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2022 **NSARB-2022-001**
NSARB 2022-002
NSARB-2022-003

Nova Scotia Aquaculture Review Board

IN THE MATTER OF: Applications made by TOWN POINT CONSULTING INC. for NEW MARINE SHELLFISH LICENCES/LEASES in ANTIGONISH HARBOUR, ANTIGONISH COUNTY for the SUSPENDED CULTIVATION OF AMERICAN OYSTERS

Town Point Consulting Inc.

APPLICANT

-and-

Minister of Fisheries and Aquaculture

PARTY

-and-

Mary Jo MacDonald, Patrick MacDonald, Lucy MacDonald, Richard Wilgenhof, Alena Wilgenhof, Sian Newman-Smith, Rick Turner, Rowan McLean, Peter Bowler, Colleen Bowler, Friends of Antigonish Harbour, Sheila MacKinnon Hudon, William Hudon, May Goring, Manfred Goring, Antigonish Harbour Watershed Association, Rod Brady, Mike MacDonald, Bill Brophy, Tim Brophy, Duncan Brophy, Daryl Beaton, and Brendon Doyle

INTERVENOR GROUPS ONE AND TWO

-and-

Mark Genuist, Stephen Feist, and the Community Liaison Committee

INTERVENOR GROUP THREE

Affidavit of Nathaniel Feindel

I, Nathaniel Feindel, of Shelburne, Nova Scotia, affirm and give evidence as follows:

1. I am the Manager of Aquaculture Development and Marine Plant Harvesting in the provincial Department of Fisheries and Aquaculture (the Department). I started with the Department in 2015 as an aquaculture advisor. I have been in my current management role since 2017.

2. I have worked in the aquaculture industry for approximately 14 years. My resume is attached to this Affidavit as **Exhibit A**.

3. I have personal knowledge of the evidence sworn to in this affidavit except where otherwise stated to be based on information or belief.

4. I state, in this affidavit, the source of any information that is not based on my own personal knowledge, and I state my belief of the source.

Review Team

5. The licensing coordinator originally assigned to these applications initially was Megan Greenwood. Due to the time it took to assess this application, Amanda Spencer took over from Megan Greenwood. Lynn Winfield took over from Ms. Spencer and remains the licensing coordinator today.

6. The Review Team for these applications consisted of a number of people. I led the Review Team. Aquaculture Advisors Lew Clancey and Jennifer Feehan from my section were also part of the team. From the Aquatic Animal Health section, Dr. Anthony Snyder participated in the review. From the Operations section, Danielle St. Louis, David Cook, and Gretchen Wagner were also part of the Review Team. Mapping was provided by Matthew King, a GIS Officer in the Department.

Three Lease Sites

7. This Affidavit will address the three applications before the Nova Scotia Aquaculture Review Board (the Board) in this adjudicative hearing. Although a single application was submitted by the Applicant Town Point Consulting Inc. ("Town Point Consulting"), the application is actually comprised of three proposed lease areas: AQ #1442, AQ #1443, and AQ #1444. A map showing all three sites is attached to this Affidavit as **Exhibit B**.

8. The three sites are located in close proximity to each other and have similar characteristics. As a result, my comments in this Affidavit will apply to all three sites, unless specifically stated otherwise.

9. The coordinates submitted in the Development Plan do not align with the Schedule A maps generated by the Department. This is common and was a result of an incorrect coordinate and conversion of geographic location units. My Team discussed this with the Applicant during the review process. The resulting "Schedule A", produced by the Department, depicts the official lease spaces for the three individual site applications. These can be found in the respective Application Packages.

History of Application

10. An option to lease was granted to Town Point Consulting on March 28, 2019 for a period of six months. It was extended a further six months, expiring on March 28, 2020.

11. Megan Greenwood received the Application on January 27, 2020.

Network Consultation

12. Under the Aquaculture Lease and Licence Regulations, when the Department receives a completed application, we are required to undertake consultations with relevant federal and provincial departments or agencies (the Network).

13. When an application is submitted to the Aquaculture Review Board, the Minister is required to submit a Report on the outcome of the Network consultation. For these applications, the Network consultation reports submitted to the Board are entitled "Report on the Outcomes of Consultation". Although a Report for each lease application was submitted to the Board, most of the Network partners provided a single response for all three sites with the result that the feedback from each partner is identical feedback for AQ #1442, AQ #1443, and AQ #1444.

14. The only exception is the feedback from the Canadian Wildlife Service regarding site specific feedback at AQ#1444 regarding buffer areas for nesting bird colonies and piping plovers.

15. Any feedback from the Network partners that is relevant to the Board's consideration of the factors outlined in s.3 of the Aquaculture Licence and Lease Regulations is discussed further below.

Technical Review (Verification and Evaluation)

16. The Review Team conducts the Department's internal review of the technical feasibility of the application and its ability to align with the Department's regulations. The technical review analysis includes the assessment of information relevant to the factors the Board must consider, listed in s. 3 of the Aquaculture Licence and Lease Regulations. The conclusions reached by the Review Team as part of this review are summarized below according to the s. 3 factor that is most relevant. This summary includes the Departmental staff's knowledge of the industry, the advice provided to the Department from Network agencies, and the information supplied by Town Point Consulting.

Section 3(b): Contribution to Community and Provincial Economic Development

17. The Review Team looks at a variety of aspects of the application under this factor, including the Production Plan, infrastructure, services/suppliers, employment etc.

18. The Production Plan is a key piece of the application.

Production Plan

19. Town Point Conssulting proposes to culture American Oysters, which is an acceptable species to be cultivated in Nova Scotia.

20. Town Point Consulting proposes the suspended culture method for production. The type of culture equipment proposed is called "Benefit of Being Round" (BOBR). The information includes volume, stocking density, mesh sizes, and floatation. The BOBR

equipment is similar in principle to other suspended culture equipment. The Department is satisfied that this equipment is suitable for oyster culture at the proposed lease sites.

21. Town Point Consulting has obtained a DFO spat collection permit. They will assess a number of areas in the Antigonish Harbour for spat collection. Town Point Consulting also has a licensed land-based lease that houses an oyster spat nursery that will be used to augment growth of the spat collected in the Harbour prior to deployment to the marine leases.

22. Town Point Consulting initially provided total gear stocking information for all three leases combined. In the additional information provided on June 1, 2020, Town Point Consulting provided information pertaining to stocking that breaks out the information for each lease space. The proposed operations AQ #1442 will be used for inventory and overwintering oysters so infrastructure, number of oysters and year classes will vary from time to time depending on the farming cycle, environmental conditions and markets. AQ #1443 and 1444 will be used as ongoing culture based on the proposed production plans.

23. The following chart shows the production estimates provided by Town Point Consulting per lease site:

AQ# 1443 Production Plan				
Year Class	Density (Oysters/BORB)	Oyster Size (mm)	# Cages	# Oysters Total
1 (Seed)	1000	15-30	2000	2,000,000
2	500	30-50	4000	2,000,000
3	250	50-75	8100	2,025,000
AQ#1444 Production Plan				
Year Class	Density (Oysters/BORB)	Oyster Size (mm)	# Cages	# Oysters Total
1 (Seed)	1000	15-30	1250	1,250,000
2	500	30-50	2500	1,250,000
3	250	50-75	5000	1,250,000

24. The Review Team assessed the site design including whether the lease layout, number and length of lines are reasonable for the level of production described which is 100m lines with approximately 100 BOBRs per line. We determined this was reasonable for the establishment of the site. Ultimately the maximum number of lines will be determined by how the site performs in its biological ability to support oyster aquaculture. The lease may be able to support more, or less, shellfish than those presented in the Development Plan. Time will be required to determine this.

25. In addition to the number of lines, the Review Team also assessed whether the level of production (number of oysters) proposed was reasonable. We concluded it was feasible. Town Point Consulting indicates that approximately 23,100 BOBR units will be deployed on three leases.

26. The Review Team also examined whether the expected time to reach maximum production proposed by Town Point Consulting was reasonable. We concluded that it aligns with what is known for the industry. Town Point Consulting estimates it will take 3 years to reach maximum production. In Nova Scotia, historically, the time required to establish oyster farms at full production is 4 to 6 years due to the 4 year growth cycle of oysters, and the requirement for re-investment in farm supplies and materials for that length of time without realizing significant profit while establishing a continuous production of marketable oysters. It is possible to produce cocktail oysters in 3 years and the utilization of a land-based oyster spat nursery in this case may reduce the production time further.

27. Dr. Anthony Snyder from our Aquatic Animal Health section indicated that Town Point Consulting's plan was reasonable from an animal health perspective and concluded there were no health concerns with the Company's plan to have a harvestable product in 3 years.

Infrastructure

28. The Review Team assessed the adequacy of the infrastructure that Town Point Consulting intends to use. The identified infrastructure includes a nearby waterfront property owned by Town Point Consulting that has an existing wharf, winch, boat slip and supporting out-building. The waterfront property is also the location of AQ#1422, a land-based oyster nursery, that will be used in conjunction with the marine grow out leases.

29. The Review Team concluded that the existing infrastructure is acceptable for the development of these leases.

Services and Suppliers

30. Small to medium sized aquaculture operations such as the one described in these applications have shown a reliance on local suppliers and services ranging from fuel, marine services, and industrial manufacturers to food, legal and scientific equipment suppliers.

