feed release type	Continuous release of food
Particle Information (defaults)	
Feed water content	9%
Feed digestibility	85%
Feed wasted as % of feed pellets (dry weight)	3%
Carbon as % of feed pellets (dry weight)	49%
Carbon as % of feces (dry weight)	30%
Settling velocity of feed pellets (mean)	9.5 cm/s
Settling velocity of feces (mean)	3.2 cm/s
Current velocity data (see Appendix A for Current information)	
Current velocity layers	3: near-surface, mid-depth, near-bottom

Grid Generation Module (values set by user)	
Current velocity time step	1200 s (20 minutes)
Turbulence model (default values)	
Random walk model	Yes
Dispersion coefficient (x)	0.100 m^{-2} s^{-1}
Dispersion coefficient (y)	0.100 m^{-2} s^{-1}
Dispersion coefficient (z)	0.001 m^{-2} s^{-1}
Particle trajectory model (default values)	
Number of particles released	10
Trajectory evaluation accuracy (model time step)	High (60 s)
Resuspension module	Turned off

2.4 CAGE INFORMATION

Number of Cages	12 per site (6 at Brine island and Iona island)
Cage Circumference	160 m
Cage diameter	51 m
Cage depth (below water surface)	30 m
Feed input	1,124 kg/cage/day

3.0 FARM SITE RESULTS

Below are the depth layers used, maps of the lease area, and depositional contours generated using DEPOMOD for 1, 5 and 10 grams of carbon per meter squared per day calculated for each marine production site based on the specified daily quantity of feed input. Depths depicted in all figures are in meters.

3.1 Gallows Harbour

Table 3-1: Gallows Harbour depth layer information

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Gallows Harbour (47.3588N, 54.6942W)	113 m	Near-Surface	2159	20	83 m above bottom
		Mid-Depth	2159	20	43 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-1: Gallows Harbour Map

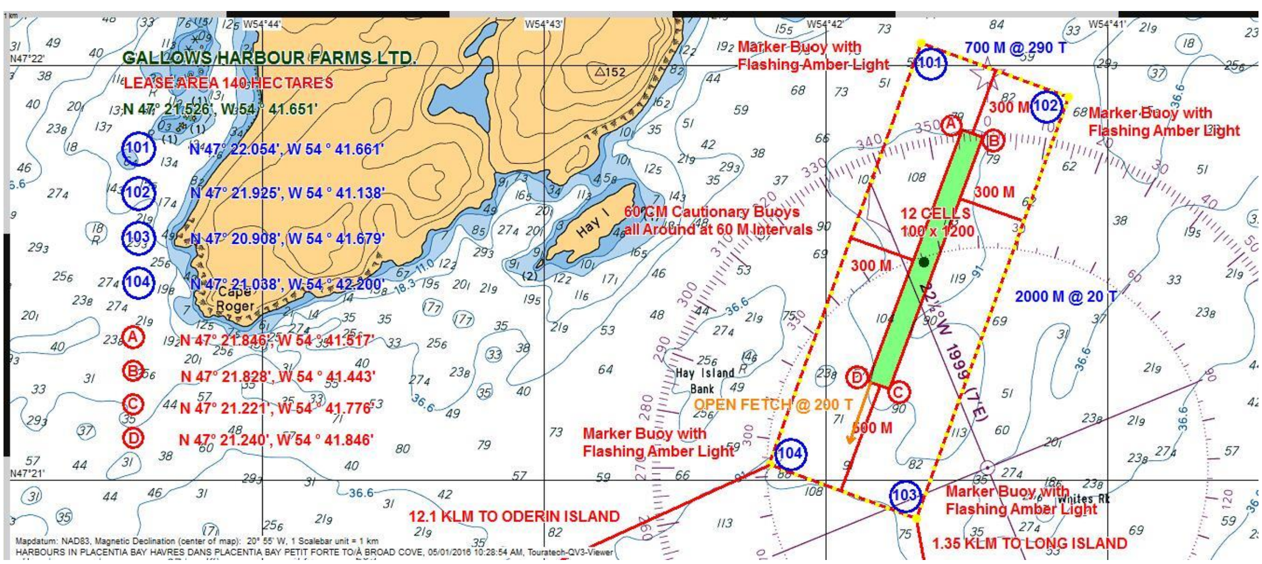
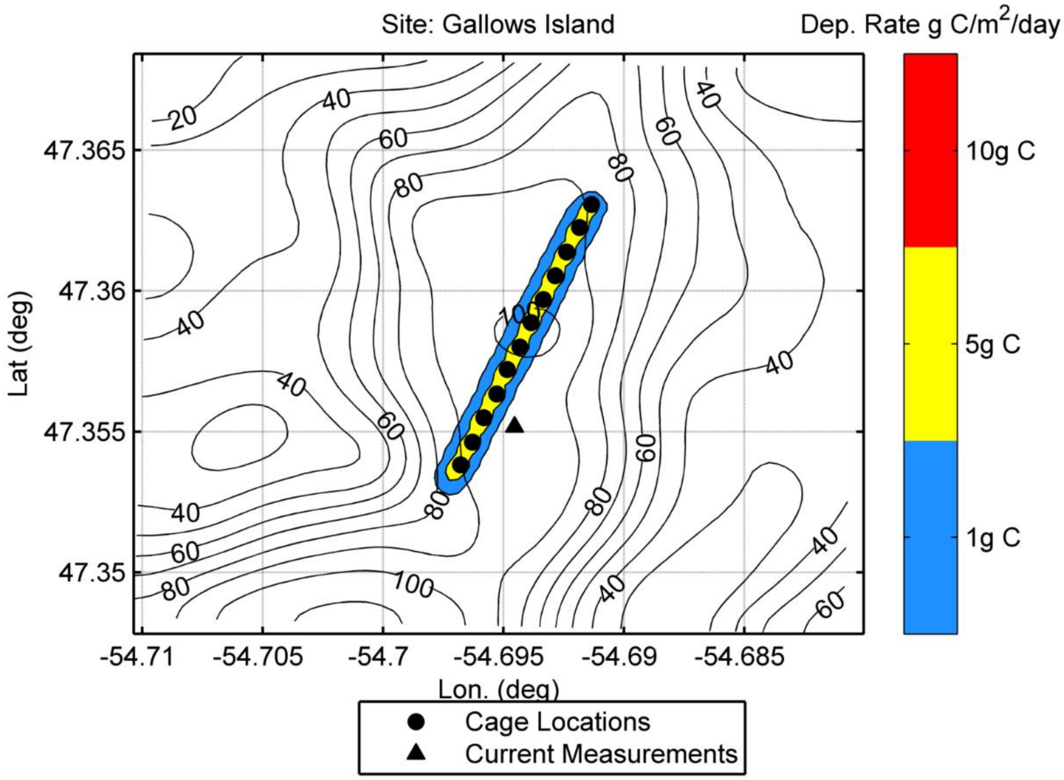


Figure 3-2: Gallows Harbour depositional contours



3.2 Long Island

Table 3-2: Long Island depth layer information

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Long Island (47.3283N, 54.6979W)	137 m	Near-Surface	2159	20	107 m above bottom
		Mid-Depth	2159	20	50 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-3: Long Island map

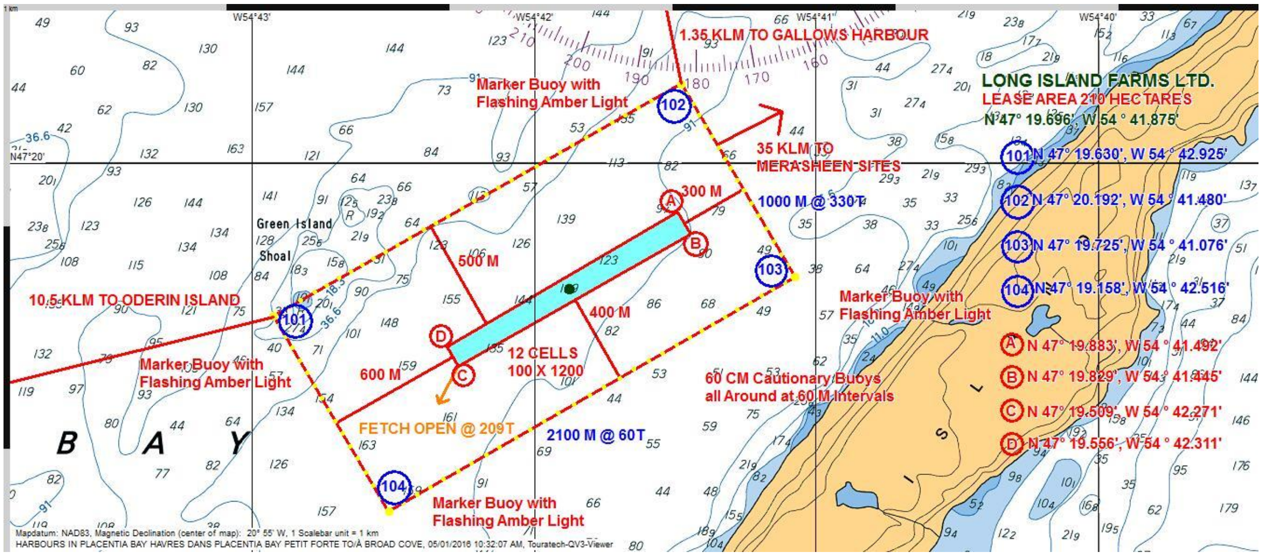
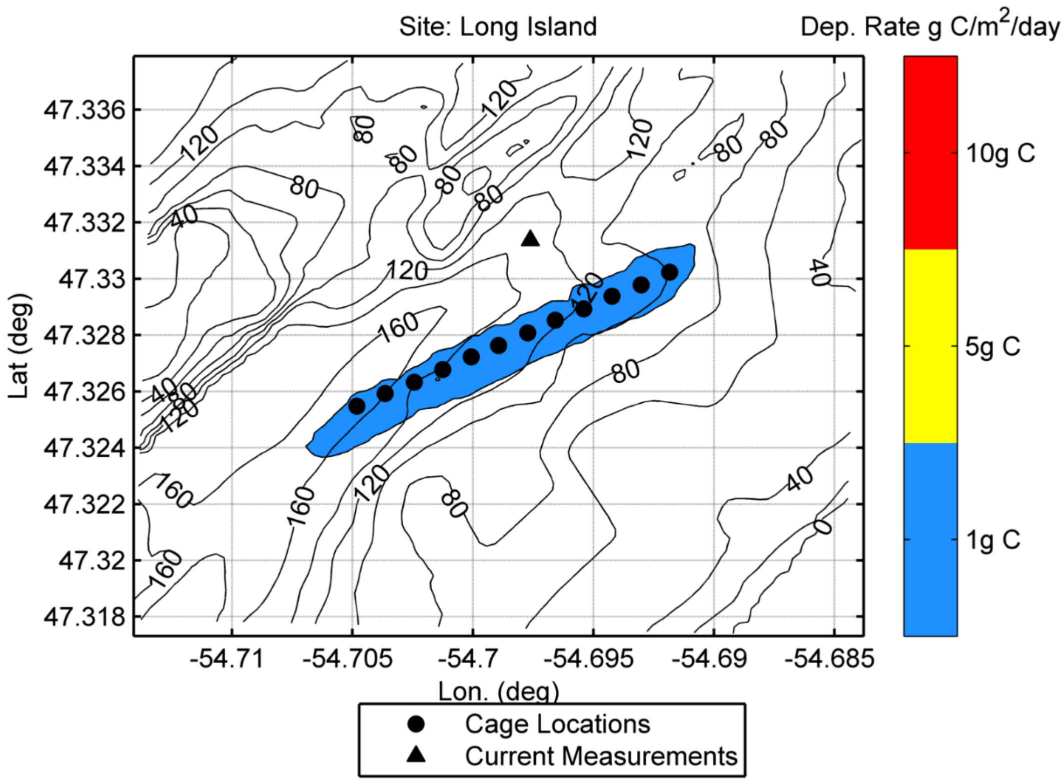


Figure 3-4: Long Island depositional contours



3.3 Oderin Island

Table 3-3: Oderin Island depth layer information

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Oderin Island (47.2983, 54.8595W)	83 m	Near-Surface	2159	20	53 m above bottom
		Mid-Depth	2159	20	25 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-5: Oderin Island map

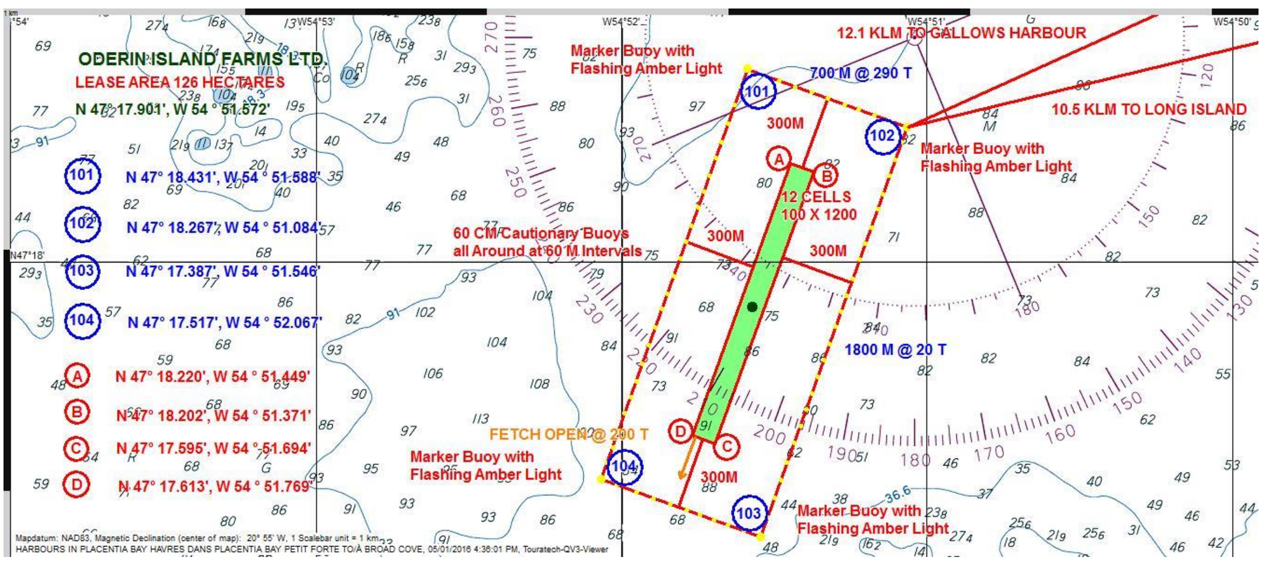
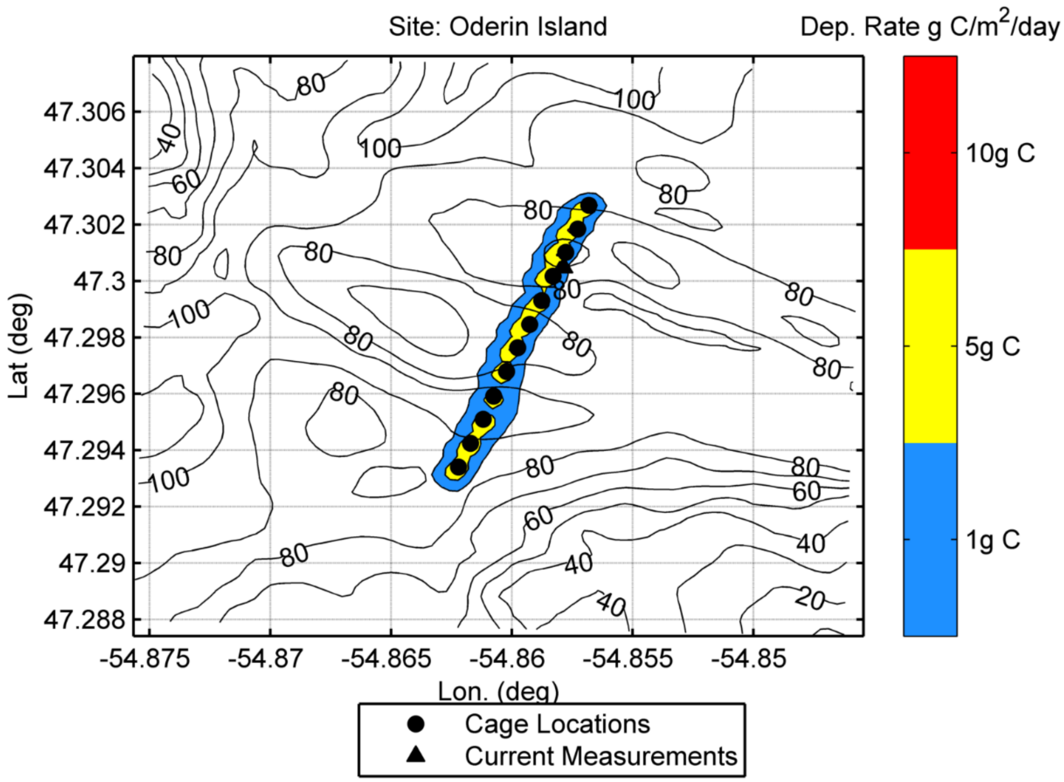


Figure 3-6: Oderin island depositional contours



3.4 Valens Island

Table 3-4: Valens Island depth layers

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Valens island (47.5243N, 54.3901W)	238 m	Near-Surface	2159	20	213 m above bottom
		Mid-Depth	2159	20	108 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-7: Valens Island map

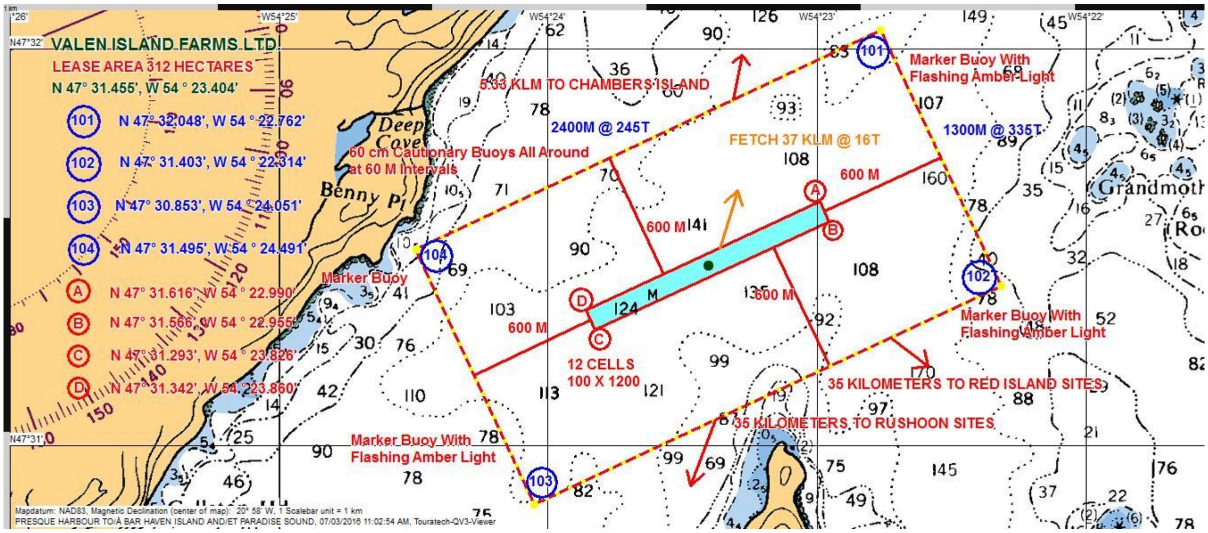
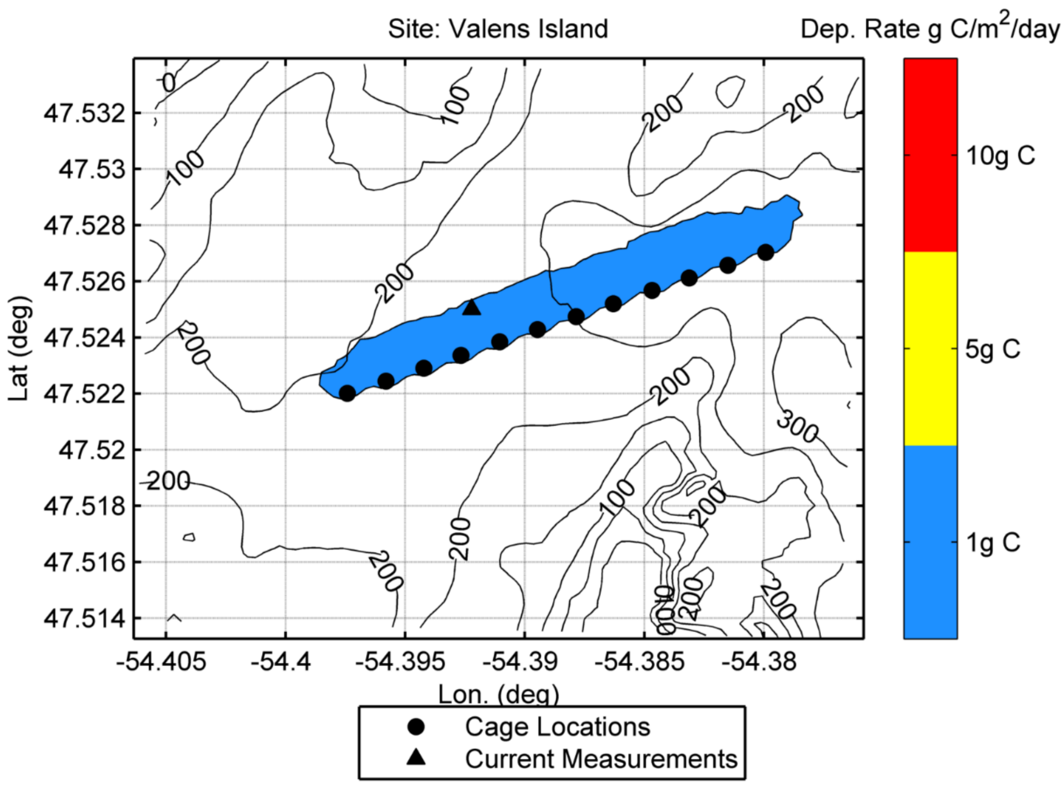


Figure 3-8: Valens Island depositional contours



3.5 Chambers Island

Table 3-5: Chambers Island depth layers

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Chambers Island (47.5795N, 54.3520W)	268 m	Near-Surface	2159	20	238 m above bottom
		Mid-Depth	2159	20	108 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-9: Chambers Island map

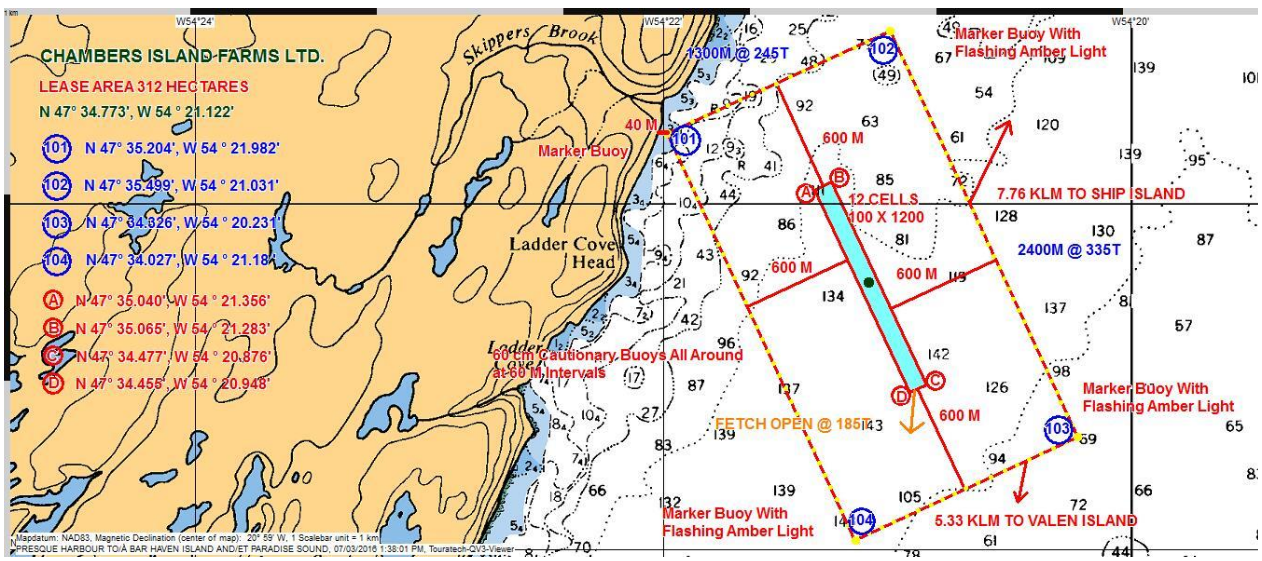
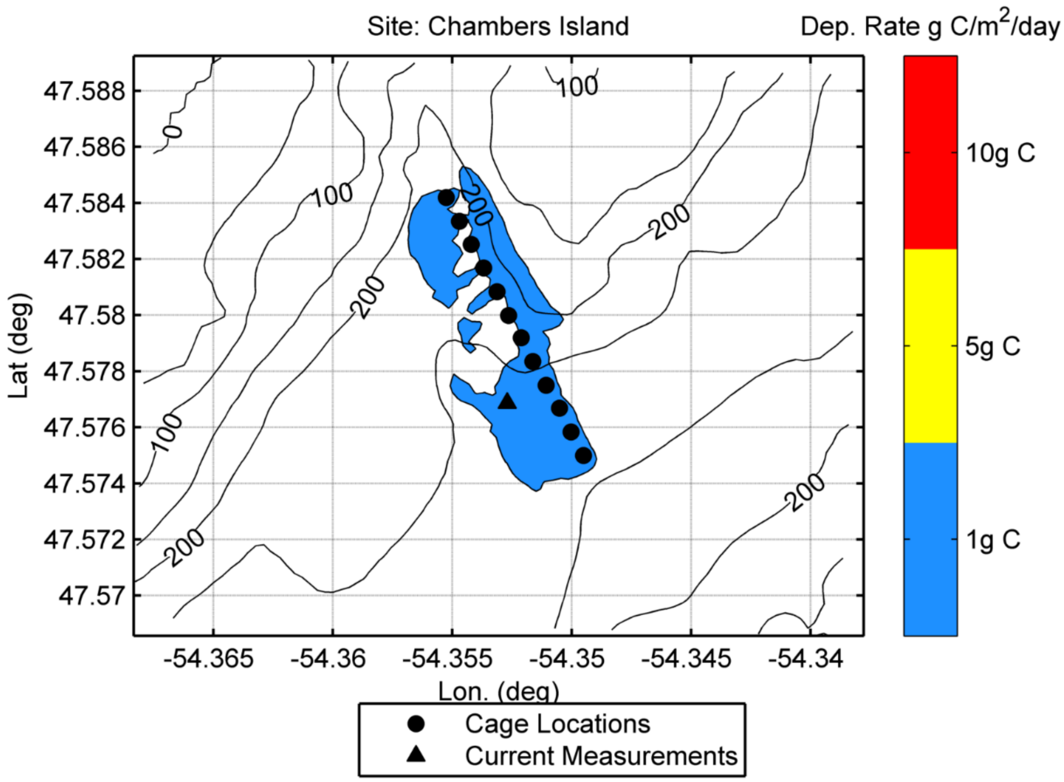


Figure 3-10: Chambers island depth contours



3.6 Ship Island

Table 3-6: Ship island depth layers

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Ship Island (47.6490N, 54.2794W)	203 m	Near-Surface	2159	20	173 m above bottom
		Mid-Depth	2159	20	88 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-11: Ship Island map

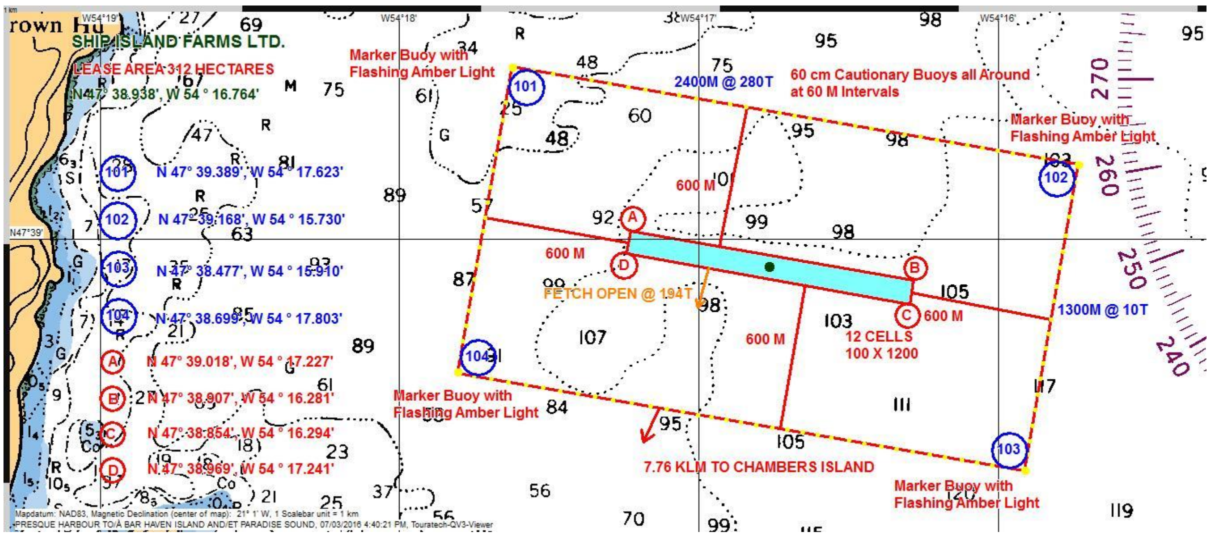
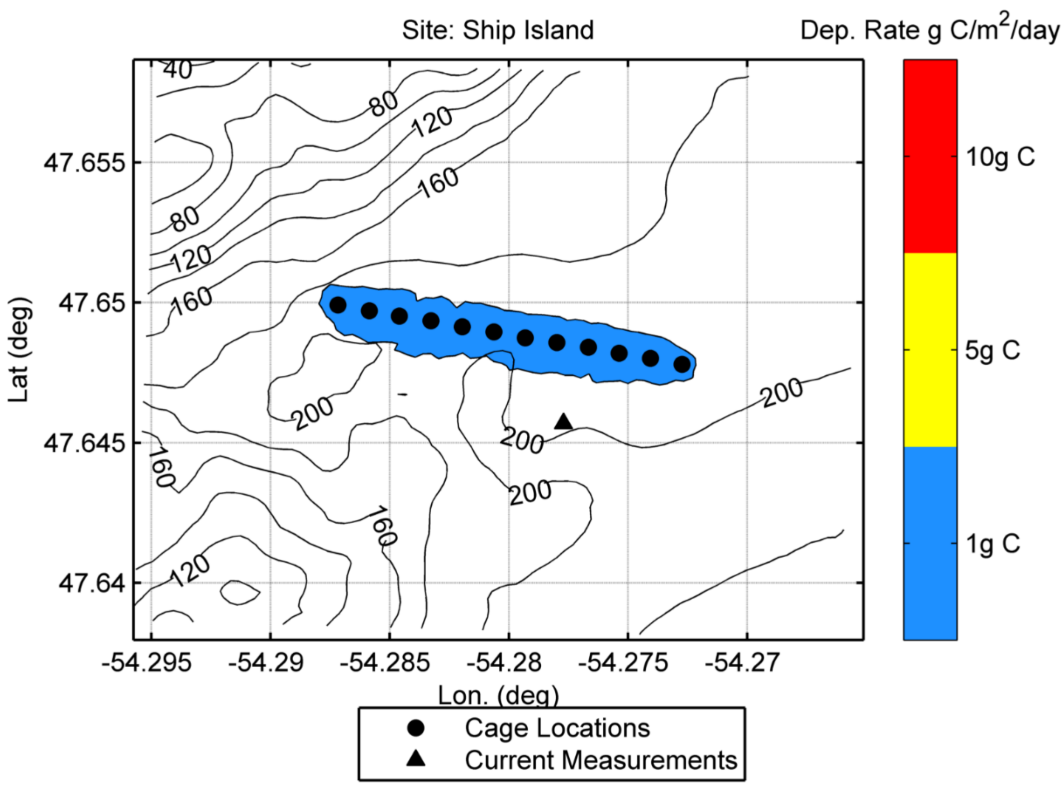


Figure 3-12: Ship Island depositional contours



3.7 Butler Island

Table 3-7: Butler Island depositional contours

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Butler Island (47.5700N, 54.1159W)	103 m	Near-Surface	2159	20	73 m above bottom
		Mid-Depth	2159	20	33 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-13: Butler Island map

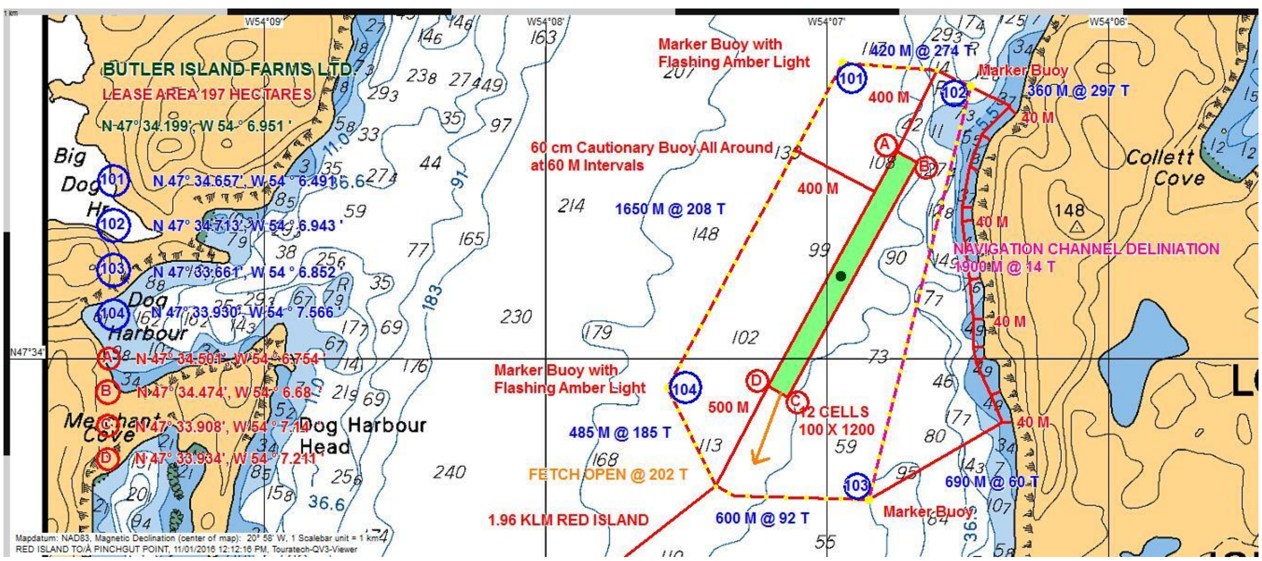
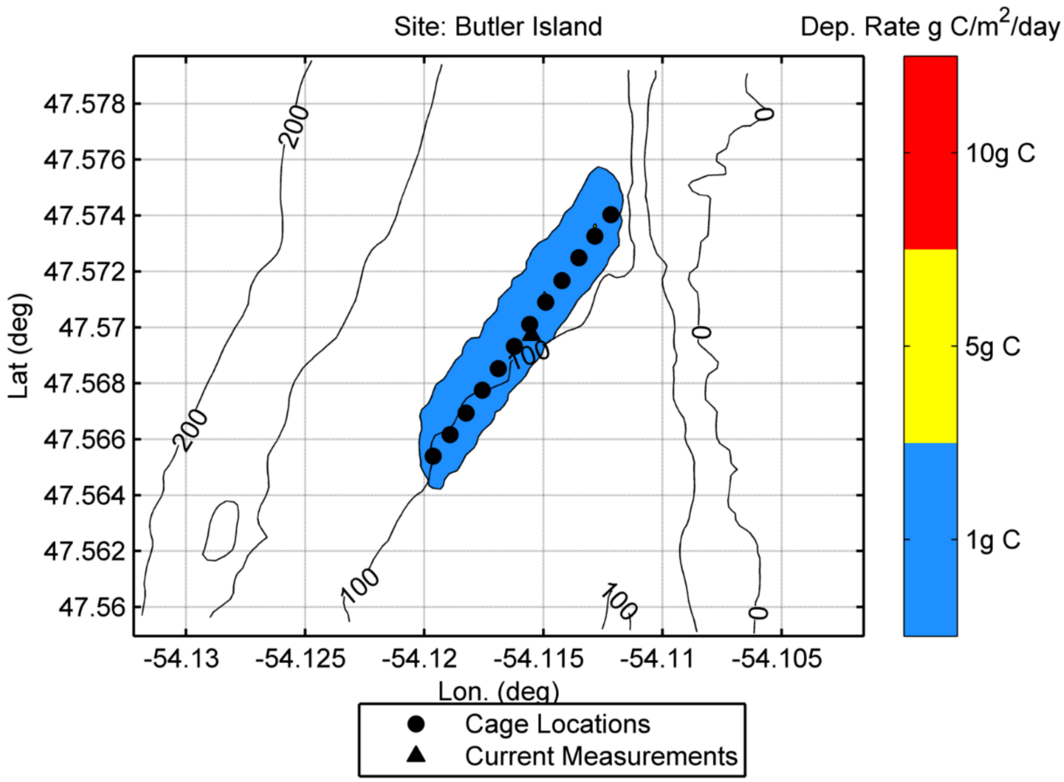