Employment

31. Town Point Consulting plans to employ 11 staff by its fourth year of operation (5 seasonal and 6 full-time). The company plans to hire locally, or from further afield within Nova Scotia where specific technical skills are required.

Other Economic Contributions to the Local Community and Province

32. The potential economic contributions are dependent on the success of the nursery, farm, and sales of aquaculture products. Given the scale of the proposed operations, the employment of 5 seasonal and 6 full-time staff is considered by the Department to be the primary economic contribution with potential spin offs from processing and sales.

Section 3(c): Fisheries Activities in the Public Waters Surrounding the Proposed Aquacultural Operations

33. There are a number of fishery activities in the public waters surrounding the lease sites. Town Point Consulting identified the following fisheries in the areas around the lease sites:

(a) 4 oyster fishing licenses,

(b) 5 lobster enterprises,

(c) 1 crab enterprise,

(d) 15 recreational fishers, and

(e) 1 inactive bait fisher.

34. Town Point Consulting did extensive public engagement in preparing its application for these three leases.

35. None of the network reviewers raised a concern with the lease sites interfering with other fisheries in the surrounding public waters.

Section 3(d): Oceanographic and Biophysical Characteristics of the Public Waters

36. The Review Team assessed many aspects of the oceanographic and biophysical characteristics of the public waters where the lease sites are located.

Wind Data

37. The wind data presented by Town Point Consulting was assessed by the Review Team and we concluded that given the sheltered nature of the proposed locations, and the low structural profile of the lease infrastructure, typical wind regimens will not be problematic.

Wave Data

38. The Review Team assessed whether there might be a risk to the structural integrity of the operation from waves or current.

39. The wave data provided by Town Point showed a maximum wave height of .7 m. Generally, in Nova Scotia, optimal wave height for oyster culture is 1 meter or less. Given this data and the sheltered nature and the fetch length of the proposed locations, and the low structural profile, the Department anticipates that typical wave regimens should not be problematic.

40. Dr. Snyder, from the Aquatic Animal Health section of our Department, advised that no health concerns are expected in this region due to wave height.

Current Data

41. Town Point Consulting has indicated that the surface current speed ranges from 0 to 25 cm/s, with an average current speed of 12.5 cm/s. The Department collected current data at three different points throughout the Harbour and this aligns with speeds provided by Town Point Consulting. The Acoustic Doppler Current Profilers deployed (June 7 to July 25, 2022) in Antigonish Harbour collected data in a vertical profile, with water speed and direction measurements recorded in 0.5m 'bins' throughout the water column every 3 seconds. The 'Average' current speed presented below is the mean of all these measurements at all depths over the course of the 48-day deployment period. The 'Max' and 'Min' values below are the highest and lowest 15-minute averaged speeds of the whole water column that occurred during the 48 days.

Location	Average (cm/s)	Depth Averaged Max	Depth Averaged Min
Ferry Point	20.6	66.8	2.6
Antigonish Harbour	18.6	56.2	2.4
Reef Island	10.9	35	0.9

42. Town Point Consulting plans to use AQ #1442 for overwintering and storage of mature oysters and excess seed. The site will incorporate a number of different suspended culture techniques which does include occasional sinking of equipment to the bottom. The equipment at this site will be well anchored and will be situated in a sheltered bay, distant from the main channel and any strong currents. No risk to structural integrity is expected.

43. Similarly, the Review Team does not foresee any risk to the structural integrity at the other lease sites: AQ #1443 and AQ #1444.

44. Dr Snyder assessed the current data from an animal health perspective and advised the Review Team that the current velocity for this region is not expected to negatively impact shellfish health or welfare.

Salinity

45. The water salinity at the proposed sites is another aspect of Town Point Consulting's applications that the Review Team analyzed. Town Point Consulting indicates the following salinity ranges recorded at the lease sites as follows: minimum 4ppt and maximum 32.8ppt.

46. Optimal salinity is 20-30ppt with minimum and maximum 5 and 35 ppt, respectively.

47. The annual minimum salinity at the site is 3.9ppt, which is considered low. However, this is assumed to be based on a worst case scenario and would likely only occur for a short

period of time, such as after a large rainfall. Oysters are adapted to surviving low salinity conditions for short periods of time (days) with no negative impacts.

48. Dr. Snyder noted that the annual minimum salinity is lower than ideal, but noted that the assumption is the animals would not be exposed to this salinity for extended periods of time. He concluded that exposure to low salinities for short period of times should not negatively impact the health of the animals.

49. The Review Team also considered the presence of natural oyster populations in the Harbour and an active wild fishery which indicates that the salinity is acceptable for oyster culture.

Water Temperature

50. Town Point Consulting reports the minimum and maximum temperatures at these sites to be -0.8 to 26.4 Degrees Celsius.

51. These lease sites, on Nova Scotia's north shore, are natural habitat for oysters and contain many natural oyster beds. Since oysters thrive in these conditions naturally, there is no concern with the water temperature at the proposed lease sites.

52. Dr. Snyder advised the temperature range provided by Town Point Consulting is within the known acceptable temperature range for this oyster species. Health related issues are not expected due to water temperature.

Water Depth

53. Water depth is another issue examined by the Review Team. The tidal range for this area is approximately 1m. Acceptable oyster culture depth for suspended culture is 1-6m.

54. Maps supplied by Town Point Consulting show depths measured at low tide at the corners:

(a) AQ 1442 – 0 - 1.6m

(b) AQ 1443 – 1.1-2.0

(c) AC 1444 – 1-2.4m

55. As AQ 1442 is intended to be used as a finishing and holding lease for market oysters and overwintering of excess seed collected in the previous summer. The water depth at this site is acceptable for those purposes. Dr. Snyder, from the Aquatic Animal Health section concurred that given the intended use of this site, the water depth is unlikely to have an effect on the health of the animals.

56. The Review Team is satisfied that the water depth at these sites is appropriate for the intended purposes.

Environmental Carrying Capacity

57. Environmental carrying capacity is essentially how many oysters could be placed in an area before they have an impact on the ecosystem. Seston in the environment would inform environmental carrying capacity of an area. Seston is composed of small organic particles (plant matter), small photosynthetic organisms (phytoplankton), as well as plankton and inorganics (minerals). Essentially seston are the initial building blocks or support system of an ecosystem and these small particles are the feed for bivalves like oysters. If too many oysters are put in an area, they will remove the seston and the system will eventually crash. However, if an area has too much seston, it can lead to systems crashing due to excess loading resulting in oxygen depletion. Oysters are very beneficial in areas where there is excess loading as they feed on the seston and maintain the balance of the ecosystem. Each ecosystem is unique and other variables influence carrying capacity like the hydrodynamics of an area.

58. No two areas are alike, but similarities can be drawn between areas to determine if carrying capacity is a concern or not. Three areas in Nova Scotia were the subject of a recent study done by Filgueira et al, entitled "The effect of embayment complexity on ecological carrying capacity estimations in bivalve aquaculture sites" published in the Journal of Cleaner Production in 2021. The study looked at three areas in Nova Scotia where active farming is taking place that varied in hydrodynamics and geophysical coastal attributes. This provided a range of conditions that are most likely to be seen across Nova Scotia. Mainly, areas that are deep and relatively open, areas that are open and shallow to choked and shallow. Antigonish estuary would fall somewhere within this range, and at a proposed lower percentage of leased area than what was present in the study by Filgueira. Overall, the models show that farming in these areas could increase up to 20% with minimal concern. This study by Figueira et al is attached to this Affidavit as **Exhibit C**.

59. The total lease space of all three leases combined is approximately 2% of the Antigonish estuary. Based on work conducted for other sites in Nova Scotia and around Atlantic Canada, the risk of these sites having an impact on primary production is low. There is a significant amount of tidal flushing in Antigonish Harbour as well as freshwater input sources, and anthropogenic influences, all of which continually supply the estuary with seston and nutrients to support the ecosystem.

60. There is some agricultural farming occurring around Antigonish. As a result, nutrient runoff has the potential to increase nutrient loads in the estuary and primary production. The oyster farm will help mitigate the potential impacts of nutrient loading or increased nutrient loading in the future by filtering out the phytoplankton that utilize nutrients being loaded into the estuary and reduce the chance of events like algal blooms or increased epiphyte growth. The successful culture of American Oysters in the vicinity of the proposed lease areas, suggests sufficient primary production to support viable production capacity.

Water Quality

61. Water quality was examined by the Review Team. The Canadian Shellfish Sanitation Program (CSSP) classification for Antigonish Harbour is "restricted". Essentially there are three classifications under the CSSP: open, restricted and closed. Open means that you can harvest freely with no concerns. Closed means that due to water quality oysters cannot be harvested for human consumption. Restricted means there are concerns about water quality and, as a result, oysters harvested must be cleansed or "depurated" before human consumption.

62. There is an existing oyster lease and an active oyster fishery in the Harbour which operate under the *Management of Contaminated Fisheries Regulations* licence, and a Decontamination Plan, that are issued through DFO. Essentially these operators/harvesters transport their oysters to an "approved" site for cleansing, which is referred to as "relay". Another option would be for operators/harvesters to depurate through a controlled aquatic environment. Town Point Consulting is aware of the classification and intends to use approved depuration or cleansing processes.

63. Communication with Angela Smith (CFIA) indicates that no history of closures due to biotoxins have occurred in Antigonish Harbour.