Figure 3-14: Butler Island depositional contours



3.8 Red Island

Table 3-8: Red Island depth layers

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Red Island (47.5404N, 54.1489W)	108 m	Near-Surface	2159	20	78 m above bottom
		Mid-Depth	2159	20	33 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-15: Red Island map

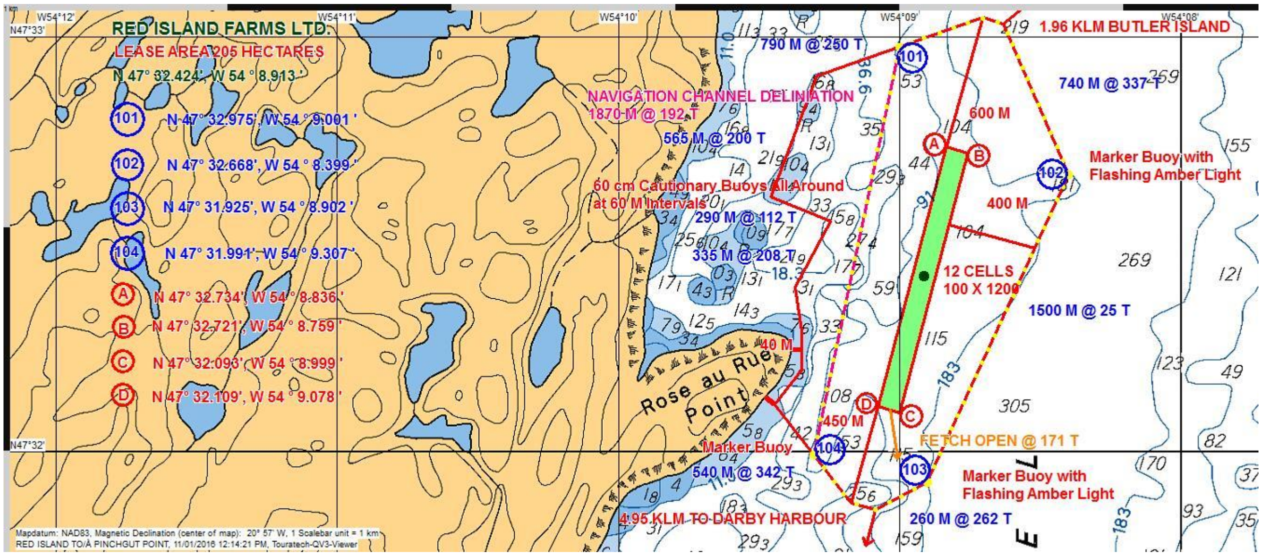
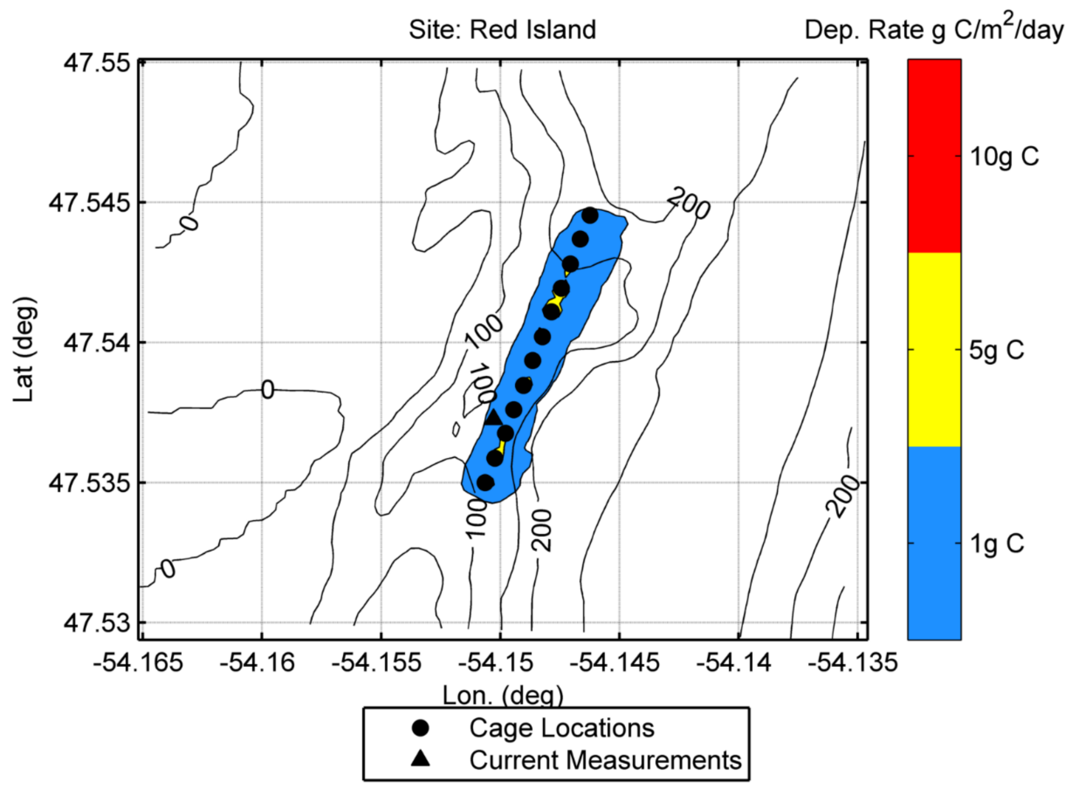


Figure 3-16: Red Island depositional contours



3.9 Darby Harbour

Table 3-9: Darby harbour depth layers

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Darby Harbour (47.4798N, 54.1863W)	125 m	Near-Surface	2159	20	95 m above bottom
		Mid-Depth	2159	20	45 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-17: Darby Harbour map

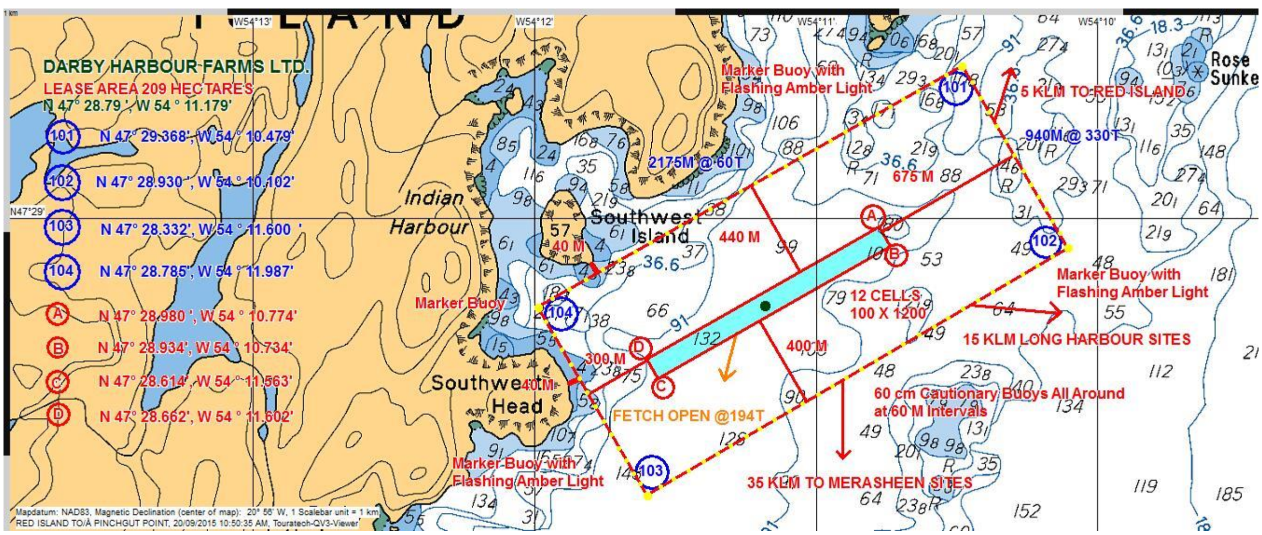
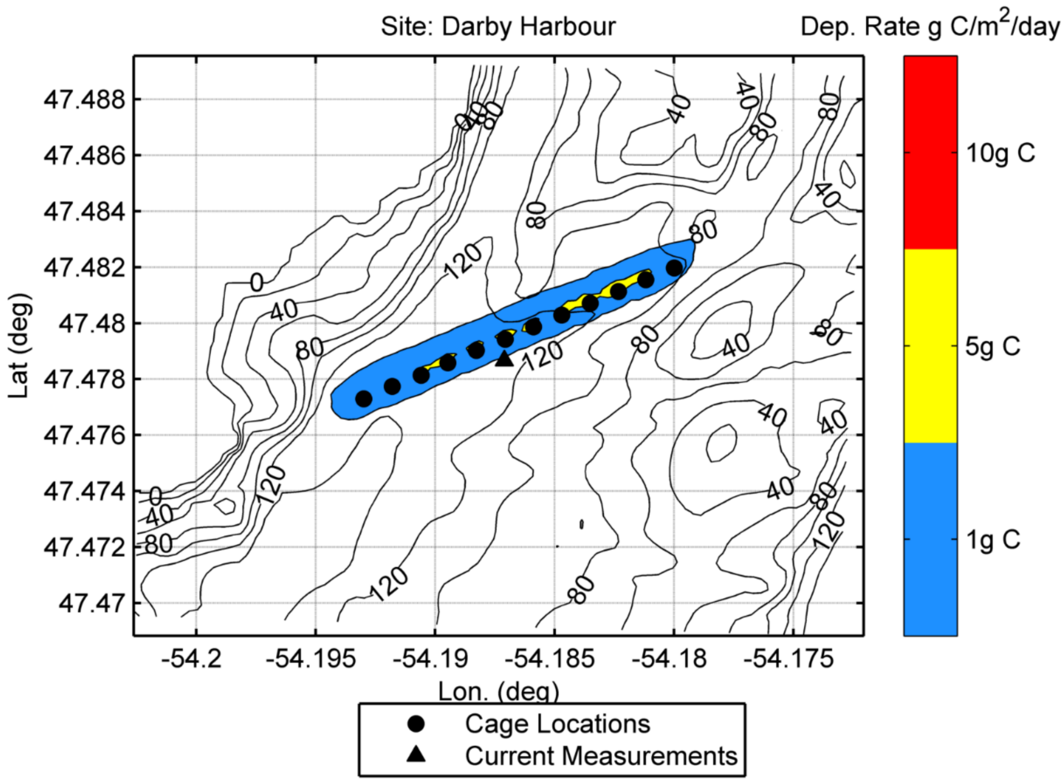


Figure 3-18: Darby Harbour depositional contours



3.10 Brine Islands

Table 3-10: Brine Island depth layers

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Brine Islands (47.4455N, 53.9671W)	118 m	Near-Surface	2159	20	88 m above bottom
		Mid-Depth	2159	20	42 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-19: Brine island map

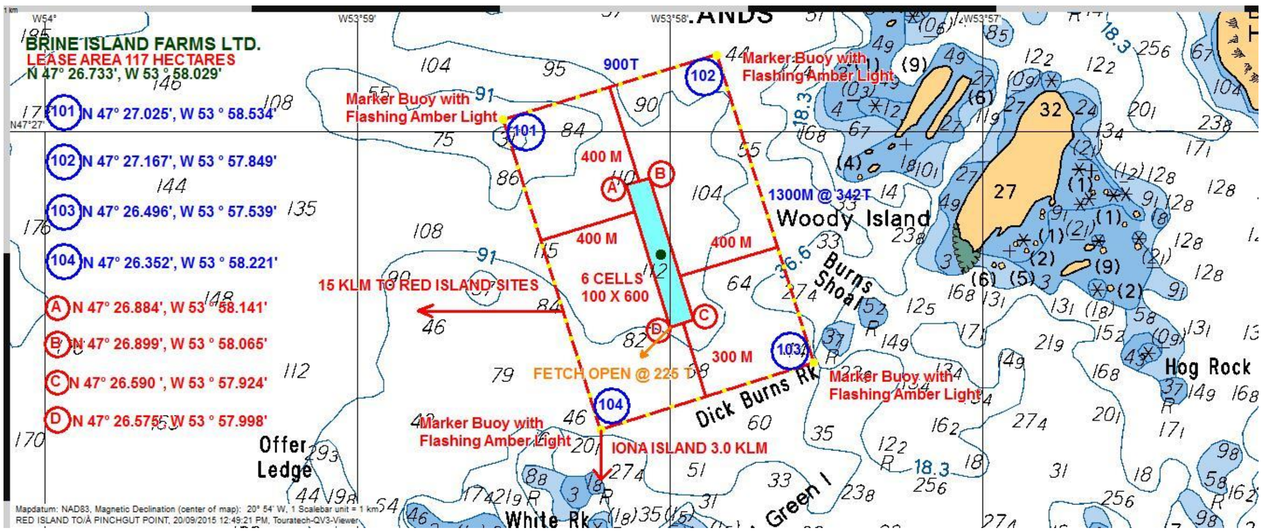
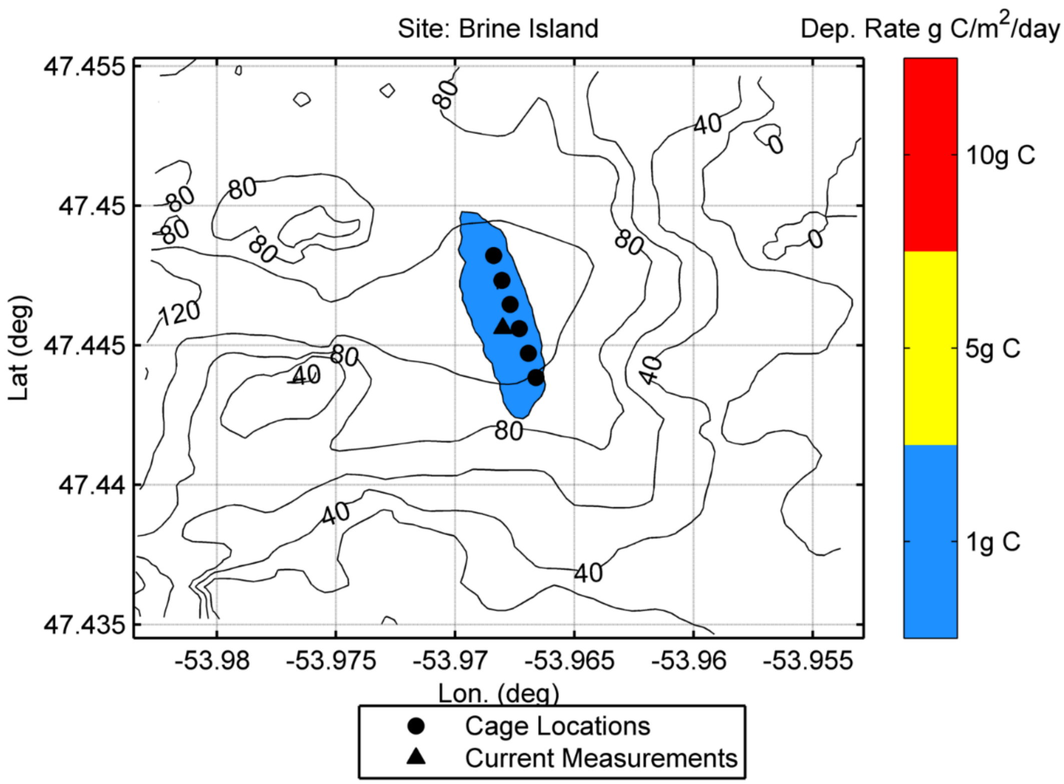


Figure 3-20: Brine Island depositional contours



3.11 Iona Islands

Table 3-11: Iona Island depth layers

Farm Site	Average water depth at current meter (m)	Depth layer	Number of records	Record length (minutes)	Location of depth layer
Iona Islands (47.4086N, 53.9750W)	98 m	Near-Surface	2159	20	68 m above bottom
		Mid-Depth	2159	20	33 m above bottom
		Near-Bottom	2159	20	3 m above bottom

Figure 3-21: Iona Islands map

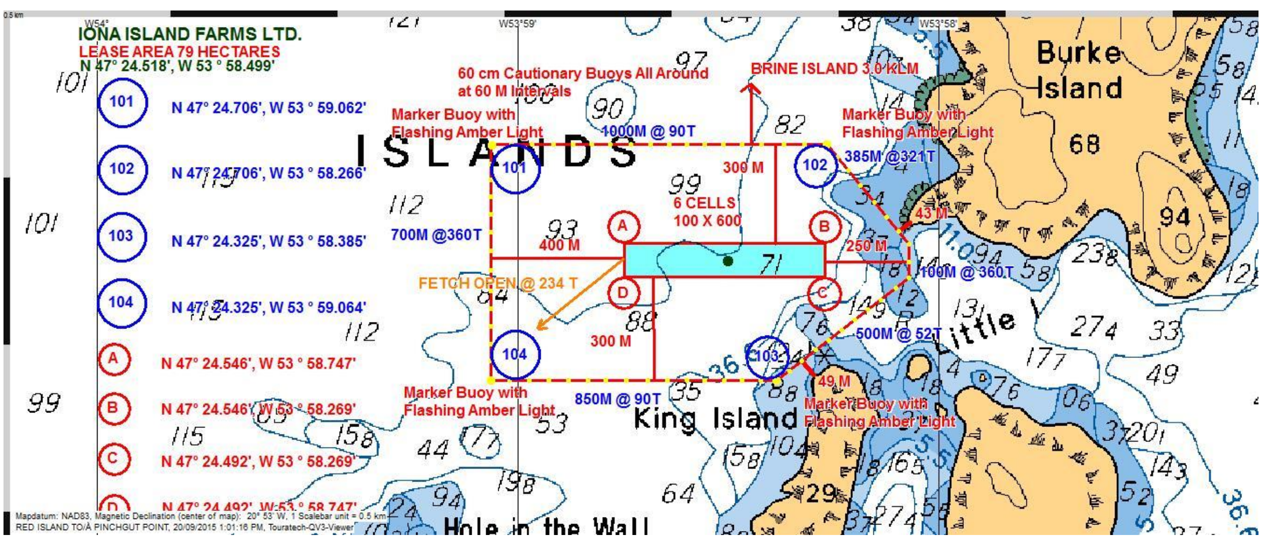
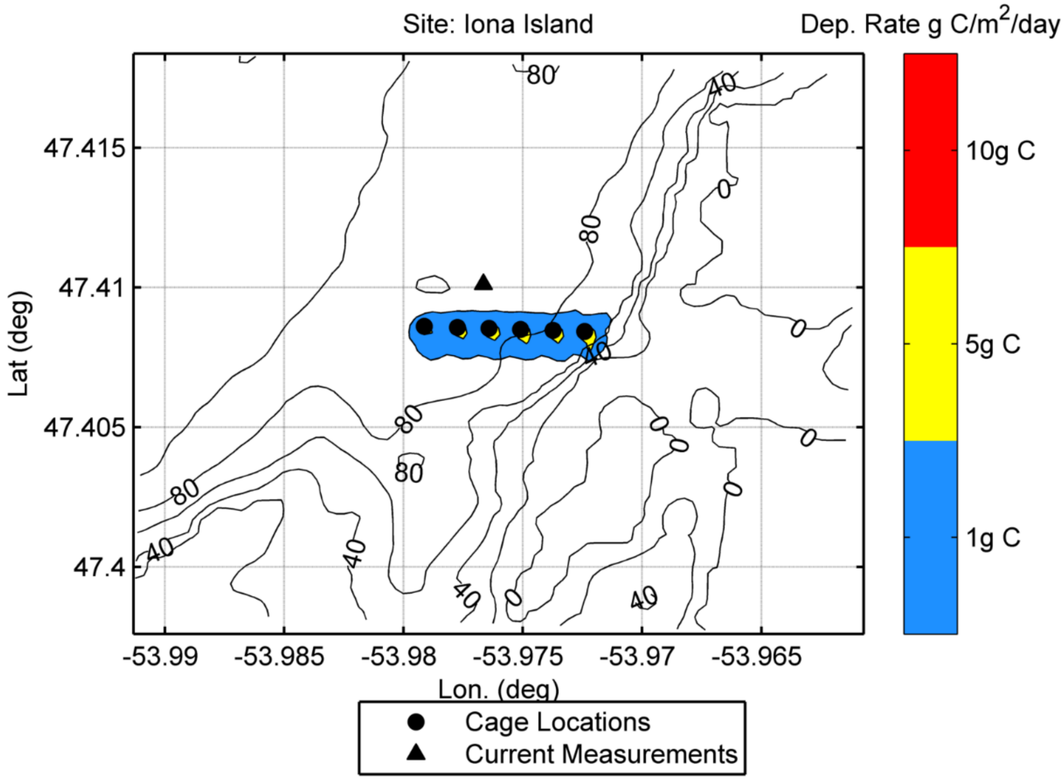


Figure 3-22: Iona Islands depositional contours



4.0 CLOSURE

Amec Foster Wheeler has prepared this Aquaculture Benthic Depositional Modeling Report for Grieg NL Seafarms Ltd. as part of their Aquaculture Activities Regulations permitting requirements. Any questions associated with this report should be directed to the undersigned and we appreciate the opportunity to conduct this work on your behalf.

Yours sincerely,

Amec Foster Wheeler Environment & Infrastructure,
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APPENDIX A: DHI Hydrographic Report

Grieg Seafarms, Newfoundland

Hydrographic surveys

Grieg Seafood BC Ltd

Report

March 2016

The expert in WATER ENVIRONMENTS

This report has been prepared under the DHI Business Management System
certified by Bureau Veritas to comply with ISO 9001 (Quality Management)

ISO 9001
Management System Certification
BUREAU VERITAS
Certification Denmark A/S

Grieg Seafarms, Newfoundland

Placentia Bay, current measurements

Prepared for	Grieg Seafood BC Ltd
Represented by	Knut Skeidsvoll

View of Placentia Bay

Project manager	Lindsey Aies
Quality supervisor	Ulrik Lumborg

Project number	11819009
Approval date	11 March 2016
Revision	1.0
Classification	Confidential

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1 Introduction

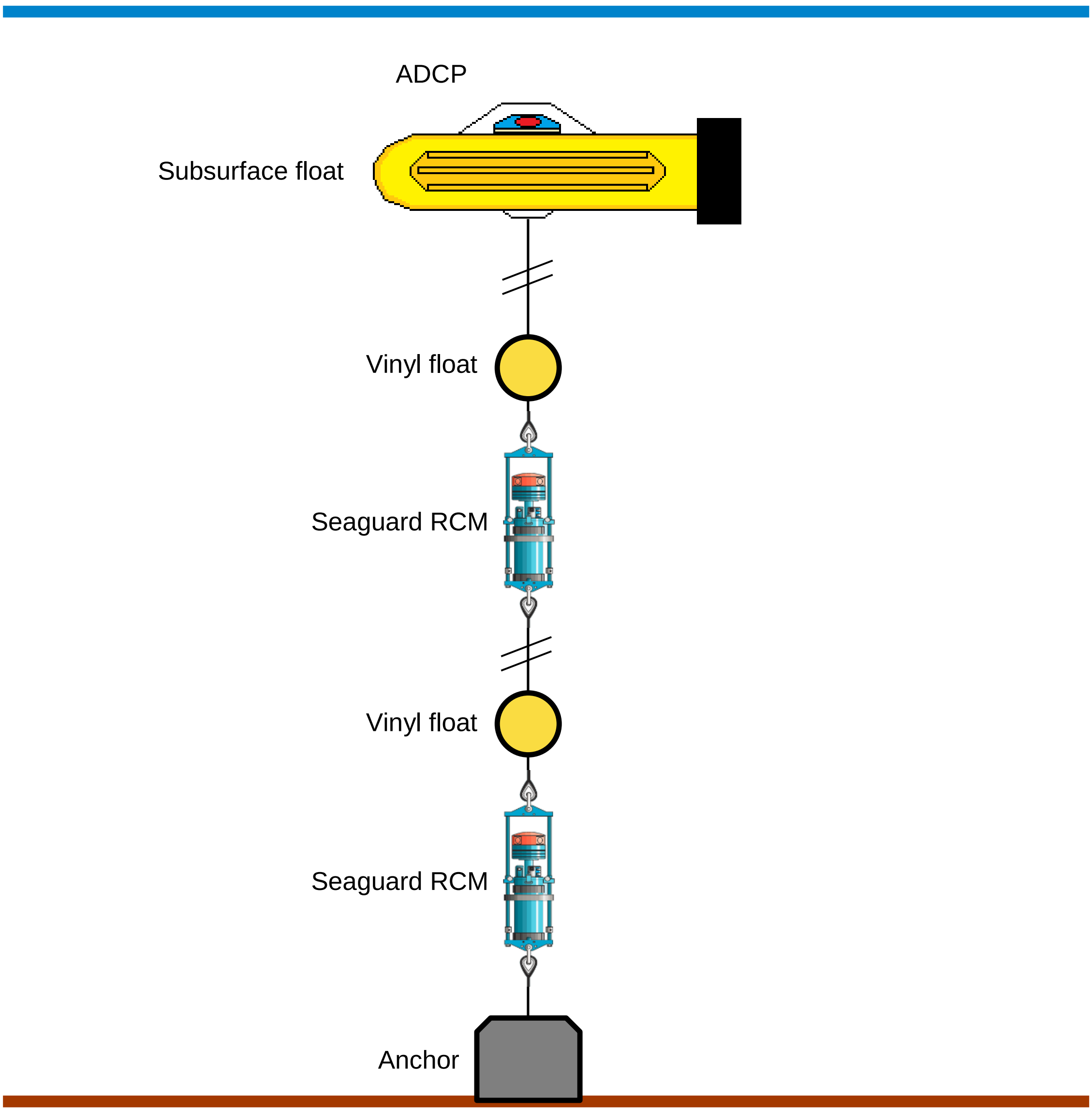
Grieg Seafarms has contracted with DHI to undertake hydrographic surveys in connection with application for establishment of new sites in Placentia Bay, Canada.

This report covers task undertaken from January to March 2016 and includes current measurements at 11 locations. Current measurements are taken at 3 points in the water column.

At all locations the aim was to document current speed and –direction during a period of 1 tidal period. Due to the rough weather during the survey period the total length of each deployment varies. The majority of deployment was over 24 hours where in three instances the deployment was only slightly less than 24 hours.

The system was compromised of two Aanderaa Seaguard RCMs and a RDI 600 kHz Workhorse Sentinel ADCP in conjunction with a subsurface float.

The system deployment is illustrated in the figure below.



Schematic view of the deployed system. The deployment was similar for all survey sites

2 Current Data

2.1 Rushoon BMA

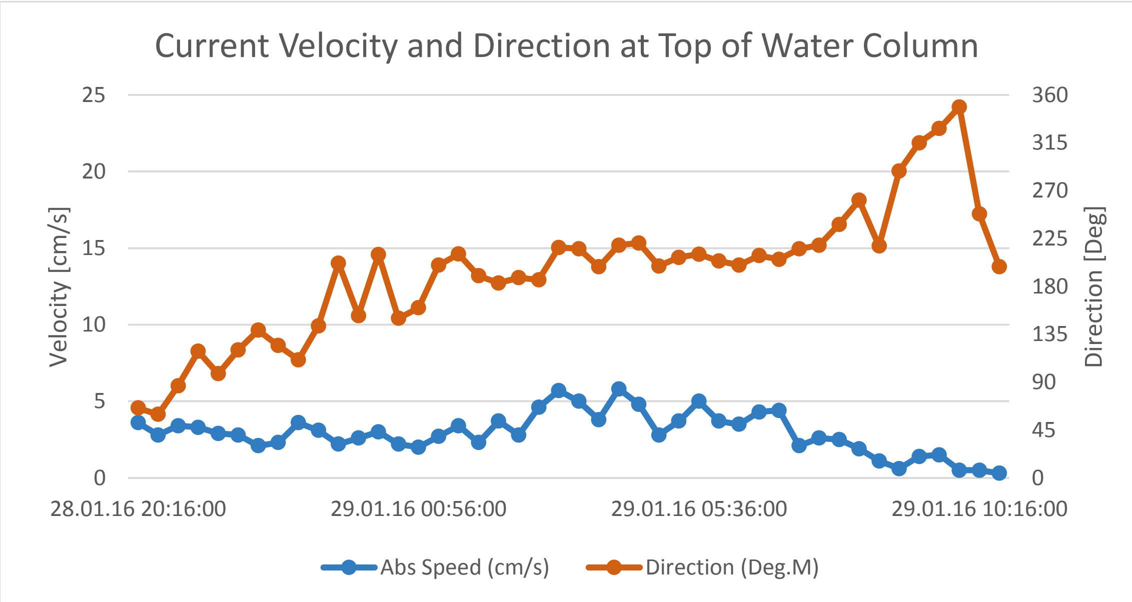
2.1.1 Gallows Harbour

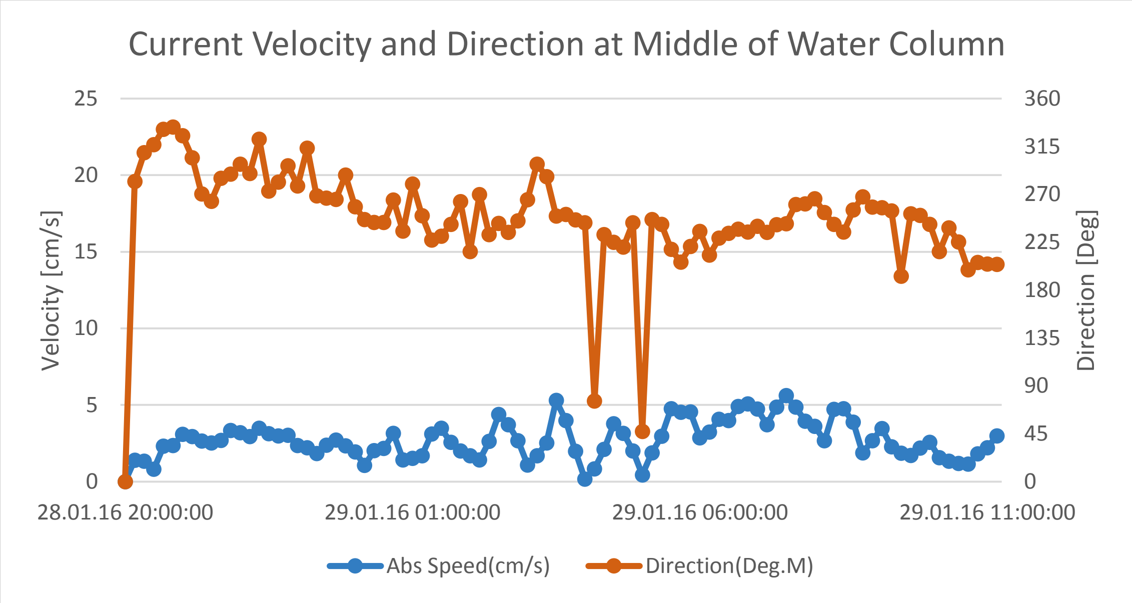
The system was placed at the follow coordinates:

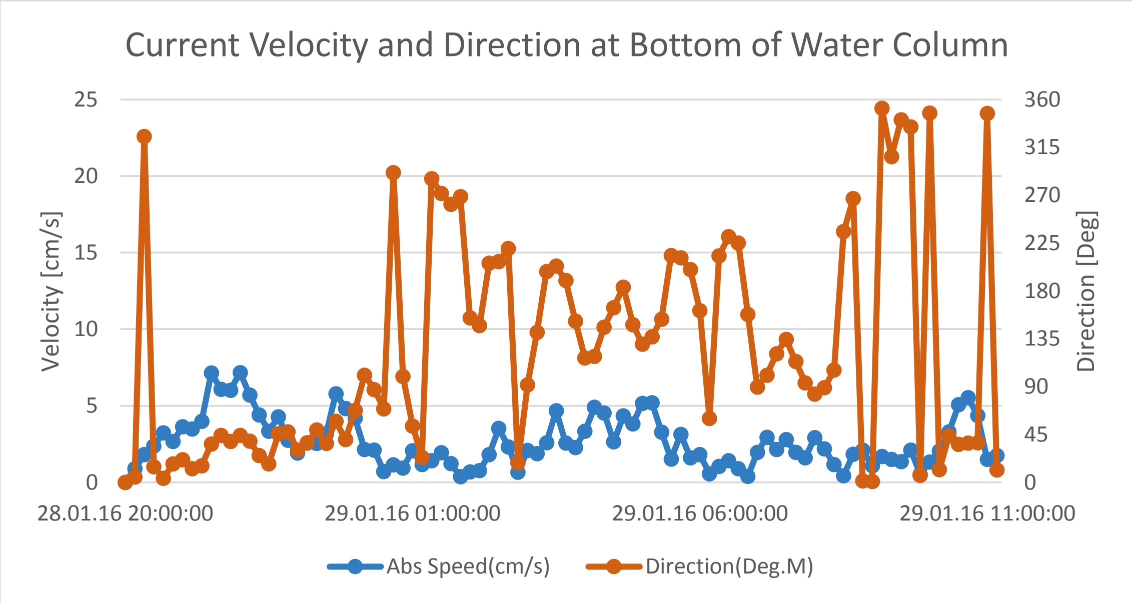
Latitude: 47º 21.311’ N
Longitude: 54º 41.673’ W

The system was deployed on the 28th of January 2016 at 20:00 UTC and recovered on the 29th of January 2016 at 11:00 UTC.