Baseline Environmental Monitoring

64. The baseline video monitoring footage provided by Town Point Consulting indicates the presence of eel grass. This footage was shared with DFO as part of the Network Consultation. DFO reviews the baseline information to determine whether the proposed development is likely to result in changes to fish and fish habitat, aquatic species at risk, and aquatic invasive species.

65. DFO has recommended that Town Point Consulting implement a number of measures to avoid and mitigate the potential for prohibited effects to fish and fish habitat; and also carry-out a post-monitoring survey (1, 3 and 5 years) to characterize eel grass within the lease boundary, and at a reference site.

66. The Department will collaborate with DFO to design the eelgrass monitoring survey which Town Point would be required to implement if their applications are approved.

Site Design

67. The Review Team is satisfied that oceanographic and biophysical characteristics were considered in the Applicant's site design. Scaled drawings have been provided that outline the site design.

Section 3(e): The Other Uses of the Public Water Surrounding the Proposed Aquacultural Operation

68. Town Point Consulting has identified the following other users of the public waters surrounding the lease sites, not including the fisheries discussed above or the aquaculture sites discussed below:

    (a) Local land owners, and

    (b) Recreational boaters and fishers.

69. Town Point Consulting has conducted many public engagement sessions which are described in their Development Plan and Scoping Report.

Impacts to Wildlife

70. The Department also considers impacts to wildlife under this factor. To determine potential impacts to wildlife from the proposed operation, the Review Team relies on the feedback from the Network consultation. We received feedback from two network partners regarding potential impact to wildlife: The Canadian Wildlife Services Division of the Department of Environment and Climate Change Canada (CWS) and the Nova Scotia Department of Lands and Forestry (now the Department of Natural Resources and Renewables) (DNRR).

71. CWS provided feedback regarding species at risk. With respect to leases AQ #1442 and AQ #1443 no *Species at Risk Act* (SARA) listed species were identified in the areas adjacent to these sites.

72. Concerns were raised by CWS regarding AQ #1444. CWS recommends a two pronged approach: establishment of buffers zones and the adoption of operational mitigation measures to avoid adverse effects.

73. The mitigation measures are listed in the response from CWS at pages 69-71 of the Report on Outcomes of Consultation for AQ #1444. Town Point Consulting has expressed a willingness to alter its operational activities to adopt the mitigation measures, as recommended, to reduce disturbances.

74. There are two buffer zones recommended by CWS in relation to AQ #1444. CWS identified Dunn's Beach sandspit, on the North side of AQ #1444, as a critical habitat for Piping Plovers (a SARA listed species). A buffer zone of 300m is recommended. The proposed site is less than 300m from Dunn's Beach.

75. Gooseberry Island, on the South side of AQ #1444, was also identified as a nesting island for 2 species of gulls. A 300m buffer zone from this site was also recommended. Again, the proposed site is less than 300m from Gooseberry Island.

76. CWS recommended that the proposed lease at AQ #1444 be moved to an alternate location that would be at least 300m from Dunn's Beach and Gooseberry Island.

77. Town Point Consulting has provided information suggesting that a 230m buffer zone from the ocean side of the beach, which is the side they say is used by Piping Plovers, is sufficient to protect this species. Town Point retained Dillon Consulting to assess the potential impacts to nesting Piping Plovers as a result of AQ #1444. This Report is in the Application Package for AQ #1444 at p. 153.

78. CWS' initial feedback was provided on December 7, 2020. Town Point provided a response to the CWS' concerns which included the report by Dillon Consulting. CWS completed an additional review and provided a response on October 28, 2021. CWS' advice regarding buffers did not change.

79. DNRR provided a response on December 11, 2020 requesting additional information on a variety of topics, including more information on possible impacts to wildlife.

80. DNRR indicated that it was satisfied with the Piping Plover report prepared by Dillon Consulting and its conclusion (pending other stakeholder feedback) that a 230m buffer, along with Town Point Consulting's planned mitigation measures, appeared to be acceptable. (Report on Outcomes of Consultation AQ #1444, p. 118)

81. Town Point Consulting provided a detailed response to DNRR's concerns, including various scientific literature which can be found in the Report on Outcomes of Consultation AQ #1444 at pages 122-689.

82. DNRR provided an updated response on May 27, 2021 indicating that its concerns had been addressed. DNRR concluded that it did not anticipate any undue negative effects to avifauna. DNRR indicated it was satisfied with the proposed operation, but advised that Town Point Consulting must incorporate the operational mitigation measures and management techniques that would lessen ecological impact and human wildlife conflict.

83. DFA followed up with CWS to request more information regarding the rationale for the recommended 300m buffer. CWS responded on October 28, 2021, describing the two-pronged approach of buffers and mitigations (Report of Outcomes of Consultation – AQ#1444, p. 80). Unfortunately, the response from CWS did not provide any insight into the rationale for the 300m recommended buffer.

84. Based on the differing positions of CWS and DNRR, the Department asked the Centre for Marine Applied Research (CMAR) to provide a literature review of the state of knowledge regarding the application of buffer zones to critical habitat or geographic locations of known rare bird species. In addition, the Review Team wanted more information on interactions with bird species and various aquaculture activities. CMAR's report is attached to this Affidavit as **Exhibit D**.

85. CMAR's report outlines several options that this Board may consider.

Impacts to Other Users

86. The Review Team is satisfied that the proponent has consulted with the other users of the proposed development area through an extensive public engagement process.

87. The Review Team notes that some of Town Point Consulting's adjacent property owners near AQ#1442 oppose the project. Concerns include environmental impact, scale, proximity, risk of new technology, visual impact/aesthetics, property value, commercialization of Town Point, and increased traffic leading to increased dust in their homes on dry days.

88. Town Point Consulting has expressed a willingness to accommodate kayakers and canoeists by allowing them to transit the leased area if they wish.

Negative Impacts by Other Users

89. Possible impacts from roosting sea birds are addressed by the use of the culture equipment being deployed on the lease sites, it will have a near neutral buoyancy which deters birds from roosting on it.

Section 3(f): Public Right of Navigation

90. Transport Canada was consulted regarding any potential impacts on the public right of navigation from the three proposed lease sites. They have not raised any concerns.

91. Town Point Consulting will need a valid *Canadian Navigable Waters Act* approval.

92. Transport Canada will complete its approval process if this Board approves Town Point Consulting's applications.

Section 3(g): Sustainability of Wild Salmon

93. Town Point Consulting has identified the West and the South Rivers in Antigonish Harbour as Salmon Run Rivers and notes, from DFO scientific literature, that a negative trend in salmon populations has been identified in these rivers since 2005.

94. Town Point Consulting states that they ensure that their operation complies with all environmental regulations relating to salmon and salmon rehabilitation.

95. The Review Team is satisfied that the proposed operations are unlikely to impact the sustainability of wild salmon.

Section 3(h): The Number and Productivity of Other Aquacultural Sites in the Public Waters Surrounding the Proposed Aquacultural Operation

96. The other aquaculture lease in the Antigonish Harbour is a bottom culture oyster aquacultural operation. Town Point Consulting consulted with the owner of that operation, at the time (it has since been sold to a new owner). Town Point Consulting reports that he was supportive of the operation and did not foresee any adverse impacts on his site.

Affirmed before me on May 11, 2023, at
Halifax, Nova Scotia

Alison W. Campbell
A Barrister of the Supreme Court
of Nova Scotia

Nathaniel Feindel

ALISON CAMPBELL
A Commissioner of the Supreme
Court of Nova Scotia

2022	NSARB-2022-001 NSARB-2022-002 NSARB-2022-003

This is Exhibit "A" referred to in the Affidavit of Nathaniel Feindel ~~sworn~~ affirmed before me this 11th day of May, 2023.

Alison Campbell

Alison W. Campbell
A Barrister of the Supreme Court of Nova Scotia

ALISON CAMPBELL
A Commissioner of the Supreme Court of Nova Scotia

Nathaniel Feindel

Education

2008-2010 University of New Brunswick (Fredericton) Fredericton, NB

Masters of Science. (Biology)

- Specialization in Aquaculture

2002-2006 St. Francis Xavier University Antigonish, NS

Bachelor of Science

- Double Major in Aquatic Resources and Biology

Employment Experience

Nova Scotia Department of Fisheries and Aquaculture Shelburne, NS

April 2017 - Present

Manager (EC 12)

- Managing the Development Section in the Aquaculture Division of the Nova Scotia Department of Fish and Aquaculture.
- Develops, manages, advises and administers funding programs designed to assist and foster sustainable aquaculture industry development initiatives (e.g. Nova Scotia Aquaculture Research and Development Funding Program (NSARDFP)).
- Collaborates closely with the Aquaculture Development staff, Department staff as well as other Departments (where applicable) to ensure a coordinated and consistent approach to program/process development, implementation and day to day administration.
- Implements collaborative approaches for application reviews and discussions with other government agencies and review committees to recommend funding levels and restrictions.
- Manages the review of applications, corresponding with applicants, providing feedback, and composing formal departmental response letters for senior management
- Manage the oversight of the performance of multiple industry projects, involving multiple industry stakeholders; extensive monitoring, analysis and evaluation of operational activities to ensure compliance with contractual funding agreements in conjunction with licensing requirements. Provides Sr. management with progress reports on a program/project success.
- Corresponds, collaborates and supports the Policy Department in drafting legal contracts, maintaining and managing tracking documents, and reviewing interim and final reports
- Corresponds with proponents to ensure they are conforming to contractual agreements
- Advise on and implement aquaculture lease/license application documents and processes with respect to aquaculture regulations.
- Manages staff and their detailed technical and performance reviews on requests for aquaculture options to lease, new applications, scoping reports, development plans, licence and lease renewals, amendments, assignments, and production statistics analysis to advise the Minister and Aquaculture Review Board in decisions pertaining to the allocation of public resources. Assess technical feasibility, operational performance and environmental impact or adverse risk effects the current or potential aquaculture operations could have on the marine environment and its associated fisheries.
- Working with departmental staff to ensure industry compliance and understanding of Farm Management Plan (FMP) requirements and processes to enable the incorporation of regulatory oversight by the Nova

Scotia Department of Environment, as per the Aquaculture Licencing and Aquaculture Management Regulations. Assesses sections of FMPs, which may include Fish Health and Containment Management, Farm Operations, and Environmental Monitoring.