Displayed current measurements were taken at the following depths:
Top: 30 m
Middle: 70 m
Bottom: 110 m







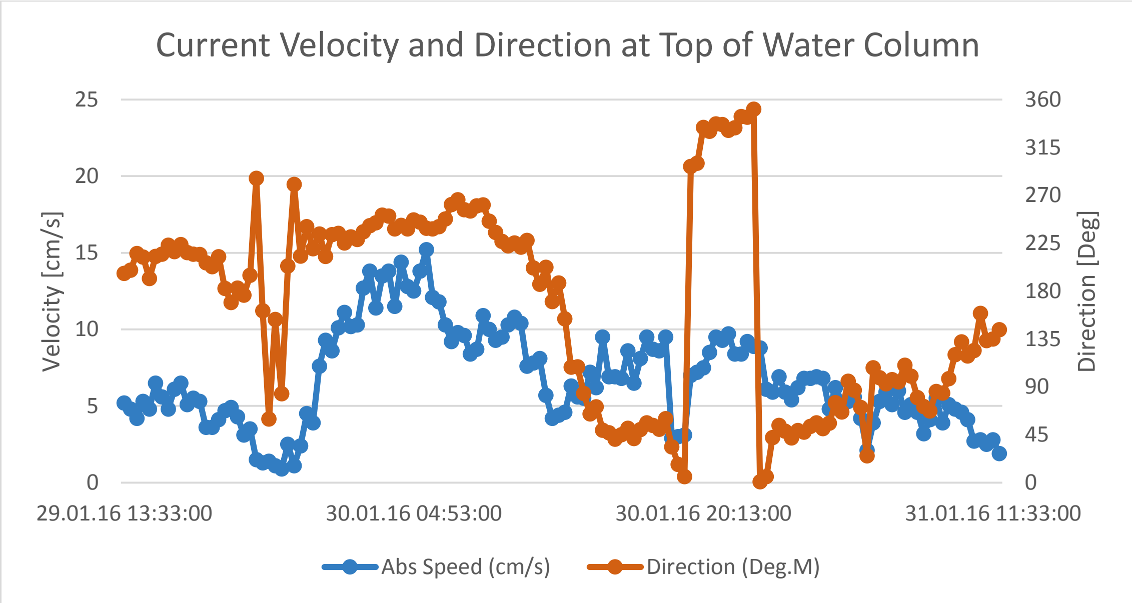
2.1.2 Long Island

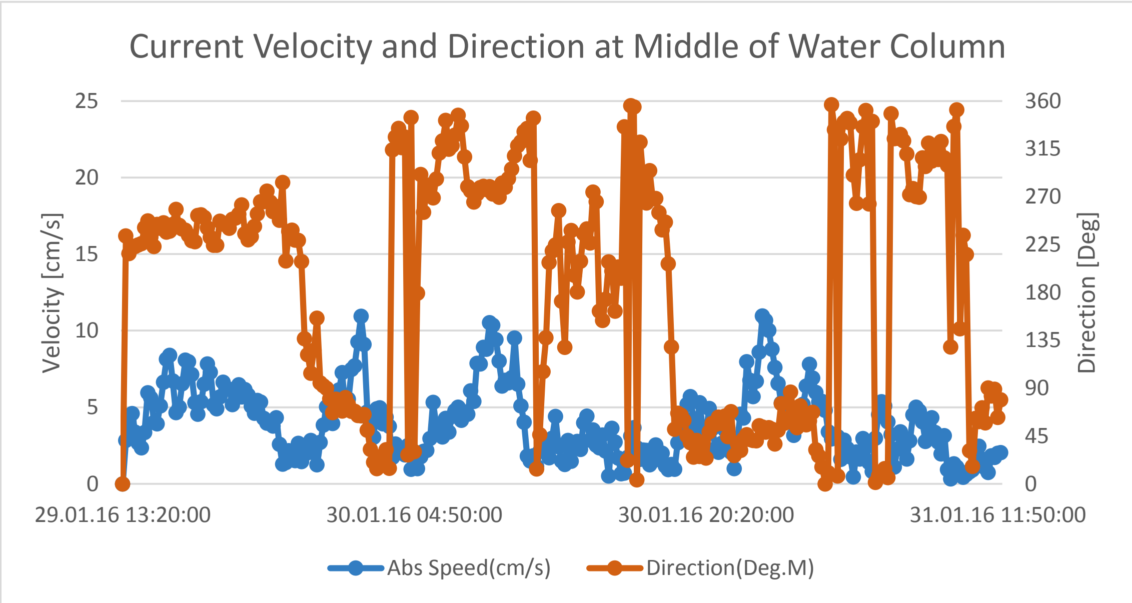
The system was placed at the following coordinates:

Latitude: 47º 19.881' N
Longitude: 54º 41.858' W

The system was deployed on the 29th of January 2016 at 13:20 UTC and recovered on the 31st of January 2016 at 12:00 UTC.

Displayed current measurements were taken at the following depths:
Top: 30 m
Middle: 87 m
Bottom: 135 m


Current Velocity and Direction at Top of Water Column
Velocity [cm/s]
25
20
15
10
5
0
Direction [Deg]
360
315
270
225
180
135
90
45
0
29.01.16 13:33:00
30.01.16 04:53:00
30.01.16 20:13:00
31.01.16 11:33:00
Abs Speed (cm/s)
Direction (Deg.M)


Current Velocity and Direction at Middle of Water Column
Velocity [cm/s]
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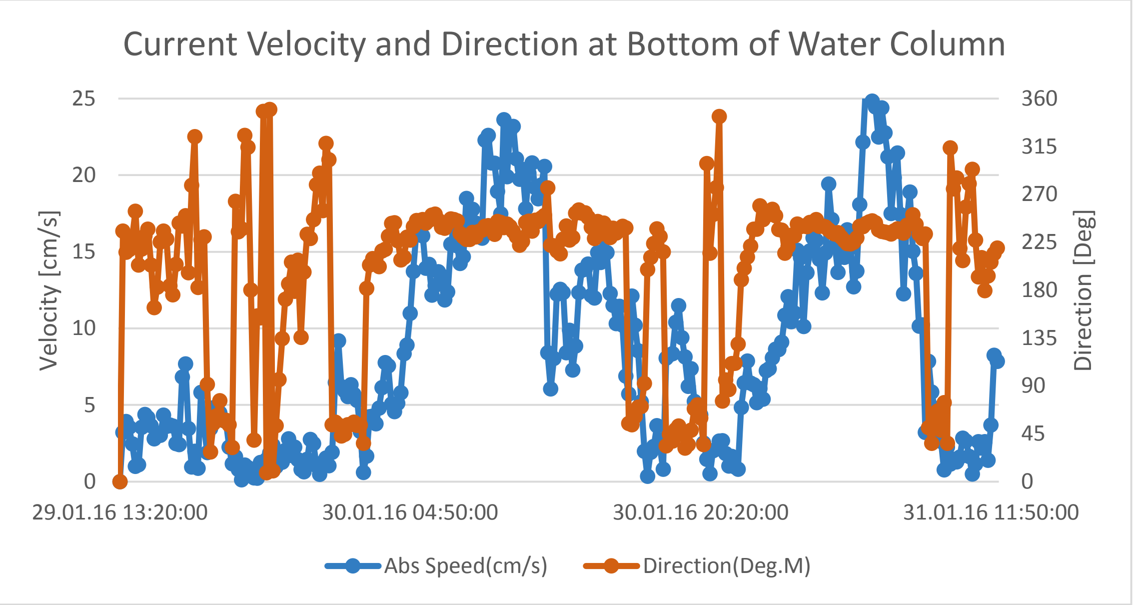
20
15
10
5
0
Direction [Deg]
360
315
270
225
180
135
90
45
0
29.01.16 13:20:00
30.01.16 04:50:00
30.01.16 20:20:00
31.01.16 11:50:00
Abs Speed(cm/s)
Direction(Deg.M)



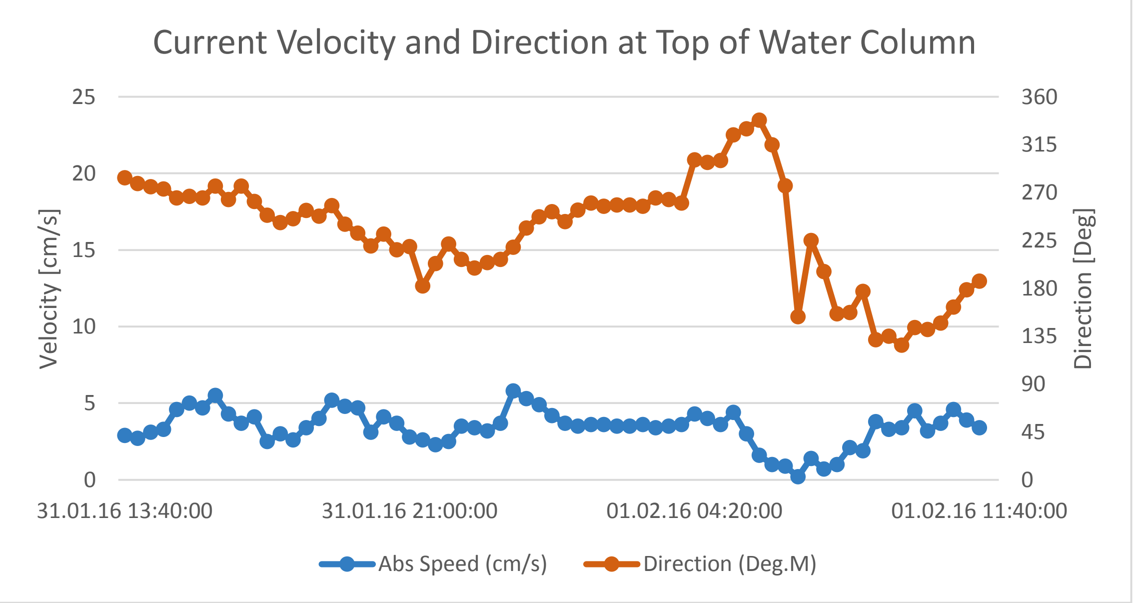
2.1.3 Oderin Island

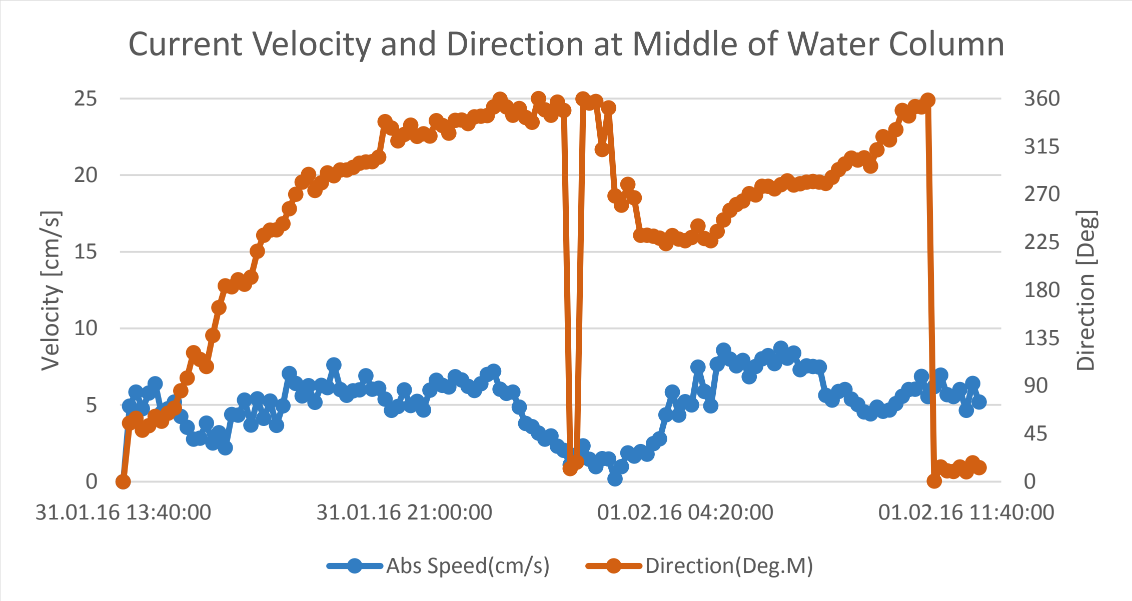
The system was placed at the follow coordinates:

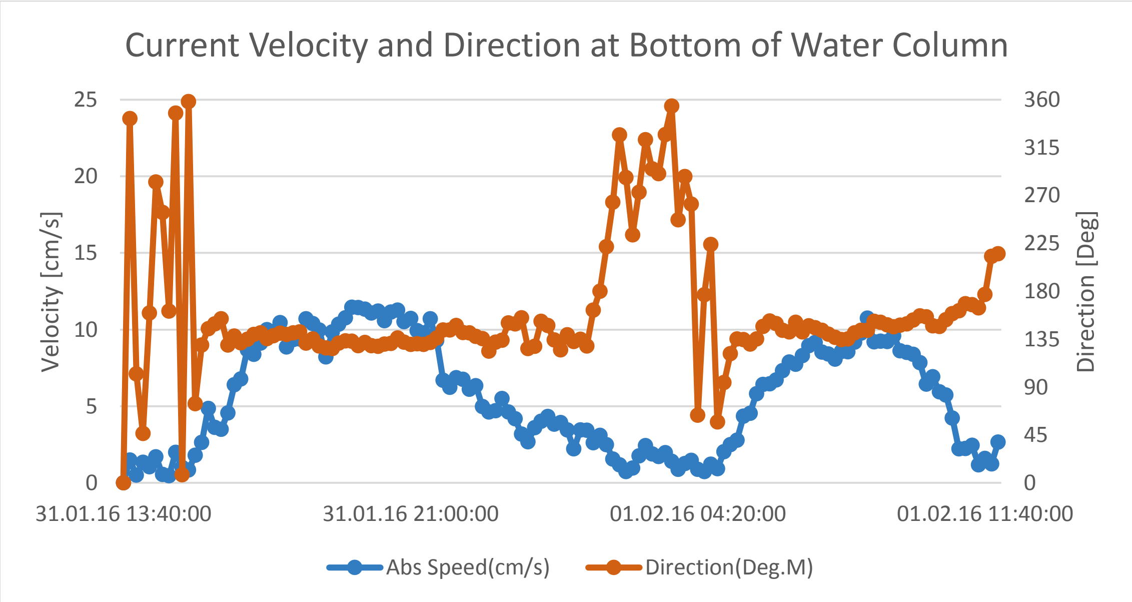
Latitude: 47º 18.030’ N
Longitude: 54º 51.470’ W

The system was deployed on the 31st of January 2016 at 13:30 UTC and recovered on the 1st of February 2016 at 11:45 UTC.

Displayed current measurements were taken at the following depths:
Top: 30 m
Middle: 58 m
Bottom: 80 m







2.2 Merasheen BMA

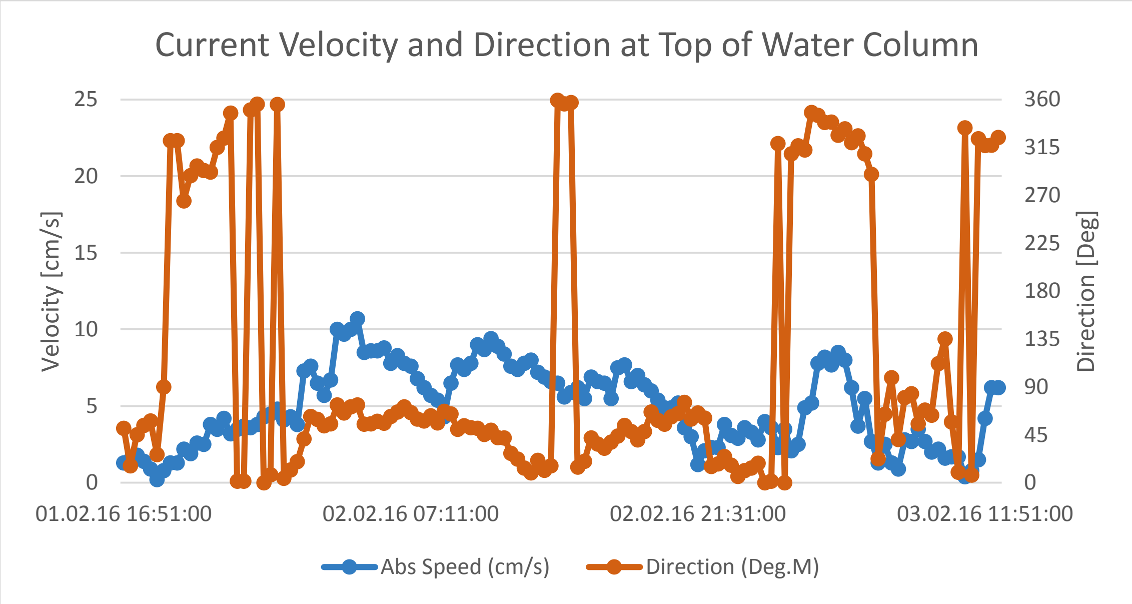
2.2.1 Valen Island

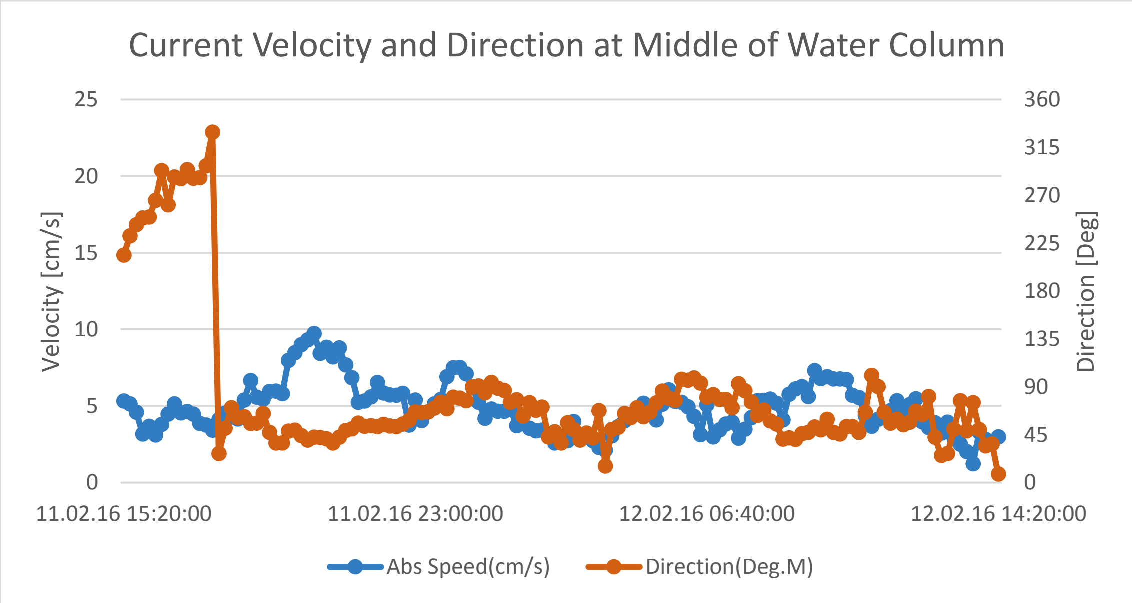
The system was placed at the follow coordinates:

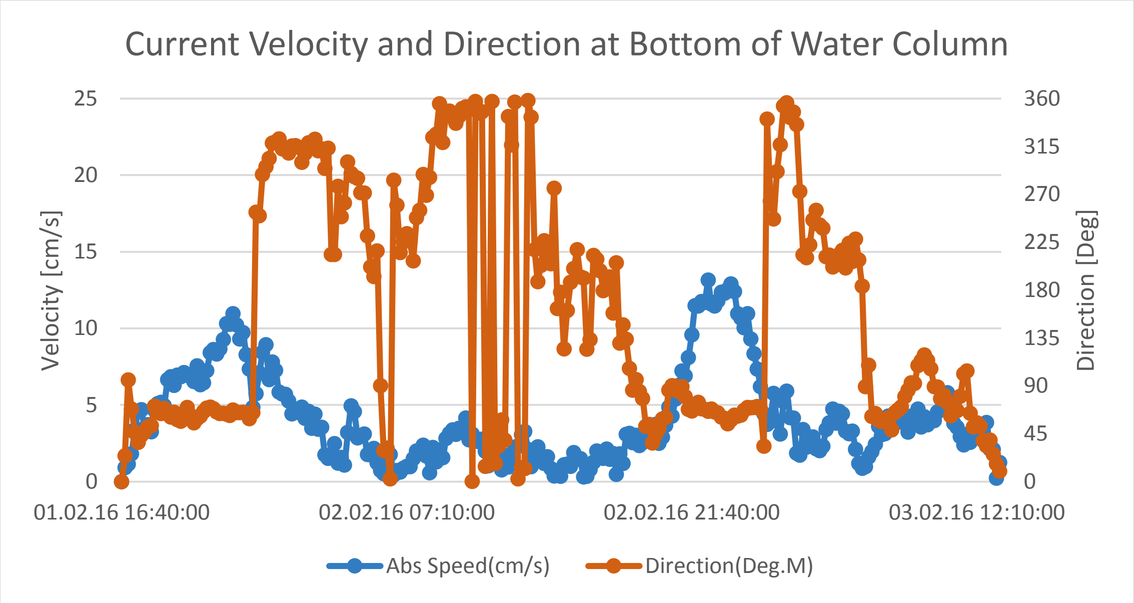
Latitude: 47º 31.500’ N
Longitude: 54º 23.533’ W

The system was deployed on the 1st of February 2016 at 16:30 UTC and recovered on the 3rd of February 2016 at 13:30 UTC.

Displayed current measurements were taken at the following depths:
Top: 25 m
Middle: 130 m
Bottom: 235 m







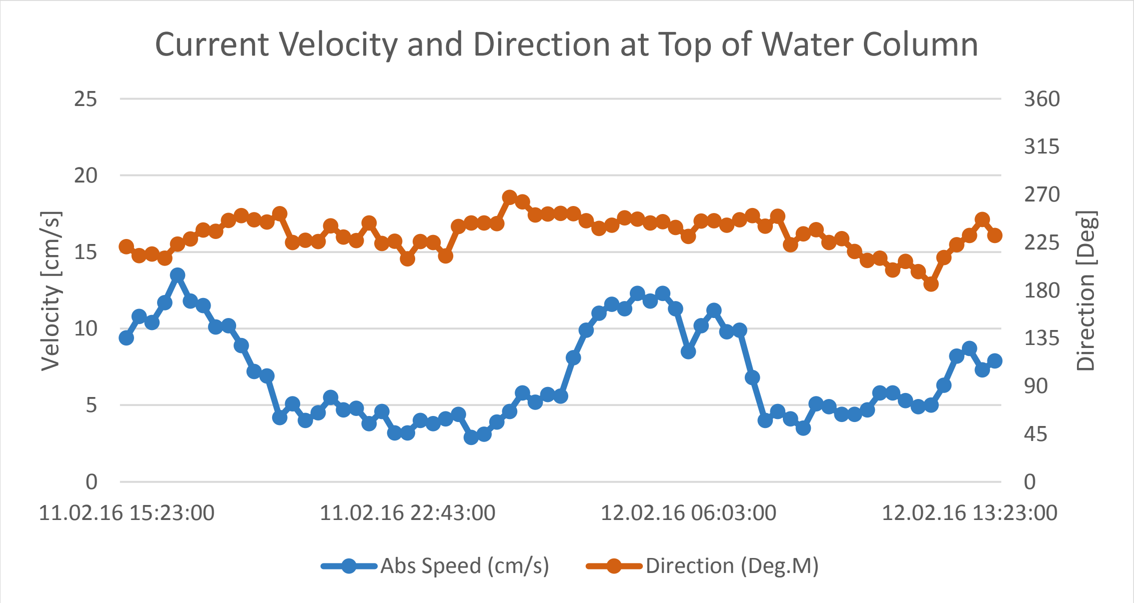
2.2.2 Chambers Island

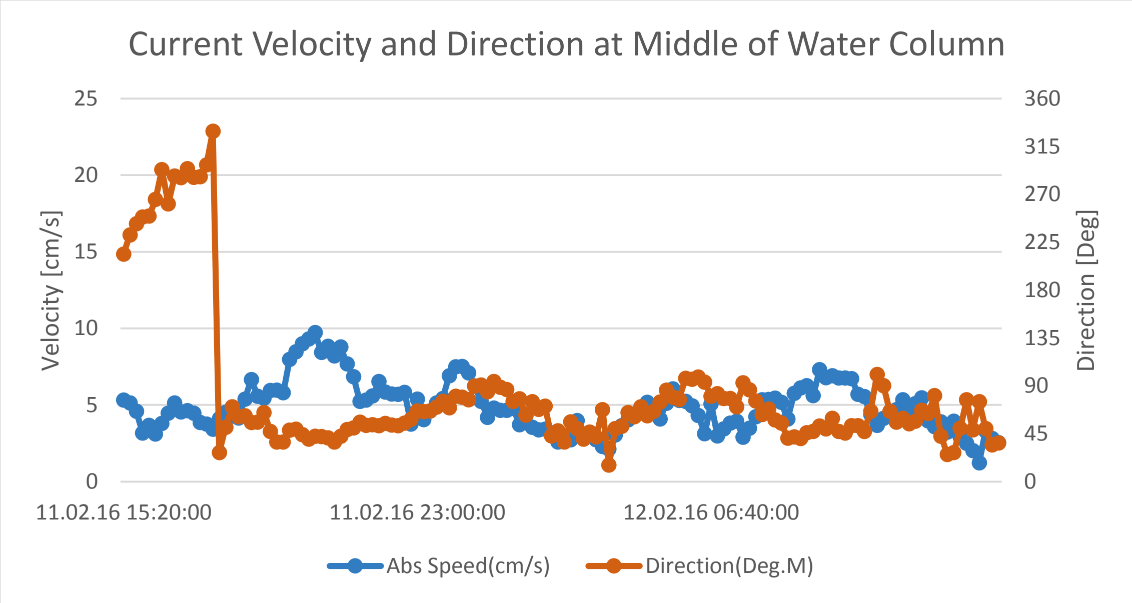
The system was placed at the follow coordinates:

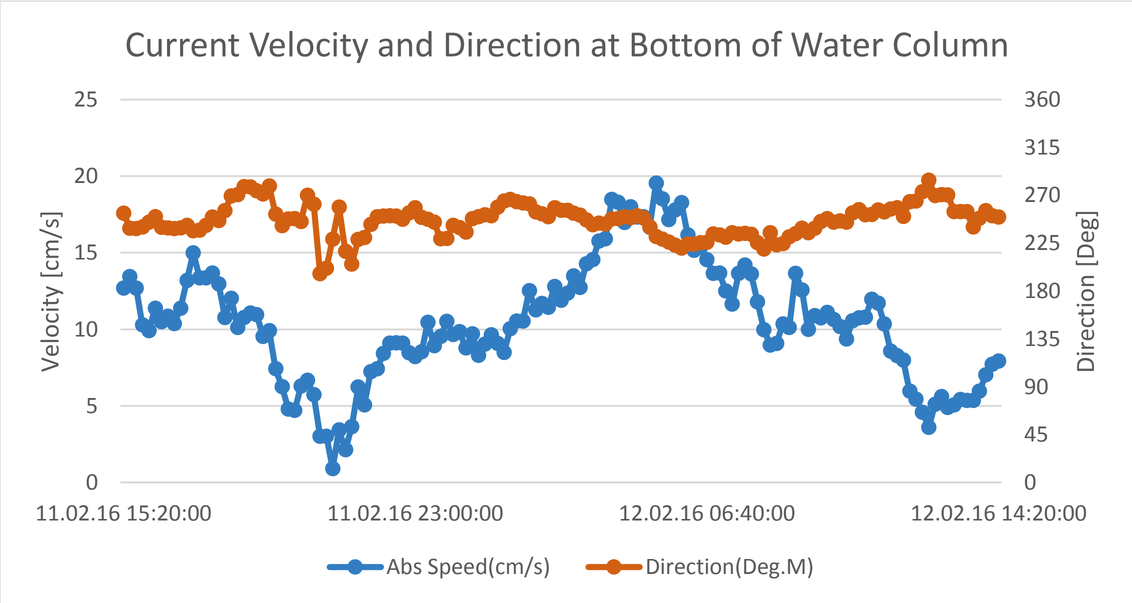
Latitude: 47º 34.728’ N
Longitude: 54º 20.926’ W

The system was deployed on the 11th of February 2016 at 15:00 UTC and recovered on the 12th of February 2016 at 14:30 UTC.

Displayed current measurements were taken at the following depths:
Top: 30 m
Middle: 160 m
Bottom: 265 m







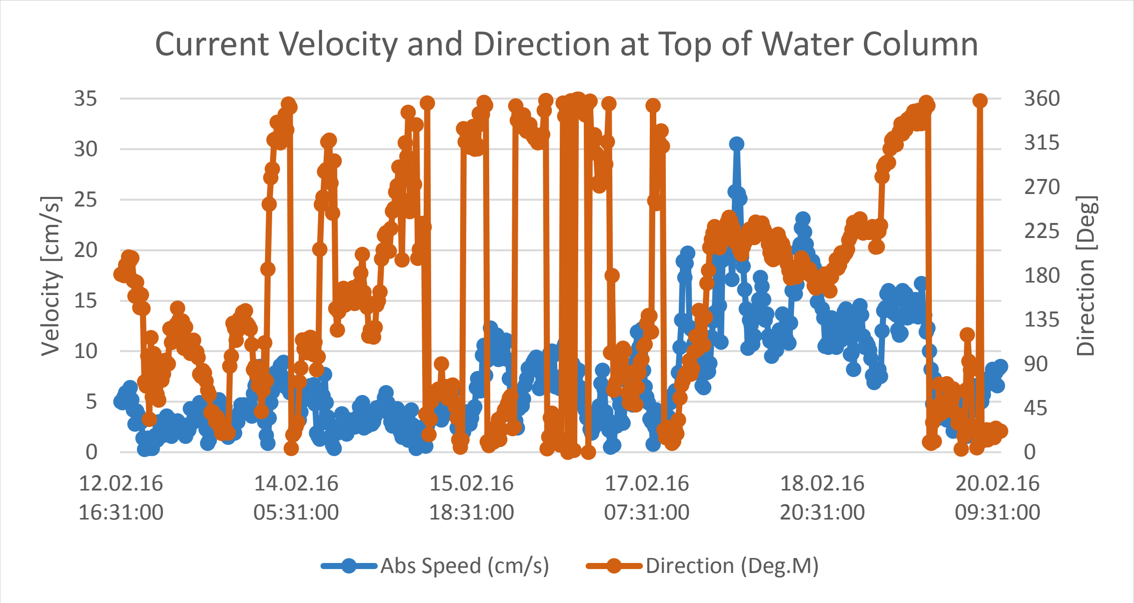
2.2.3 Ship Island

The system was placed at the following coordinates:

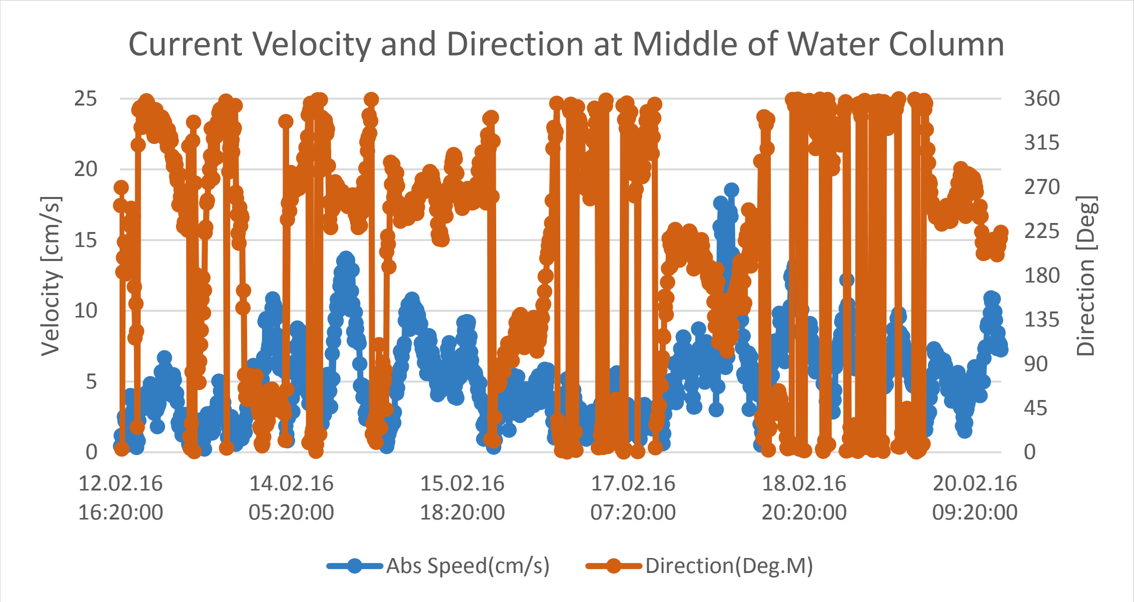
Latitude: 47º 38.740’ N
Longitude: 54º 16.662’ W

The system was deployed on the 12th of February 2016 at 16:15 UTC and recovered on the 20th of February 2016 at 15:00 UTC.

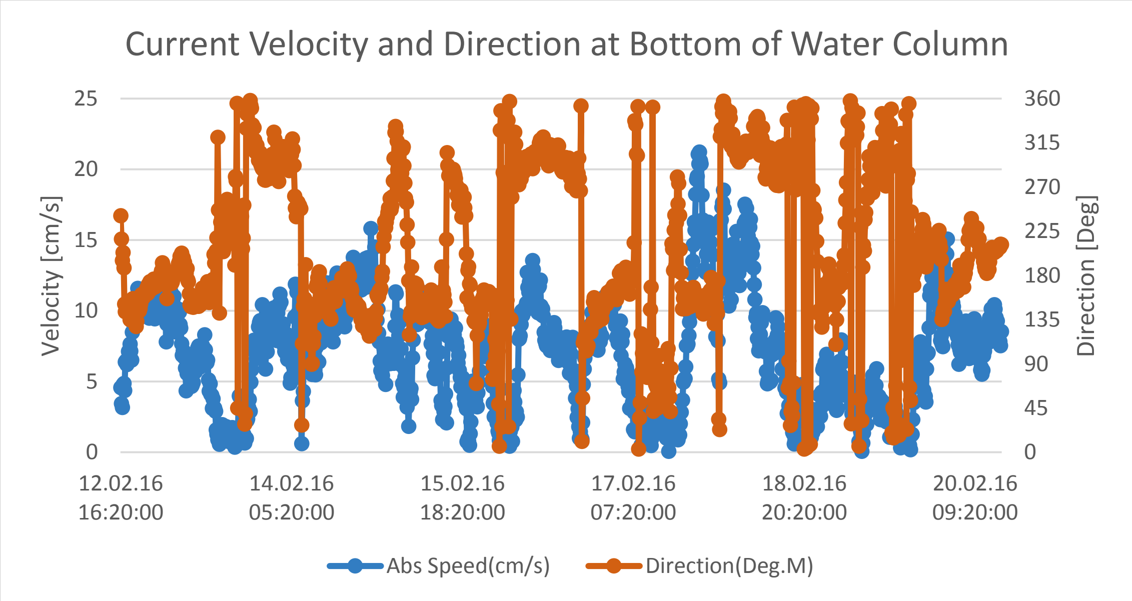
Displayed current measurements were taken at the following depths:
Top: 30 m
Middle: 115 m
Bottom: 200 m



Current Velocity and Direction at Top of Water Column
Velocity [cm/s]
Direction [Deg]
35
30
25
20
15
10
5
0
360
315
270
225
180
135
90
45
0
12.02.16 16:31:00
14.02.16 05:31:00
15.02.16 18:31:00
17.02.16 07:31:00
18.02.16 20:31:00
20.02.16 09:31:00
Abs Speed (cm/s)
Direction (Deg.M)



Current Velocity and Direction at Middle of Water Column
Velocity [cm/s]
Direction [Deg]
25
20
15
10
5
0
360
315
270
225
180
135
90
45
0
12.02.16 16:20:00
14.02.16 05:20:00
15.02.16 18:20:00
17.02.16 07:20:00
18.02.16 20:20:00
20.02.16 09:20:00
Abs Speed(cm/s)
Direction(Deg.M)