- Manage staff on the execution of performance reviews of individual farm owner FMPs through evaluation on the utilization rates through analysis of annually submitted farm production statistics and FMP records. Makes recommendations to farmers on techniques and technology to improve operations and to use provincial leased space to its full potential.
- Manage policy, regulatory and program program development
- Provides feedback, technical advice, and insight on Aquaculture Strategy, initiatives, and industry practices on program planning strategies and approaches
- Provides advice and assistance to program/operational areas throughout implementation of policies, providing interpretation on complex policy and regulatory issues; and provides guidance in monitoring and reviewing the effectiveness of policy interventions.
- Provides scientific/specialized knowledge and evidence for the effective development, implementation and evaluation of policy/regulatory changes and recommendation of legislative proposals that are responsive to the aquaculture industry and stakeholder needs.
- Manage research and the analysis of developments including new technologies, approaches and best practices and activities occurring in other jurisdictions in the field of aquaculture.
- Makes effective recommendations on implications and alternative methods to leverage potential opportunities to address key, critical issues of strategic relevance to the department's policy and legislative requirements.
- Provision of Aquaculture Industry Development and Extension Services
- For both Government and Non-Governmental Organizations: lead, coordinate and facilitate the design and execution of a variety of complex research projects related to aquaculture that support the refinement of techniques and methods to increase production, profitability and environmental sustainability or that focus on the potential socioeconomic impacts of aquaculture.
- Manages and reviews project development, activities and performance, including the gathering, interpretation, analysis and preparation of data for studies and reports: organize steering and other committees, liaise with pertinent project partners, participants, and supports, implement corrective actions in project phases; review work and monitor, approve and control budget expenditures to ensure project deliverables are on time and within budget.
- Evaluate adverse impacts of industry development on aquatic wildlife resources, and recommend mitigation or enhancement measures to industry developers, other government departments, consultants and other key stakeholders to ensure responsible development of the aquaculture industry.
- Respond to urgent and on-going situations that are non-biological in nature such as oil spills, damage by ice or storm, etc.; conduct site visits as required to conduct situation impact analysis and recommend corrective actions.
- Manage collaboration with other federal/provincial/municipal government organizations (DFO, Canadian Food Inspection Agency, Environment Canada etc.) to facilitate integrated solutions for those issues that cut across jurisdictions and disciplines.
- Manage the preparation of requests for proposals, selecting consultants, contractors and internal program participants as necessary; negotiate contractual terms of agreement with successful bidders, set project goals, priorities, and performance criteria. Manage reviews for other Provincial and Federal funding programs and advice on aquaculture specific requests from the department's perspective.
- Manage and Intra/Inter-Departmental and Intergovernmental Coordination and Cooperation
- Lead and participate on a variety of cross-jurisdictional planning and project committees to ensure a coordinated, strategic approach for the promotion, advancement and sustainable growth of the aquaculture industry.
- Provides advice to federal and provincial departments in decision making related to the movement of aquatic organisms both intra/inter-provincially to help control the spread of disease organisms and aquatic invasive species.
- Manages the Nova Scotia Department of Fisheries and Aquaculture representation on various committees and working groups at both the regional and national level (e.g. the Atlantic Region Interdepartmental

Shellfish Committee (ARISC)). Consults on approaches to respond to issues related to aquaculture science, capacity and development (e.g. participation in research projects and papers)

- Works closely with departmental employees to develop and present educational programs, courses, materials, etc. for a variety of audiences including industry sectors, schools, colleges and universities, and the public. Facilitates and supports planning committees to develop special events (conferences, trade shows, etc.) or campaigns sponsored by the Department in order to influence industry participation and engage the public on aquaculture or related topics.

Feb 2015 – April 2017

Biologist III (PR-15)

- Providing the aquaculture industry with development and extension services.
- Managing, coordinating and facilitating aquaculture development projects
- Coordinating and implementing research and development projects and activities for Non-Governmental Organizations, stakeholders, fisheries associations participating in species enhancement, and coastal community development projects.
- Providing technical research and advice to pertinent project partners, participants and other stakeholders
- Evaluating adverse impacts of industry development on aquatic resources, and providing/recommending mitigation or enhancement measures to industry developers, government agencies, consultants and other stakeholders
- Managing, administering and coordinate provincial funding for aquaculture research and development within the province
- Developing provincial program guidelines and policies to support provincial legislation
- Collaborating with other government agencies and stakeholders on project designs and funding
- Collaborate with other government agencies on planning and project committees to ensure a coordinated, strategic approach for the promotion, advancement and sustainable growth of the aquaculture industry
- Manage and review industry project performance; analyze and evaluate to ensure contractual funding agreements are being achieved
- Provide expert advice to senior management on current projects as well as potential future projects
- Provide feedback and insight on industry practices and technical advice from a science perspective on program planning strategies and approaches that will strengthen the provinces capacity to support the aquaculture industry
- Actively seek collaborators and leverage additional funding for projects within Nova Scotia
- Develop strategic and supporting documents for the Aquaculture Division.
- Serve as a provincial representative to collaborate nationally and internationally on strategic programs to develop and strengthen the finfish aquaculture industry in Nova Scotia
- Provide relevant technical/specialized knowledge for the effective development, implementation and evaluation of policy/regulatory changes and recommendation of legislative proposals that are responsive to marine finfish industry and stakeholder needs.
- Drafting legislative language and policies to support the continued development of the aquaculture industry in an economical and environmentally acceptable manner
- Monitor, research and analyze developments in new industry approaches, technologies as well as what is happening in other jurisdictions, enabling their application in Nova Scotia
- Respond to urgent and on-going situations and provide recommendations and facilitate solutions
- Manage, coordinate and facilitate the procurement of assets to support the development of the aquaculture industry and mandate of the Department of Fisheries and Aquaculture.
- Training and developing government employees in techniques that are acceptable under provincial government standards
- Organizing regional, national and international conferences/workshops involving multiple stakeholders

Nathaniel Feindel

July 2014 – Feb 2015 Parks Canada Port Mouton, NS

Project Manager (PM-04)

- Managing the costal restoration project in the Kejimkujik National Park Seaside
- Conducting condition monitoring and management effectiveness monitoring within Kejimkujik National Park Seaside in both marine and terrestrial environments
- Managing human and financial resources, including external service providers, volunteers and contractors
- Working in a collaborative environment with diverse groups (e.g. cross functional, other government departments, NGO's, businesses/corporations, community groups, educational institutions rural municipalities, the general public)
- Developing and delivering documents including action plans, communication plans and messaging, project financial reports and briefing notes.
- Delivering the Parks Canada mandate, strategic and operational objectives, policies, directives and regulations
- Managing and developing staff to effectively interact with the general public to communicate Parks Canadas mandate through the implementation and facilitation of eco-tourism and educational experiences
- Developing and managing contracts
- Planning, prioritizing and implementing complex projects or programs involving cross-functional teams, contractors and multiple stakeholders with a broad range of competing or conflicting interests
- Working independently and in cross-functional teams using a multi disciplinary approach
- Evaluating complex situations and making sound decisions and/or providing authoritative advice
- Preparing reports, presentations, and briefing notes for senior Parks Canada management, collaborators and the general public

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Jun 2012 - April 2014 Fisheries and Oceans Canada St. Andrews, NB

Aquatic Science Biologist (BI-02)

- Managing, implementing and facilitating an Aquaculture Collaborative Research and Development (ACRDP) project
- Managing the field testing of "green-technology" sea lice traps and further documentation of on-site dynamics of sea lice early life history
- Managing the deploy prototype traps on farms to evaluate the equipment performance in at-sea conditions.
- Compare the variation in larval sea lice, on salmon sites, captured between traps in the same cage as well as between different cages and different depths in the water column.
- Supporting a research scientist on experiments relating to sea lice in the marine environment.
- Designing and plumbing in various systems in wet lab facility from quarantine lab to a sea lice hatchery system and various types and sizes of tanks
- Producing sea lice larvae in an experimental hatchery from egg strings collected from naturally infected salmon on local farms
- Collecting sediment samples for larval hatching experiments on various sediment types
- Deploying mesocosms for sea lice larval hatching experiments
- Deploying oceanographic equipment, CTDs, LISST-100, Cyclops Submersible samplers, ph and temperature sondes, sediment collection tubes and collecting water samples with Niskin Bottle
- Maintaining the sea lice hatchery system and conducting routine maintenance
- Continue with the testing of the relative efficiency of the prototype sea lice traps developed in phase 1 and 2 of this project measured by selective efficiency
- Develop and minimize the energy requirements of the traps
- Developing and conducting experiments on sea lice, in and around salmon aquaculture sea cages in the Bay of Fundy and Nova Scotia
- Operating and maintaining Rossborough boats in and around salmon sites and the Bay of Fundy
- Conducting experiments off of Coast Guard vessels in and around salmon sites and the Bay of Fundy

- Loading and offloading research equipment and trawl gear on/off research vessels with overhead crane
- Liaising with industry partners and collaborators to conduct experiments on private aquaculture leases
- Writing, reporting and presenting findings of experiments being conducted to senior DFO management and industry partners
- Presenting results at national conferences
- Chairing conference sessions and general meetings
- Working with NB Department of Agriculture, Aquaculture and Fisheries on chemotherapeutant treatments for salmon
- Making recommendations to senior scientists on logistics and design of future projects
- Managing/training technicians and summer students
- Managing a budget
- On-call after hours for emergency response to the wet-lab, broodstock facility and quarantine lab

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Apr 2012 - Jun 2012 | Fisheries and Oceans Canada | St. Andrews, NB

Aquatic Science Biologist (Bi-02)

- Managing, compiling and drafting the publication of a specialized chapter in a Canadian Manuscript of Fisheries and Aquatic Sciences for the Aquatic Climate Change Adaptation Services Program (ACCASP)

Shackell, N.L., B.W. Greenan, P. Pepin, D. Chabot and A. Warburton (Editors). 2013. Climate Change Impacts, Vulnerabilities and Opportunities (IVO) Analysis of the Marine Atlantic Basin. Can. Manuscr. Rep. Fish. Aquat. Sci. 3012: xvi + 366 p.

Chapter 6: Feindel et al.,"Climate Change and Marine Aquaculture in Atlantic Canada and Quebec."

- On-call after hours for emergency response to the wet-lab, broodstock facility and quarantine lab

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Jan 2011 - Mar 2012 | Fisheries and Oceans Canada | St. Andrews, NB

Aquatic Science Technician (EG-04)

- Designing, managing and conducting scientific studies on American lobsters in both lab and field settings
- Managing the coordination of industry stakeholders to conduct experiments and deployment scientific equipment in the marine environment
- Deploying divers with mesocosms and scientific equipment to conduct studies in the field relating to chemical chemotherapeutants
- Conducting chemtherapeutant experiments on adult, juvenile and larval lobsters
- Conducting climate change studies on larval lobsters
- Writing manuscripts from experiments that were conducted and presenting data at national and international conferences and to senior DFO management
- Maintaining lobsters in the holding facility at the biological station
- Maintaining the holding facility and carrying out routine maintenance
- Developing standard operating procedures to be used by conservation and protection officers in the field for specific infractions of the *Fisheries Act*
- Managing a lab and a budget
- Providing scientific support and advice on various studies being conducted by multiple divisions at the biological station, industry stakeholders and conservation officers
- Spawning Atlantic salmon, Atlantic cod, Arctic charr, Atlantic halibut and American lobster
- Hatchery production of Atlantic salmon, Atlantic cod, Arctic charr and American lobster
- Training technicians, students and interns in animal husbandry and standard operating procedures to conduct scientific studies
- Entering, extracting and analyzing data using Oracle/SQL, SPSS, R, Minitab and Excel
- Supporting other technicians in the group with experiments they are conducting
- Loading and offloading research equipment and trawl gear on/off research vessels with overhead crane

- On-call for after hours emergency response to the wet-lab facility, broodstock facility and quarantine lab

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Oct 2010 - Jan 2011 Fisheries and Oceans Canada St. Andrews, NB

Aquatic Science Technician (EG-02)

- Providing technical support as part of an animal care/scientific support team
- Designing and conducting various scientific studies on finfish and crustaceans
- Mixing and producing vitamins to supply various finfish programs
- Spawning Atlantic salmon, Atlantic cod, Arctic charr, Atlantic halibut and American lobster
- Hatchery production of Atlantic salmon, Atlantic cod, Arctic charr and American lobster
- Operating computer controlled systems for aquatic science labs
- General maintenance to filtration and dechlorination systems
- Collecting oceanographic data on population ecology survey using CTD and Rosette samplers
- Assisting in monitoring and collecting Scanmar and Marport data on trawl gear
- Entering data in to GSE database
- Loading and offloading research equipment and trawl gear on/off research vessels with overhead crane
- Placing temperature and depth probes on ground fish and lobster trawling gear
- Uploading data from different types of probes and equipment to spreadsheets and analyzing data
- On-call after hours for emergency response to the wet-lab, broodstock facility and quarantine lab

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Aug 2010 - Oct 2010 Fisheries and Oceans Canada/University of New Brunswick St. Andrews, NB

Marine Biologist

- Providing scientific and practical advice on finfish, invertebrate, plant and crustacean aquaculture management issues to senior management and industry stakeholders
- Writing reports for senior management in the DFO, industry and university research scientists
- Managing and conducting research on Integrated Multi-Trophic Aquaculture (IMTA) development
- Culturing and harvesting kelp for commercial applications and to maintain sea urchins
- Conducting research on sea lice controls by mechanical and filtration methods
- Designing, conducting and analyzing scientific studies on finfish and invertebrates
- Designing and constructing sampling/field equipment
- Deploying oceanographic equipment such as; CTD, LISST, pH sondes, chlorophyll and current meters in the field
- Assisting in the use of an acrobat used to profile the water column around aquaculture sites
- Collecting grab samples, sediment cores
- Loading and offloading equipment on/off research vessels with overhead crane
- Designing and constructing infrastructure for deployment in harsh ocean environments
- Deploying and retrieving infrastructure containing expensive scientific equipment in/from harsh environments

Nathaniel Feindel

Apr 2010 - Jul 2010 Fisheries and Oceans Canada/Genome Atlantic St. Andrews, NB

Lab Manager

- Managing technicians and students in DFO research lab
- Designed and conducted an Atlantic cod spermatozoa cryopreservation experiment.
- Collected and analyzed data
- Compiled and edited a manuscript for publication in Aquaculture Research. "Cryopreservation of Atlantic cod (Gadus morhua) sperm in large volume straws: applications for commercial production and gene banking". 2011, Volume 42, pages 1714-1722.

2007 - 2009 Casual Employment — Centre for Aquatic Health Science, Atlantic Veterinary College — St. Andrew/St. George, NB

Field Fish Health Technician

- Aided in data collection and sampling of cultured Atlantic salmon involved in vaccination trials

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2007 - 2010 Contract Work Fisheries and Oceans Canada St. Andrews, NB

At-Sea Lobster Sampler

- Arranging sampling trips with lobster fishermen
- Managing the collection of lobster stock assessment data for senior biologist
- Collecting samples for various biological analysis
- Compiling data in database
- Extracting data from database and compiling report on fish activity
- Training biologists, technicians and students in at-sea sampling protocols

May 2007 - Sept 2007 Maple Leaf Foods Canada St. Andrews, NB

Research Facility Manager

- Managing an Atlantic salmon research facility
- Coordinating and conducting a nutrition experiment on various stages of Atlantic salmon (creating and executing numerous standard operating procedures)
- Compiling data for senior scientist
- Conducting routine fish husbandry and facility maintenance
- Designing, installing and expanding the existing tank field and facility
- Obtaining contractors and sub-contractors to expand wet lab facility

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May 2006 - May 2007 Cooke Aquaculture Aspotogan, NS

Saltwater Technician

- Feeding fish (two farms totaling 30 cages)

- Monitoring water quality parameters
- Sampling and harvesting fish
- Assisting veterinarians
- Conducting site maintenance

Summer 2005 JAVI-Tech Yarmouth, NS

At-Sea Scotia-Fundy Fisheries Observer

- Monitoring and recording all activity aboard various types of fishing vessels to ensure compliance with fish regulations (e.g., scallop, tuna, lobster, ground fish, etc.)
- Recording and sampling catches aboard fishing vessels for scientific purposes
- Conducting experimental surveys for the Department of Fisheries and Oceans Canada

Research Experience

- M.Sc. Biology (Aquaculture specialization): Triploidy induction of Atlantic cod (Gadus morhua)
  - Developing an optimized protocol for the induction and commercial scale production of triploid Atlantic cod.
  - Studying the reproductive potential and spawning capacity of triploid Atlantic cod
  - Co-supervisors: Dr. Tillmann Benfey (UNBF), Dr. Edward Trippel (DFO SABS)

- Experiments/Studies conducted during employment and education experiences: Therapeutant Exposures, Development of Chemical Exposure Test Kits, Gonadal MaturityAssessment (macro/microscopic), Fertilization Success, Sperm Motility, Sperm Morphological Assessment (Micro and macroscopic), Sperm Cryopreservation Experiment, Competitive Spawning, Triploidy Pressure Induction, Deformity Assessment, Photoperiod Manipulation, Stress Response, Tagging Studies, Observational Studies using Video Equipment, Sea Lice Filtration (mechanical and bio-filtration), Particle Size Analysis, Toxicological, Compensatory Growth, Larval Hatching Success, Growth, Larval Survival, Vaccination Trials, Hypoxia Challenges, Parasitic Infection, Viral Challenges, Sedimentation Studies, Parasitic Bath Treatment

Cultured Organisms Handled

Atlantic Cod, American Lobster, Atlantic Salmon, Blue Mussels, American Oyster, Atlantic Halibut, Kelp, Sea Lice, Atlantic Sea Scallops, Turbot/Greenland Halibut, Sea Cucumber, Arctic Charr, Sea Urchins, Atlantic Sturgeon, Rotifers, Shortnose Sturgeon, Artemia, Haddock, Sea Lice, Pollack, Zebra Fish, Rainbow Trout, Polychaetes, Sable Fish, Striped Bass, Bloodworms

Additional Assets

- Ability to manage various types of projects ranging from scientific to construction projects
- Ability to train biologists, conservation and environmental compliance officers, technicians, students, interns and the general public in fish husbandry, standard operating procedures and scientific techniques
- Capacity to design and execute various types of experiments
- Write and present clear and concise reports
- Capacity to design and construct field equipment for harsh environments
- Strong public speaker and presenter
- Comfortable liaising with industry stakeholders and government officials
- Ability to operate various types of boats and oceanographic equipment
- Knowledge of statistical analysis software packages (Oracle/SQL, Minitab, SPSS, NCSS)

- Computer Software Knowledge
  - -Microsoft Office Suite
  - -Image ProPlus
  - -Nikon NIS-Elements BR
  - -Image Q
  - -Image J
  - -Integrated Semen Analysis Software (ISAS)
  - -ArcGIS

Publications

Primary Publications:

- Waddy, S.L., Feindel, N.J., Hamilton-Gibson, N., Aiken, D.E., Merrit, V., and Leavitt, N. 2017. Reproductive Cycles and Mating Capacity in Male American Lobsters (*Homarus americanus*). Fisheries Research, 186:358-366.