2.3 Red Island BMA

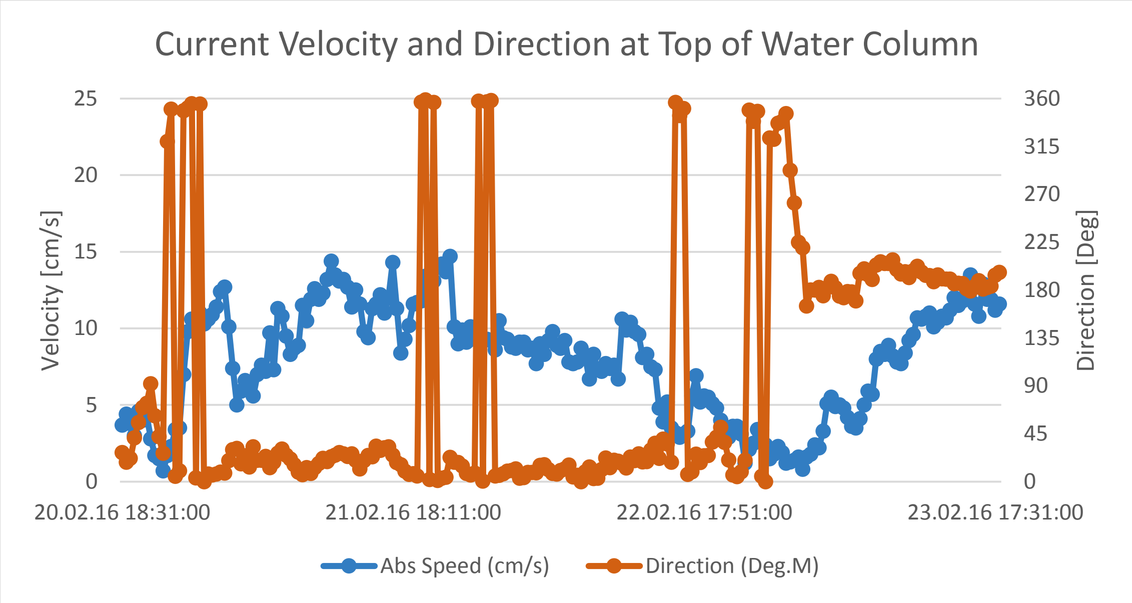
2.3.1 Butler Island

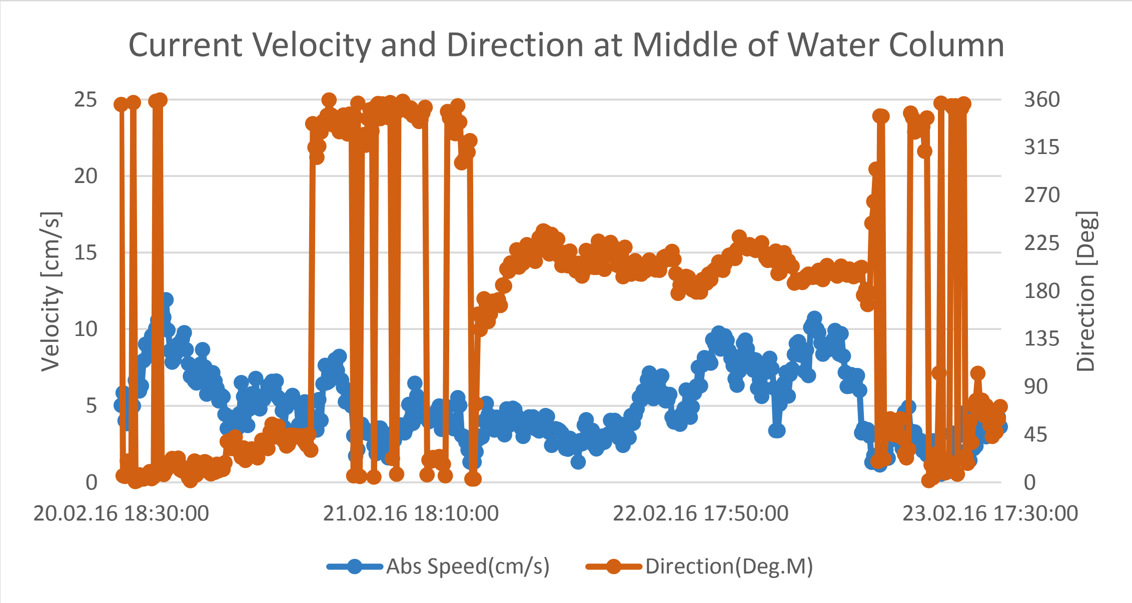
The system was placed at the follow coordinates:

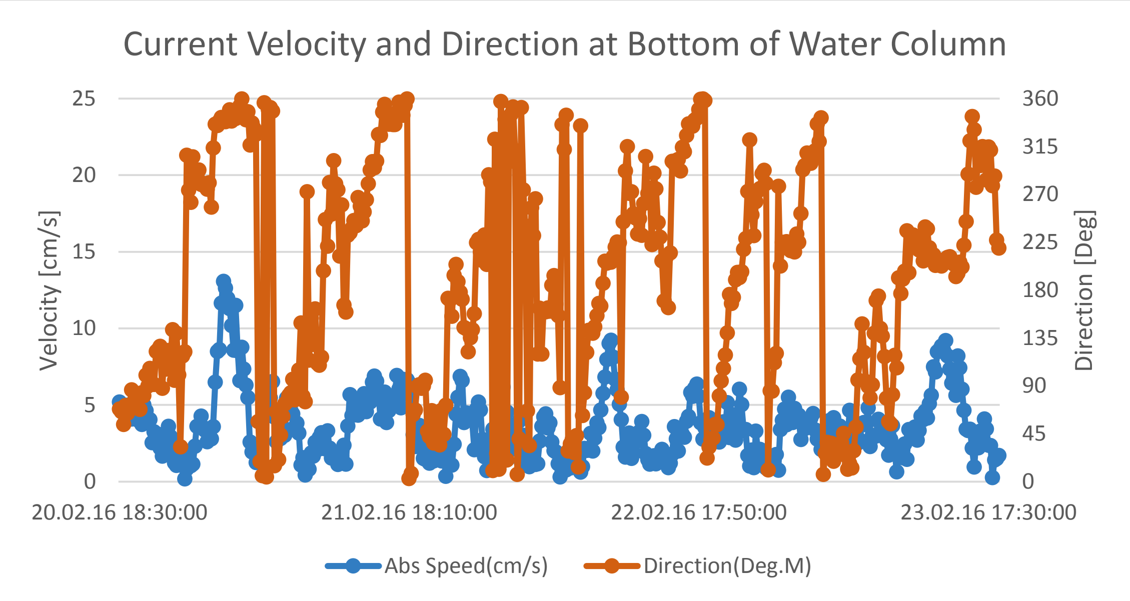
Latitude: 47º 34.183' N
Longitude: 54º 06.930' W

The system was deployed on the 20th of February 2016 at 18:00 UTC and recovered on the 23rd of February 2016 at 19:00 UTC.

Displayed current measurements were taken at the following depths:
Top: 30 m
Middle: 70 m
Bottom: 100 m


Current Velocity and Direction at Top of Water Column
Velocity [cm/s]
Direction [Deg]
25
20
15
10
5
0
360
315
270
225
180
135
90
45
0
20.02.16 18:31:00
21.02.16 18:11:00
22.02.16 17:51:00
23.02.16 17:31:00
Abs Speed (cm/s)
Direction (Deg.M)


Current Velocity and Direction at Middle of Water Column
Velocity [cm/s]
Direction [Deg]
25
20
15
10
5
0
360
315
270
225
180
135
90
45
0
20.02.16 18:30:00
21.02.16 18:10:00
22.02.16 17:50:00
23.02.16 17:30:00
Abs Speed(cm/s)
Direction(Deg.M)



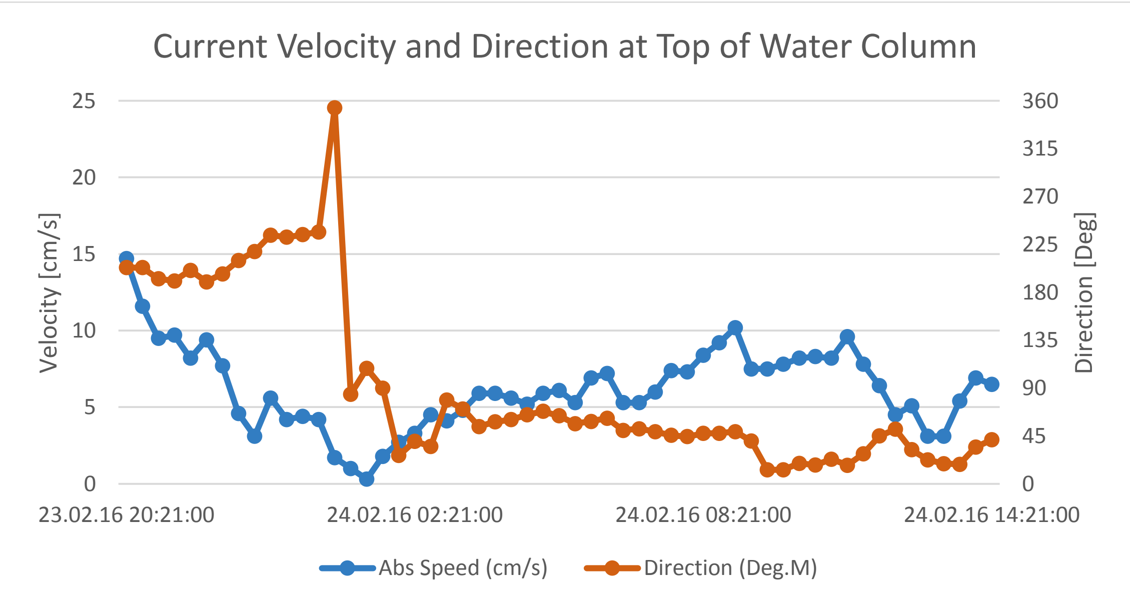
2.3.2 Red Island

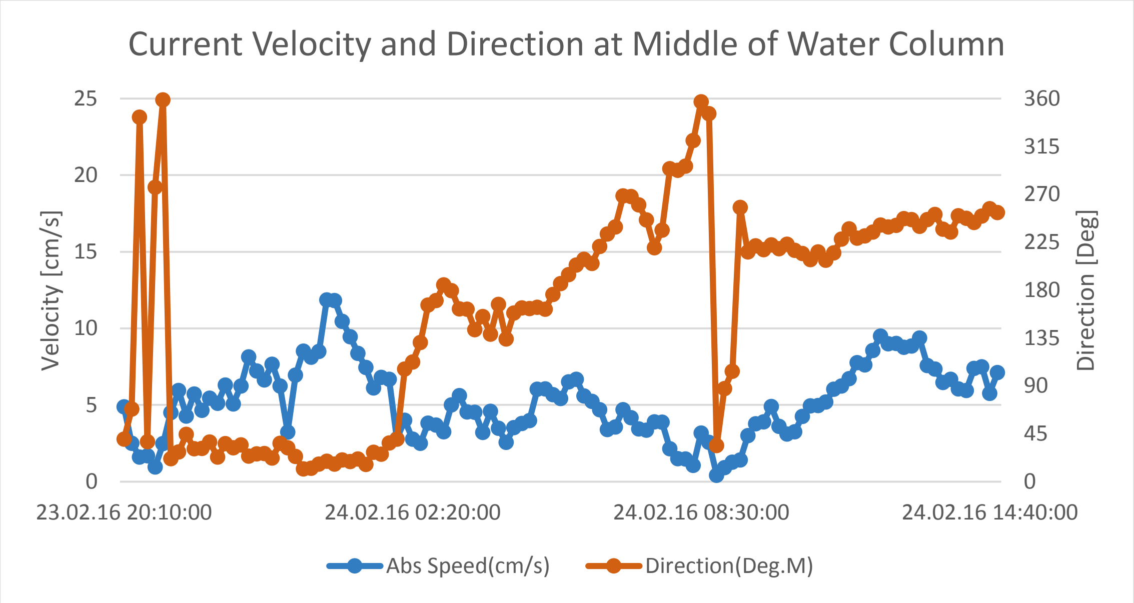
The system was placed at the following coordinates:

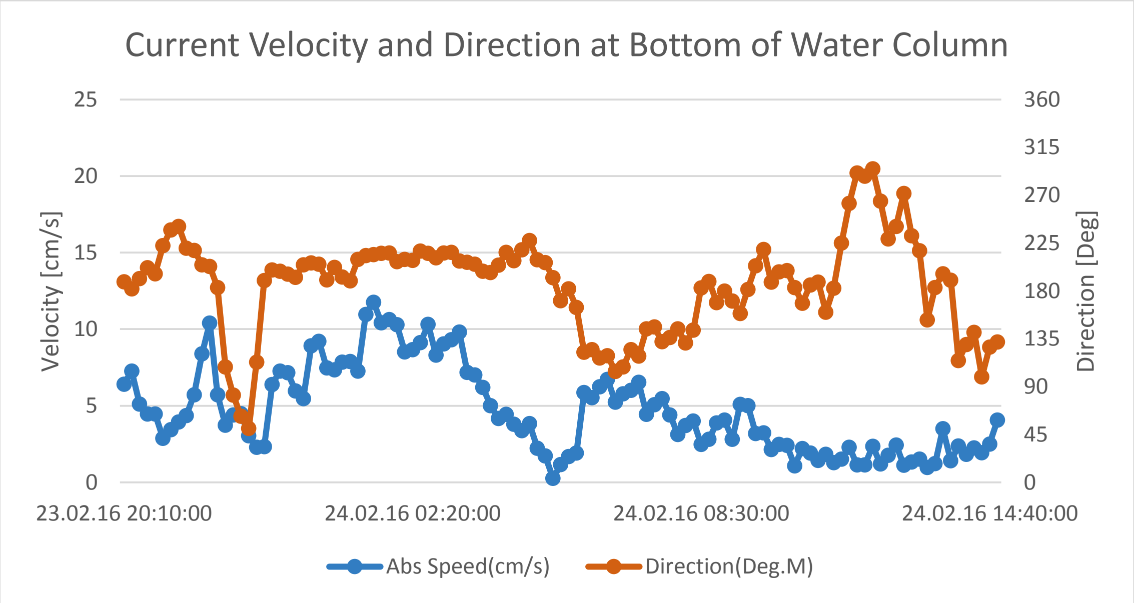
Latitude: 47º 32.237' N
Longitude: 54º 09.019' W

The system was deployed on the 23rd of February 2016 at 20:00 UTC and recovered on the 24th of February 2016 at 15:00 UTC.

Displayed current measurements were taken at the following depths:
Top: 30 m
Middle: 75 m
Bottom: 105 m







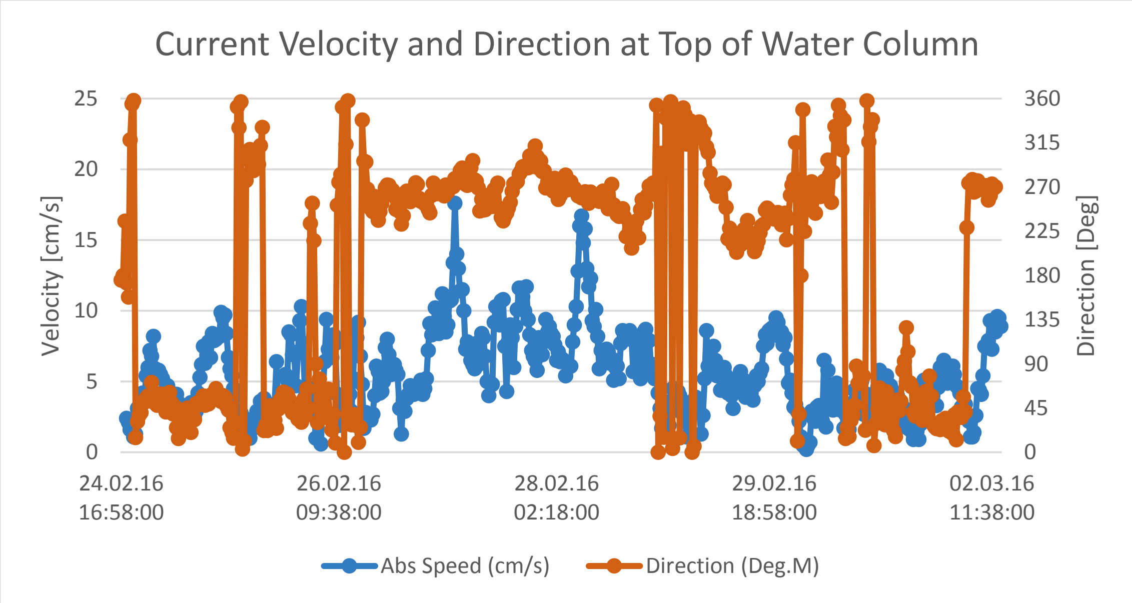
2.3.3 Darby Harbour

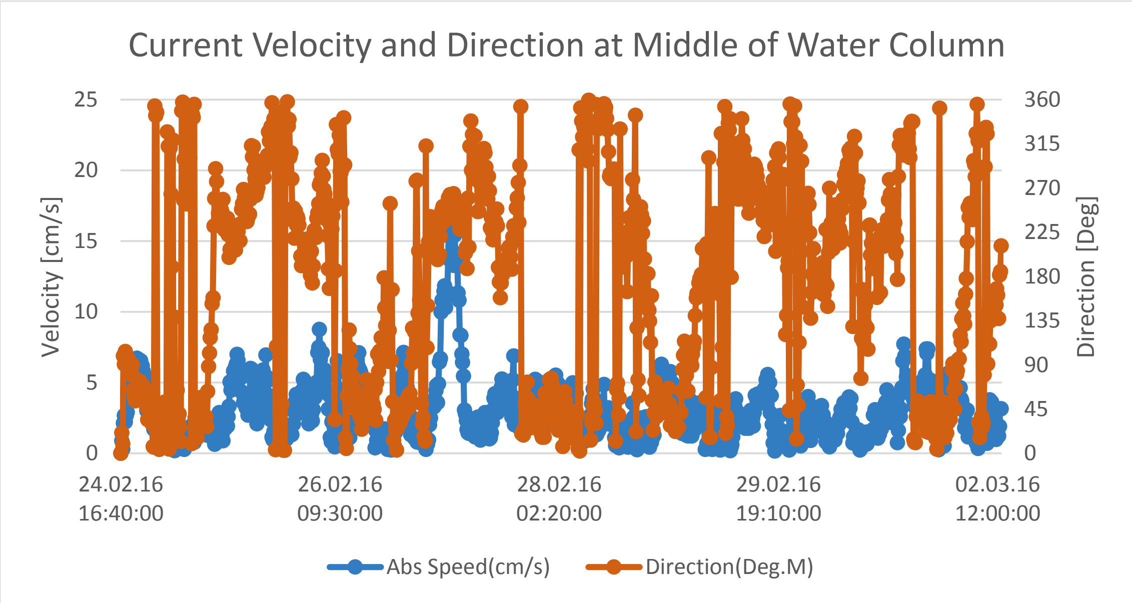
The system was placed at the following coordinates:

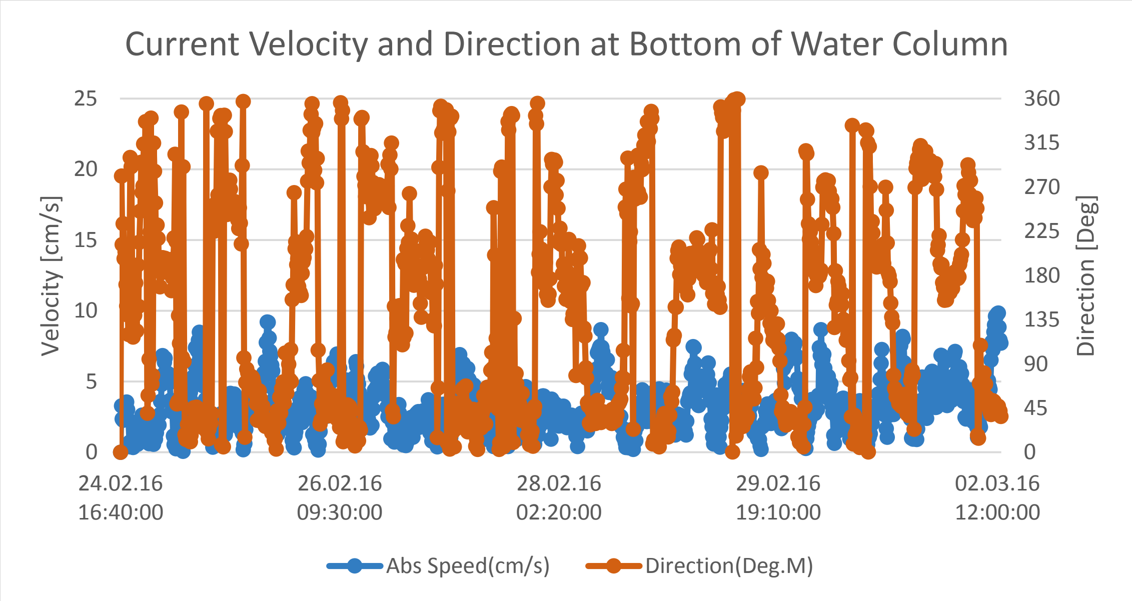
Latitude: 47º 28.720’ N
Longitude: 54º 11.227’ W

The system was deployed on the 24th of February 2016 at 15:30 UTC and recovered on the 2nd of March 2016 at 12:30 UTC.