- Trippel, E.A., Butts, I.A.E., Babin, A., Neil, S.R.E., Feindel, N.J., and Benfey, T.J. 2014. Effects of Reproduction on Growth and Survival in Atlantic Cod, Gadus morhua Assessed by Comparison to Triploids. Experimental Marine Biology and Ecology. 451: 35-43

- Shackell, N.L., B.W. Greenan, P. Pepin, D. Chabot and A. Warburton (Editors). 2013. Climate Change Impacts, Vulnerabilities and Opportunities (IVO) Analysis of the Marine Atlantic Basin. Can. Manuscr. Rep. Fish. Aquat. Sci. 3012: xvi + 366 p.
  - Chapter 6: Feindel, N.J., Cooper, L., Trippel, E.A., and Blair, T."Climate Change and Marine Aquaculture in Atlantic Canada and Quebec." pages 195-240

- Benfey, T.J., Feindel, N.J., Lin, S., Whitehead, J.A., Martin-Robichaud, D.J., Trippel, E.A., and Duffy, M. 2012. The production of single-sex and sterile populations of Atlantic cod (Gadus morhua) for aquaculture: fish health considerations with focus on Loma morhua. Aquaculture Association of Canada Bulletin 109-1.

- Feindel, N.J., Benfey, T.J., and Trippel, E.A. 2011. Gonadal Development of Triploid Atlantic Cod (Gadus morhua)". Journal of Fish Biology. Volume 76, pages 1756-1761

- Butts, I.A.E., Feindel, N.J., Neil, S.N., Kovács, É., Urbányi, B., and Trippel, E.A. 2011. Cryopreservation of Atlantic cod (Gadus morhua) sperm in large volume straws: applications for commercial production and gene banking. Aquaculture Research. Volume 42, pages 1714-1722.

- Feindel, N.J., Benfey, T.J., and Trippel, E.A. 2010. Competitive Spawning Success and Fertility of Triploid Male Atlantic Cod (Gadus morhua). Aquaculture Environment Interactions Volume 1, pages 47-55.

Conference Proceedings:

- Aquaculture Association of Canada. 2013. "Field Testing of a "Green-Technology" Sea Lice (*Lepeophtheirus salmonis*) Trap:Performance, Larval Dynamics and Trap By-Catch Around atlantic Salmon (*Salmo Salar*) Aquaculture Farms in the Bay of Fundy." Feindel, N., Robinson, S.M.C., and Ang, K.P.

- World Aquaculture Society. 2013. "Spatial Distribution Patterns of Sea Lice (*Lepeoptheirus salmonis*) Larvae around Salmon (*Salmo salar*) Aquaculture Farms in the Bay of Fundy, Canada." Robinson, S.M.C., Bartsch, A., Luitkus, M., Feindel, N., Robertson, P., Ang, P.A., Cleaves, D., and Lander, T.L.

- World Aquaculture Society. 2013. "Multi-Year Growth and Reproductive Patterns of Diploid and Triploid Atlantic Cod (*Gadus morhua*)." Trippel, E.A., Butts, I.A., Babin, A., Neil, S.R.E., Feindel, N.J., and Benfey, T.J.

- Aquaculture Association of Canada Conference Proceedings, 2009. "Spawning capacity of triploid Atlantic cod males and the early life history performance of their offspring".

- Conference Proceedings for ICES ASC, 2009. "Competitive Spawning of Male Triploid Atlantic Cod (Gadus morhua) and the Early Life History Performance of their Offspring".

Certificates/Training

- Oracle/SQL
- The Experimental Fish (Animal Care Protocol Certification)
- Government Security Clearance (Reliability Status)
- Workplace Hazardous Materials Information Systems (WHMIS) Certificate
- Passport to Safety Certificate
- Marine Emergency Duties (MED A1) Training
- Restricted Operators Certificate Maritime Commercial
- Marine First Aid
- Small Vessel Operator Proficiency Training Course (SVOP)
- Pleasure Craft Boaters License
- PADI Certified Open Water Scuba Diver
- Firearms Possession Acquisition License
- Conservation Education Certification
- Overhead Crane Training
- Advanced Wilderness First Aid Training
- Introductory ROV Training
- Introductory to Simulated Electronic Navigation
- Nova Scotia Provincial ATV Training

2022	NSARB-2022-001 NSARB-2022-002 NSARB-2022-003

This is Exhibit "B" referred to in the Affidavit of Nathaniel Feindel ~~sworn~~ affirmed before me this 11th day of May, 2023.

Alison W. Campbell
A Barrister of the Supreme Court of Nova Scotia

ALISON CAMPBELL
A Commissioner of the Supreme Court of Nova Scotia


Town Point Proposed Marine Leases & Issued Land Based Facility
Harbour Centre
N
1444
1443
1422
1442
Ferry Point
Southside Antigonish Harbour
Antigonish Harbour
Reef Island
Current Meter Deployment
Town Point Land Based Facility
Proposed Town Point Lease
0
425
850
1,700 Meters
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community, Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

2022	NSARB-2022-001 NSARB-2022-002 NSARB-2022-003

This is Exhibit "C" referred to in the Affidavit of Nathaniel Feindel ~~sworn~~ affirmed before me this 11th day of May, 2023.

Alison W. Campbell
A Barrister of the Supreme Court of Nova Scotia

ALISON CAMPBELL
A Commissioner of the Supreme Court of Nova Scotia

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The effect of embayment complexity on ecological carrying capacity estimations in bivalve aquaculture sites

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[d] Tohoku University, Graduate School of Engineering, Department of Civil Engineering 6-6-06 Aramaki Aza-Aoba, Aoba-ku, Sendai, 980-8579, Japan
[e] Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, B3H 4R2, Canada

A R T I C L E I N F O

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A B S T R A C T

Bivalve aquaculture requires the alteration of natural populations of filter-feeders by artificially increasing their density. A bivalve farm could have negative consequences for the ecosystem if the filtration pressure of stocked biomass surpasses the capacity of the system to replenish the depleted resources. The concept of ecological carrying capacity, understood as the magnitude of aquaculture activity in a given area that can be supported without leading to unacceptable changes in the aquatic environment, is commonly used to inform management and regulatory decisions of bivalve aquaculture. In this study, a hydrodynamic model has been coupled to an ecological model that simulates the main dynamics of organic seston to evaluate the effects of bivalve aquaculture on seston supply and assess ecological carrying capacity. The spatially-explicit model allows the identification of areas where organic seston could be reduced beyond precautionary thresholds of ecosystem resilience. The model has been applied to three coastal embayments in Nova Scotia (Canada) that differ in water circulation and inlet/coastal complexity. The outcomes of the model suggest that the current aquaculture operations in Sober Island, Wine Harbour, and Whitehead are within the ecological carrying capacity of the ecosystem for bivalve aquaculture. The simulation of additional hypothetical stocking scenarios had demonstrated the relevance of local water circulation to the ecological carrying capacity of the system, and consequently for aquaculture operations. Accordingly, the placement of leases in areas with optimal circulation should be considered for planning purposes. The capability of the model to explore hypothetical scenarios could be used as a tool to guide management decisions in regard to site selection for new aquaculture sites.

1. Introduction

A simple question has prevailed in the scientific literature about bivalve aquaculture in the last 20 years: 'how much is too much?'. This question has been posed by managers and regulators to quantify how many bivalves can be farmed in a bay without causing negative ecological impacts. The underlying goal of this question is to determine the carrying capacity of the ecosystem and concomitantly ensure the sustainability of farming activity. The scientific community has answered this question with different approaches, ranging from numerical models that simulate current or hypothetical aquaculture scenarios (Ferreira et al., 2008; Byron et al., 2011), to monitoring programs that aim to infer the environmental effects of aquaculture based on a suite of indicators (Filgueira et al., 2013a, 2014). One of the key outcomes from the scientific literature on this topic is the influence of local conditions, particularly water circulation, on ecosystem functioning and consequently on the estimation of ecological carrying capacity (ECC) for bivalve aquaculture (Dame and Prins, 1998; Smaal et al., 1997); although this statement is highly dependent on the specific local conditions (e.g. Filgueira et al., 2016; Sainz et al., 2019). For example, the ECC for mussel aquaculture in Tracadie Bay (Canada) increased after a storm opened a breach in the barrier inland at the mouth of the bay, which was attributed to the increase

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0959-6526/

in water exchange with the open ocean, and the concomitant impact on phytoplankton renewal within the bay (Filgueira et al., 2013b). The relevance of local hydrodynamics has also been recognized in decision support tools for bivalve aquaculture planning (e.g. Silva et al., 2011; Gangnery et al., 2020). These findings confirm the need for spatially explicit hydrodynamic models to fully understand bivalve-environment interactions, and consequently to estimate ECC.