Displayed current measurements were taken at the following depths:
Top: 30 m
Middle: 80 m
Bottom: 122 m


Current Velocity and Direction at Top of Water Column
Velocity [cm/s]
25
20
15
10
5
0
Direction [Deg]
360
315
270
225
180
135
90
45
0
24.02.16 16:58:00
26.02.16 09:38:00
28.02.16 02:18:00
29.02.16 18:58:00
02.03.16 11:38:00
Abs Speed (cm/s)
Direction (Deg.M)


Current Velocity and Direction at Middle of Water Column
Velocity [cm/s]
25
20
15
10
5
0
Direction [Deg]
360
315
270
225
180
135
90
45
0
24.02.16 16:40:00
26.02.16 09:30:00
28.02.16 02:20:00
29.02.16 19:10:00
02.03.16 12:00:00
Abs Speed(cm/s)
Direction(Deg.M)



2.4 Long Harbour BMA

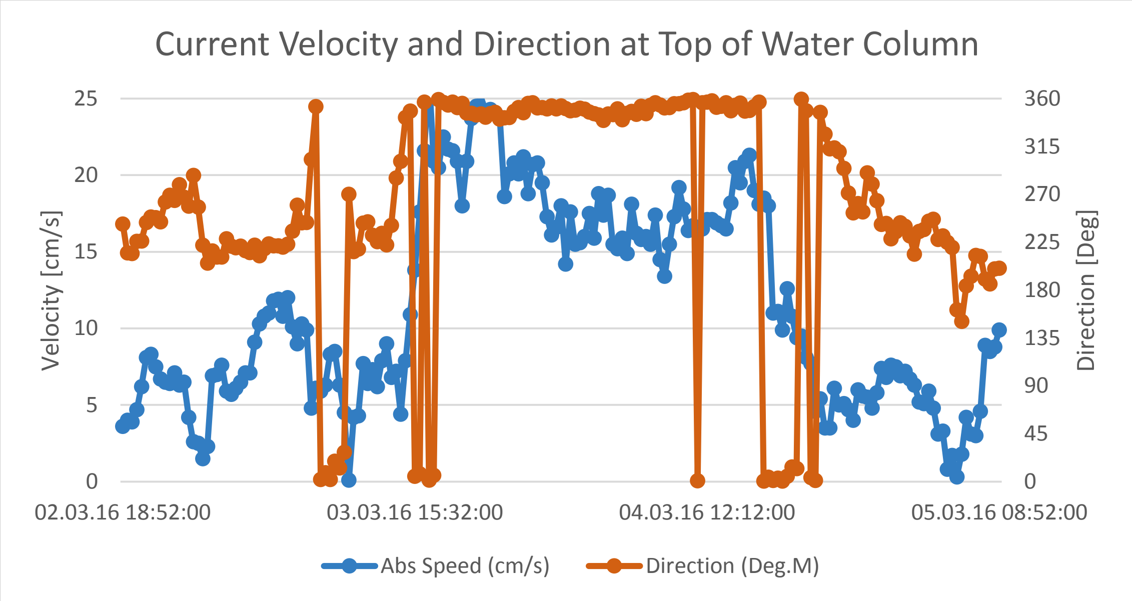
2.4.1 Brine Islands

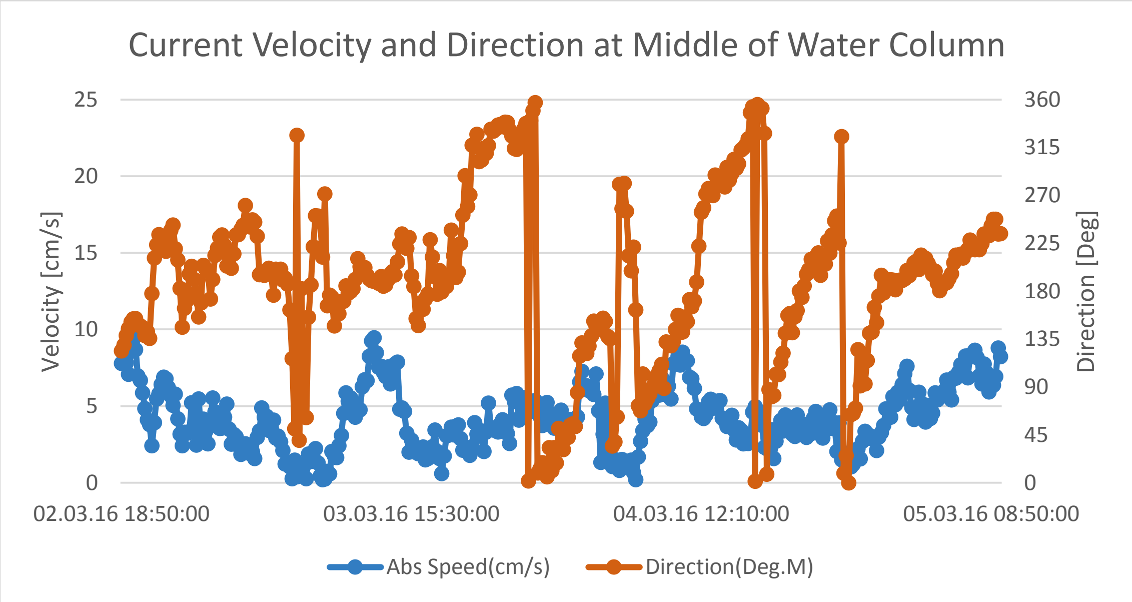
The system was placed at the following coordinates:

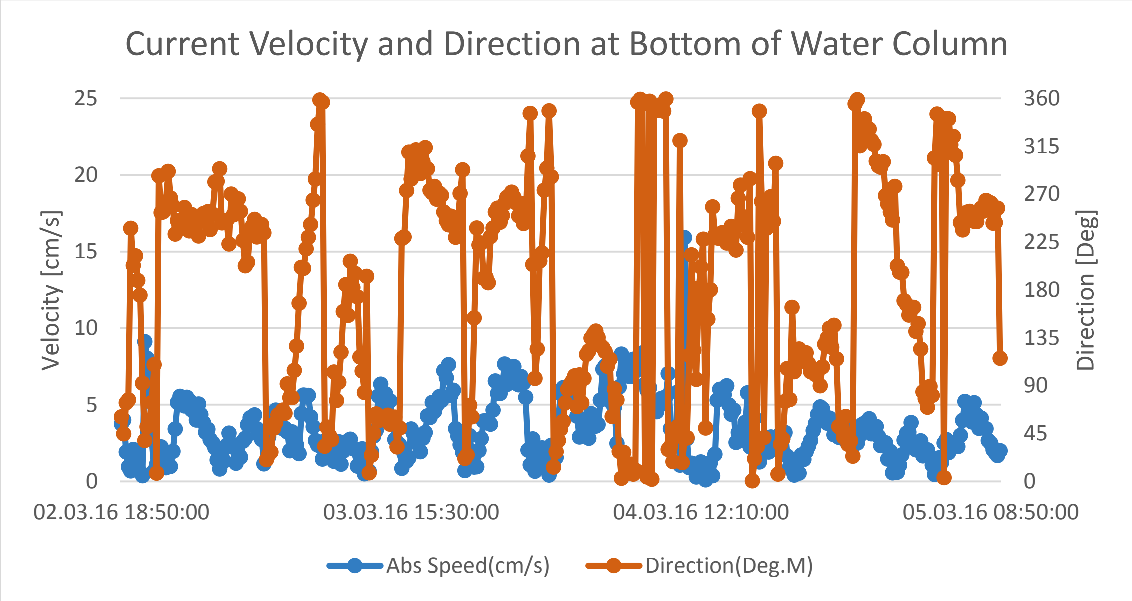
Latitude: 47º 26.736’ N
Longitude: 53º 58.079 W

The system was deployed on the 2nd of March 2016 at 15:00 UTC and recovered on the 5th of March 2016 at 09:45 UTC.

Displayed current measurements were taken at the following depths:
Top: 30 m
Middle: 76 m
Bottom: 115 m


Current Velocity and Direction at Top of Water Column
Velocity [cm/s]
Direction [Deg]
25
20
15
10
5
0
360
315
270
225
180
135
90
45
0
02.03.16 18:52:00
03.03.16 15:32:00
04.03.16 12:12:00
05.03.16 08:52:00
Abs Speed (cm/s)
Direction (Deg.M)


Current Velocity and Direction at Middle of Water Column
Velocity [cm/s]
Direction [Deg]
25
20
15
10
5
0
360
315
270
225
180
135
90
45
0
02.03.16 18:50:00
03.03.16 15:30:00
04.03.16 12:10:00
05.03.16 08:50:00
Abs Speed(cm/s)
Direction(Deg.M)



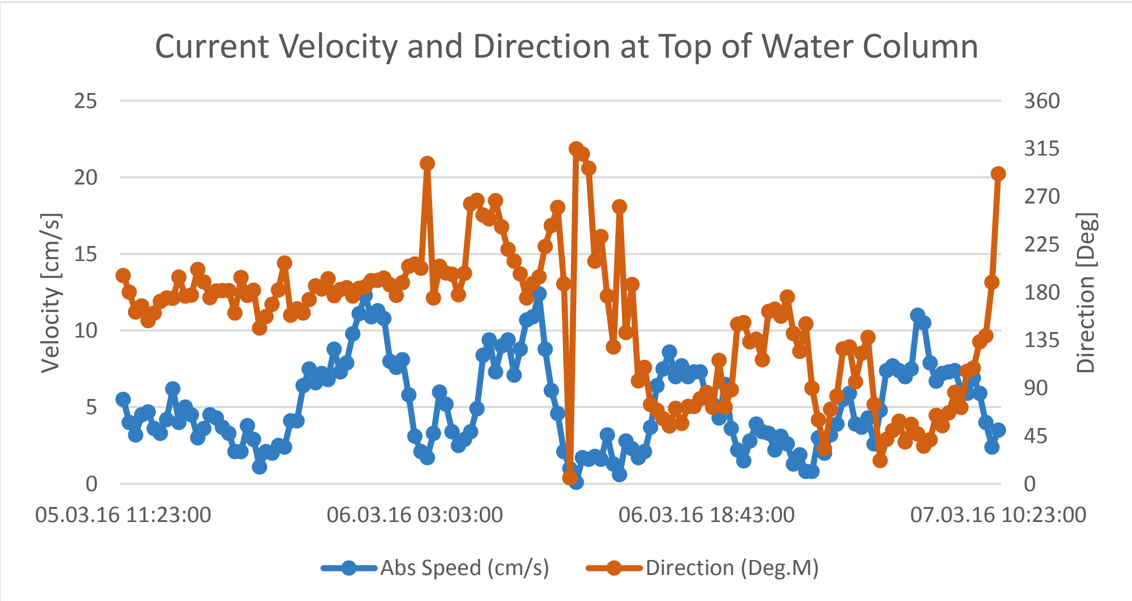
2.4.2 Iona Islands

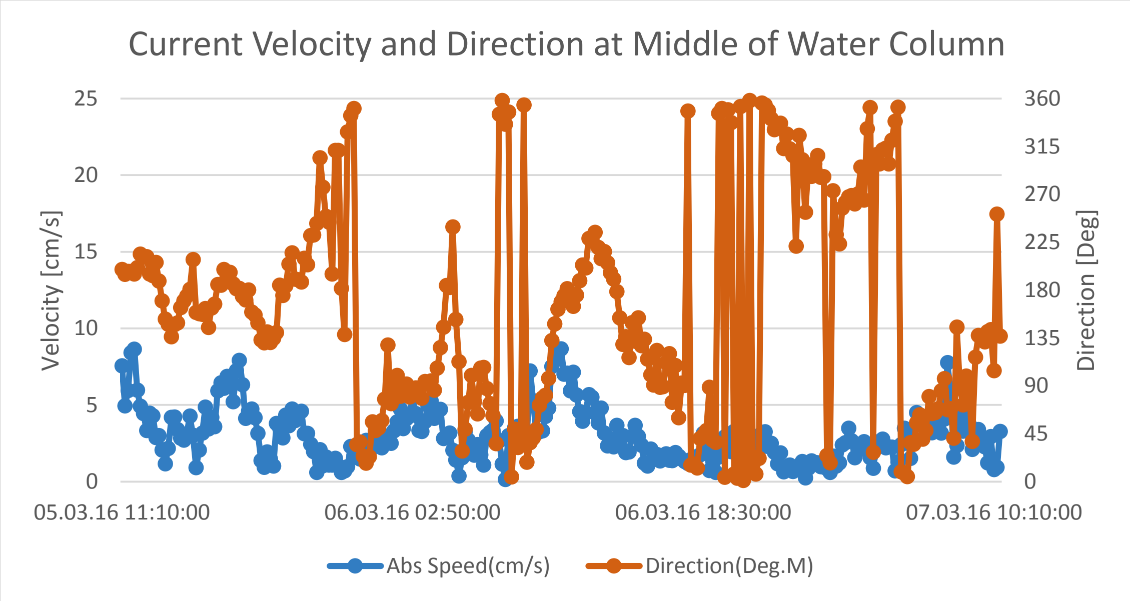
The system was placed at the following coordinates:

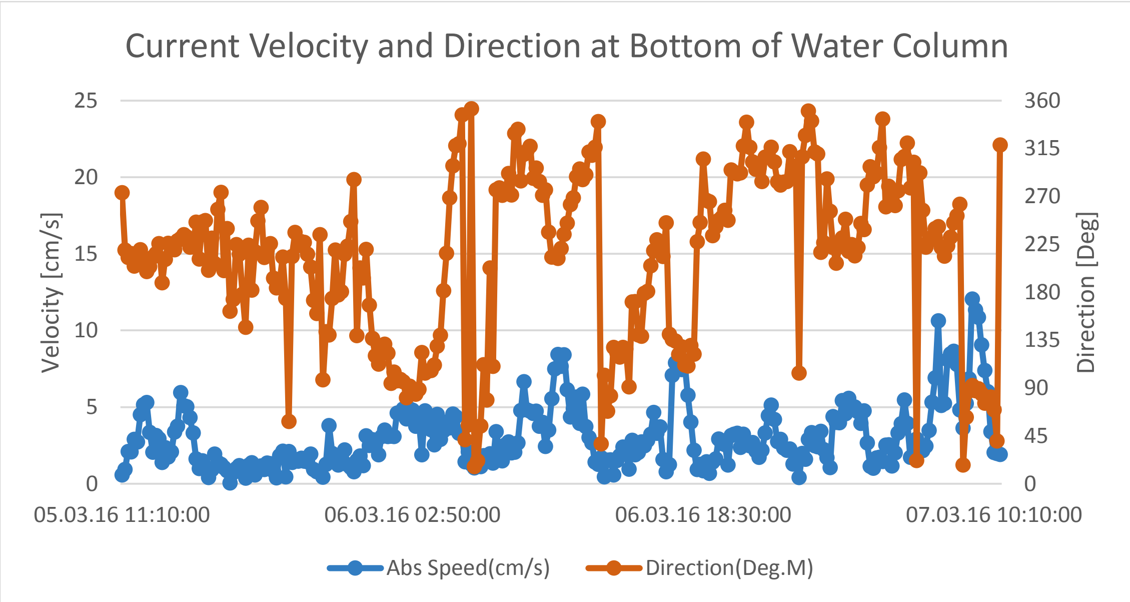
Latitude: 47º 24.607' N
Longitude: 53º 58.600 W

The system was deployed on the 5th of March 2016 at 11:00 UTC and recovered on the 7th of March 2016 at 10:45 UTC.

Displayed current measurements were taken at the following depths:
Top: 30 m
Middle: 65 m
Bottom: 95 m




Current Velocity and Direction at Middle of Water Column
Velocity [cm/s]
Direction [Deg]
25
20
15
10
5
0
360
315
270
225
180
135
90
45
0
05.03.16 11:10:00
06.03.16 02:50:00
06.03.16 18:30:00
07.03.16 10:10:00
Abs Speed(cm/s)
Direction(Deg.M)


Current Velocity and Direction at Bottom of Water Column
Velocity [cm/s]
Direction [Deg]
25
20
15
10
5
0
360
315
270
225
180
135
90
45
0
05.03.16 11:10:00
06.03.16 02:50:00
06.03.16 18:30:00
07.03.16 10:10:00
Abs Speed(cm/s)
Direction(Deg.M)

3 Conclusion

Current parameters were measured in Placentia Bay in the period January to March 2016. The current measurement platform was installed on 11 sites during the period. The total monitoring period varied from site to site between 20 hours up to 7 days.

The general impression is that the current speed is low at all sites. Only on Ship Island, Long Island and Brine Islands were speeds in excess of 20 cm/sec measured which is still considered low. It is, however, noted that the monitoring periods were very short.