Although ECC has been defined with slightly different emphasis in the context of bivalve aquaculture, ECC could generally be understood as the magnitude of aquaculture activity in a given area that can be supported without leading to unacceptable changes in ecological processes, species, populations, communities, and habitats in the aquatic environment (Byron and Costa-Pierce, 2013). The definition of thresholds for unacceptable changes is the key challenge in ECC studies, given that it requires qualitative and quantitative decisions. Qualitatively, it is crucial to define the environmental variable(s) that should be used to characterize an unacceptable change. Bivalve aquaculture could potentially exert a series of changes on the ecosystem. Firstly, feeding activity of filter-feeding bivalves could exert a top-down control on phytoplankton populations (Petersen et al., 2008; Timmermann et al., 2019). Similarly, the feeding activity could exert competition with zooplankton (Maar et al., 2008) or direct predation on zooplankton (Froján et al., 2016), which could cause a direct effect on the larvae of certain species and trigger cascade effects in the food web, although this field of research is still in its infancy. Finally, bivalve biodeposits sink to the bottom, increasing organic loading, which can alter the biochemistry of sediments and local benthic populations (Newell, 2004; Smyth et al., 2018). Feedback of altered nutrient cycles to phytoplankton populations could limit the available energy for higher trophic levels in the water column (Jiang and Gibbs, 2005; Kluger et al., 2017), including the cultured species (Grant, 1996; Bacher et al., 2003). As benthic effects have a limited spatial extension compared to pelagic effects (Newell, 2004; Weitzman et al., 2019), ECC has usually focused on the bivalve-phytoplankton interaction (McKindsey, 2013). Particularly, the reduction of phytoplankton populations, or organic seston assuming that phytoplankton is the largest component of the seston, as a consequence of bivalve filtration have been used as a benchmark to assess ECC at aquaculture sites (reviewed by McKindsey, 2013).

The definition of ECC thresholds becomes even more complex from a quantitative perspective. The definition of these thresholds should be framed in the context of the Ecosystem Approach to Aquaculture (EAA, Soto et al., 2008), which defines accepted principles for sustainable management of farming activities, acknowledging that aquaculture is part of a broader social-ecological system. Accordingly, the holistic principles of EAA include social, economic, and ecological aspects. From the ecological standpoint, EAA encourages that aquaculture should be carried out taking into account the resilience of the ecosystem to ensure that functions and the delivery of services are not compromised. However, the precise quantification of the tipping points at which a small perturbation can exceed resilience and compromise performance of the ecosystem is not straightforward (Fischer et al., 2009). Furthermore, given that these limits are site specific, it is difficult to perform field measurements to empirically determine these tipping points without manipulating the ecosystem. To overcome this issue, Grant and Filgueira (2011) suggested using the natural variation of an ecosystem variable as the precautionary limit beyond which the resilience of the system could be compromised. The application of natural variation of phytoplankton populations as a precautionary limit has been used to assess ECC (Filgueira et al., 2015; Bricker et al., 2016) and inform management decisions (DFO, 2015) at bivalve aquaculture sites.

As stated above, given the difficulty in carrying out empirical assessments, ecosystem modelling has become the standard tool to explore carrying capacity and the potential effects of different aquaculture scenarios on the environment (Dabrovski et al., 2013; Brigolin et al., 2017). Although models vary in complexity, ranging from simple ratios (Dame and Prins, 1998; Comeau, 2013) to ecosystem models (Guyondet et al., 2010; Pete et al., 2020), Filgueira et al. (2015) demonstrated that a spatially explicit model that simulates the dynamics of organic seston as a whole (e.g. Dowd, 2003; Guyondet et al., 2013) could provide the same output as a more complex ecosystem model that captures the dynamics of nutrients, phytoplankton, and seston independently. Representing seston dynamics at the proper spatial resolution is imperative given the relevance of local hydrodynamics for the replenishment of seston in farming areas, and consequently for the delivery of food to bivalve farms (Nunes et al., 2011; Filgueira et al., 2016). Therefore, simulating organic seston as a single variable aims to capture food dynamics without added complexity, parameterization, and validation resulting in an optimal solution to exploring ECC.

The main objective of this study is to explore ECC for oyster aquaculture in embayments with different hydrodynamic conditions that affect bivalve-environment interactions. To address this objective, three embayments from Nova Scotia (Canada), Sober Island Pond, Wine Harbour, and Whitehead, that currently hold active farms of the Eastern oyster *Crassostrea virginica* were selected as case-studies. The three embayments are located on the Eastern Shore of Nova Scotia, and it is assumed that the seston dynamics would be similar from a biogeochemical perspective; however, the three bays are very different from a geophysical perspective, ranging from deep and relatively open (Whitehead), to open and shallow (Wine Harbour), and choked and shallow (Sober Island). Accordingly, this study allows the evaluation of the relevance of water circulation to seston dynamics and particularly the estimation of ECC in bivalve aquaculture sites. For that purpose, a model that represents the dynamics of organic seston was coupled to a hydrodynamic model, and a series of simulations, covering current aquaculture development and hypothetical scenarios, were explored and analyzed in terms of reduction of organic seston. The outcomes of this study can be directly used to inform aquaculture managers as well as further our understanding on the role of local hydrodynamics on the resilience of aquaculture sites. These results demonstrate operational use of carrying capacity as a tool in aquaculture regulation.

2. Methods

The dynamics of organic seston were simulated by coupling a series of convection-diffusion equations to the outcomes of a hydrodynamic model constructed using the unstructured-grid Finite Volume Community Ocean Model (FVCOM) (Chen et al., 2007). The next sections provide 1) a general description of the study area, including the level of bivalve aquaculture in the three simulated embayments, 2) the details of the FVCOM model, including the data collected for their validation, 3) the equations that define the organic seston dynamics model, and 4) the scenarios that were analyzed.

2.1. Study area

Sober Island Pond, Wine Harbour, and Whitehead are located within a section of 100 km on the eastern shore of Nova Scotia (Fig. 1). Following Greenlaw et al. (2011), these embayments differ from the geophysical perspective and ecological representation. Sober Island is a small lagoon isolated from the ocean by a narrow

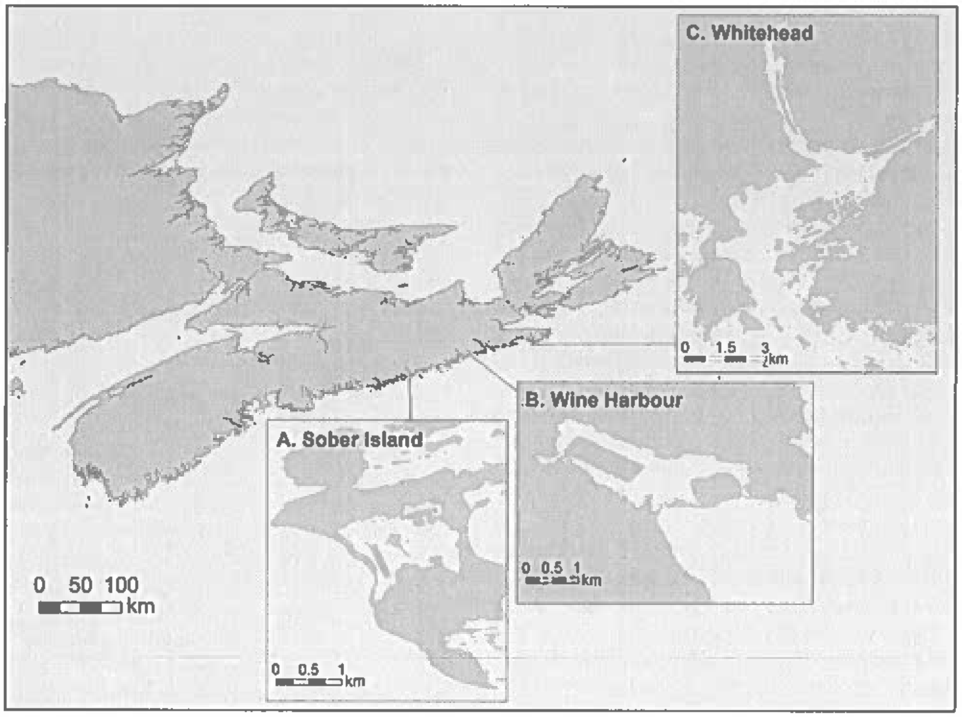

Fig. 1. Location of the three study sites - Sober Island, Wine Harbour, and Whitehead, within Nova Scotia (Eastern Canada). Current oyster leases are in red polygons. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

inlet through a gravel bar with minimal freshwater input. Therefore, this embayment does not fit within any category described by Greenlaw et al. (2011) regarding hydrographic characteristics, namely bay, estuary, and cove. Accordingly, lagoon is a better term to characterize Sober Island. Regarding complexity, Sober Island qualifies as intermediate, with a central large body of water, but also complex morphology generated by small islands, and areas with variable depth. Finally, taking into account the low percentage of intertidal area and its average depth, it is expected that the production within the lagoon has contribution from both benthic and pelagic environments. Wine Harbour is a "simple intermediate estuary" (Table 1) with low habitat heterogeneity, and high productivity based on the contribution of freshwater runoff and the restricted exchange with the open ocean, which also reduces the degree of exposure to waves and tides. Whitehead is a "complex pelagic bay" (Table 1) with high habitat heterogeneity, potentially supporting high species diversity, a dominance of pelagic over benthic production, with low contribution from the river and medium exposure to oceanic conditions. Although the outer bay is highly exposed, there are multiple islands with inner embayments protected from ocean waves. One of these inner basins is among the first bays worldwide to have been assessed for carrying capacity (Carver and Mallet, 1990). The three bays also differ in depth and extension, with Whitehead being the deepest and largest and Sober Island the shallowest and smallest (Table 1).

Oyster farms are currently active in the three embayments, but the spatial coverage of the leased area is heterogenous across them, ranging from 7.3% in Whitehead to 21.7% in Wine Harbour, respectively (Table 1). The farming technique also differs across sites. While oyster cages are used in Whitehead and Wine Harbour, a mix of oyster cages and floating bags are used in Sober Island. However, for the sake of comparability across embayments, and taking into account that the use of oyster cages is becoming the most popular farming method, the oyster density in this study has been adjusted to represent the typical values used in cages.

2.2. Hydrodynamic model

Although a single hydrodynamic model domain was initially planned to be used for the three systems, the hydrodynamics at the narrow (~20 m) and shallow (~1 m) entrance of Sober Island resulted in numerical instability at the time step that was required to ensure computational efficiency. Accordingly, two hydrodynamic models were constructed to accommodate these particular conditions. A first hydrodynamic model was constructed for Sober Island (hereafter, Sober Island Model) in which the fine spatial resolution

Table 1
Description of the embayments in terms of complexity, production regime and hydrographic characteristics based on Greenlaw et al. (2011) (see text), and physical characteristics, included the percentage of the bay that is leased for aquaculture purposes. *Lagoon is not originally in Greenlaw et al. (2011), see text for explanation.

Embayment	Complexity	Production regime	Hydrographic	Average depth (m)	Area (km^2)	Leased area (%)
Sober Island	Intermediate	Intermediate	Lagoon*	2.9	0.90	9.6
Wine Harbour	Simple	Intermediate	Estuary	4.0	1.95	21.7
Whitehead	Complex	Pelagic	Bay	9.0	14.12	7.3

allowed for an execution at a short time step without impacting computational efficiency (Figure A1). The second hydrodynamic model was constructed for Wine Harbour and Whitehead (hereafter Wine Harbour/Whitehead Model) covering approximately 120 km of the Eastern Shore.

The grid for Sober Island Model (Figure A1) included 2260 triangular elements with 1263 nodes. Given the lack of precise bathymetry data for this location in existing charts, an echosounder survey was carried out in the lagoon during July 2019 (Biosonics MX). The readings were interpolated to the nodes from FVCOM and smoothed to meet the hydrostatic conditions. The model included a total of 11 sigma layers to describe the vertical dimension. The model was forced at the boundary using tidal elevations calculated from sea surface height observations made at the boundary using an ADCP (Table A1). The tidal constituents used in the model were M2, S2, K1, O1, and N2, which were the five major constituents based on observations. The model was forced without winds to minimize mixing within the domain, which is aligned with the goal of representing the worst-case scenario in maximizing the reduction of organic seston by oyster filtration. Finally, a 500 m wide sponge layer was used at the open boundary to limit spurious reflections and other instabilities originated at the boundary.

The grid for Wine Harbour/Whitehead Model was defined by 40,895 triangular elements with 22,086 nodes. The depth was interpolated from the existing Canadian Hydrographic Service NONNA dataset (https://open.canada.ca/data/en/dataset/d3881c4c-650d-4070-bf9b-1e00aabf0a1d) to the nodes and smoothed to meet the hydrostatic conditions. Given the dynamic nature of some shallow areas, particularly at the mouth of Wine Harbour, farm operators validated the bathymetry in key locations during the current meter deployment (Table A1), to ensure that the model represented the conditions existing during the data acquisition. Similar to the Sober Island Model, a total of 11 sigma layers were used to describe the vertical dimension. The model was forced with tidal elevations calculated using WebTide and interpolated to the mesh open boundary. The tidal constituents used were M2, S2, K1, O1, and N2, which were the five major constituents based on observations. Following the same approach described above, winds were not part of the forcing. A 200 m wide sponge layer was used at the open boundary to limit spurious reflections and other instabilities.

For both Sober Island Model and Wine Harbour/Whitehead Models, the simulations were initialized from rest, and run for 30 days in total. In both hydrodynamic models, the conditions were ramped up linearly over the first 5 days to prevent any spurious oscillations due to a sudden start. Accordingly, these first 5 days were not considered for validation and numerical calculations of seston dynamics. A total of eight current profilers and single point current meters were deployed in the region during 2019 for validation purposes. Deployments were synchronous within each bay, but asynchronous across bays (Table A1). All of them were configured to measure velocity and pressure. The raw data were binned using 1 m vertical bins for the profilers. An ensemble interval of 900 s was used at each deployment. Ping rate of 0.5 Hz was used in burst mode for 300 s. The deployment period was at least 45 days at each location. The duration of each deployment together with the sampling rate of 0.5 Hz was estimated to be sufficient for analysis of the tidal elevations for the major constituents and used to validate the hydrodynamic model. Depth was only available for the current profilers due to a malfunctioning of the pressure sensor in the single point current meter detected after the deployments.

The water renewal time distribution within the three systems was calculated from the FVCOM outputs and numerical tracer experiments that quantified water exchange between each bay and the far-field, following Koutitonsky et al. (2004).

2.3. Seston dynamics model

The outputs of the hydrodynamic model for each bay were coupled to a convection-diffusion equation previously used by Dowd (2003) and Guyondet et al. (2013) to simulate the dynamics of organic seston. The original equations in Guyondet et al. (2013) for a 2-dimensional bay were extended to a 3-dimensional representation as follows:

$$\frac{\partial S}{\partial t}+u\frac{\partial S}{\partial x}+v\frac{\partial S}{\partial y}+w\frac{\partial S}{\partial z}=\frac{\partial}{\partial x}\left(D_x\frac{\partial S}{\partial x}\right)+\frac{\partial}{\partial y}\left(D_y\frac{\partial S}{\partial y}\right)+\frac{\partial}{\partial z}\left(D_z\frac{\partial S}{\partial z}\right)+\alpha-\beta S \tag{1}$$

where S is the organic seston concentration (mgC m^{-3}); u, v and w are the current speeds in directions x, y and z (m s^{-1}), respectively; D_x, D_y and D_z are the dispersion coefficients proportional to u, v and w, respectively, α is the phytoplankton primary production rate (mgC m^{-3} d^{-1}), and β is the oyster population clearance rate (d^{-1}) (see further details in Guyondet et al., 2013). The organic seston dynamics model was parameterized with existing data from the literature. The primary production rate α was kept constant in the three bays, and the average value was based on a depth-integrated 2.5 g C m^{-2} d^{-1}, typical of summer conditions in Nova Scotia waters (Platt, 1991). The bivalve population clearance rate β was calculated as the product of individual bivalve clearance rate (m^3 ind^{-1} d^{-1}) and density of bivalves in the farm area (ind m^{-3}). It was assumed that oysters filtered at a constant rate of 5 L h^{-1} (or 0.12 m^3 d^{-1}), which is assumed to be representative of suspension culture oysters of 57 mm (Comeau, 2013) at a temperature of 17 °C (mean temperature observed at the study sites over the months of June to September). A constant density of 25 ind m^{-2} was assumed for all leases under the current aquaculture scenario and cultured oysters were distributed over the top 0.5 m of the water column in accordance with the local husbandry practice. The organic seston dynamics model outer boundary was forced with a constant concentration of organic seston typical of local waters during the summer, S_∞ = 400 mg C m^{-3} (Carver and Mallet, 1990).

When the organic seston dynamics model reached steady state, the outcomes of the model were extracted and summarized using a Seston Reduction Index (SRI) that compares, at each node n of the model domain (SRI_n) the organic seston concentration over the last tidal cycle (S_n), with the average concentration in a scenario without aquaculture (S_0) as follows:

$$SRI_n = 100 \times \frac{S_0 - S_n}{S_0} \tag{2}$$

Accordingly, positive values of SRI indicate a reduction in organic seston availability caused by oyster filtration.

2.4. Scenarios

A series of scenarios were designed to explore current aquaculture development as well as potential future scenarios of expansion, which in turn also inform the ecological carrying capacity of each system for oyster aquaculture. Both oyster stock and feeding activity were parameterized using existing management practices and existing data on oyster feeding activity to simulate the worst-case scenario in terms of overall feeding pressure. It was assumed that all leases were occupied with adult oysters of 57 mm at a density of 25 ind m^{-2} to simulate the biomass that a farm could hold using current aquaculture practices. Furthermore, some scenarios with higher density, 37.5 ind m^{-2}, were simulated to characterize the maximum feeding pressure that could be

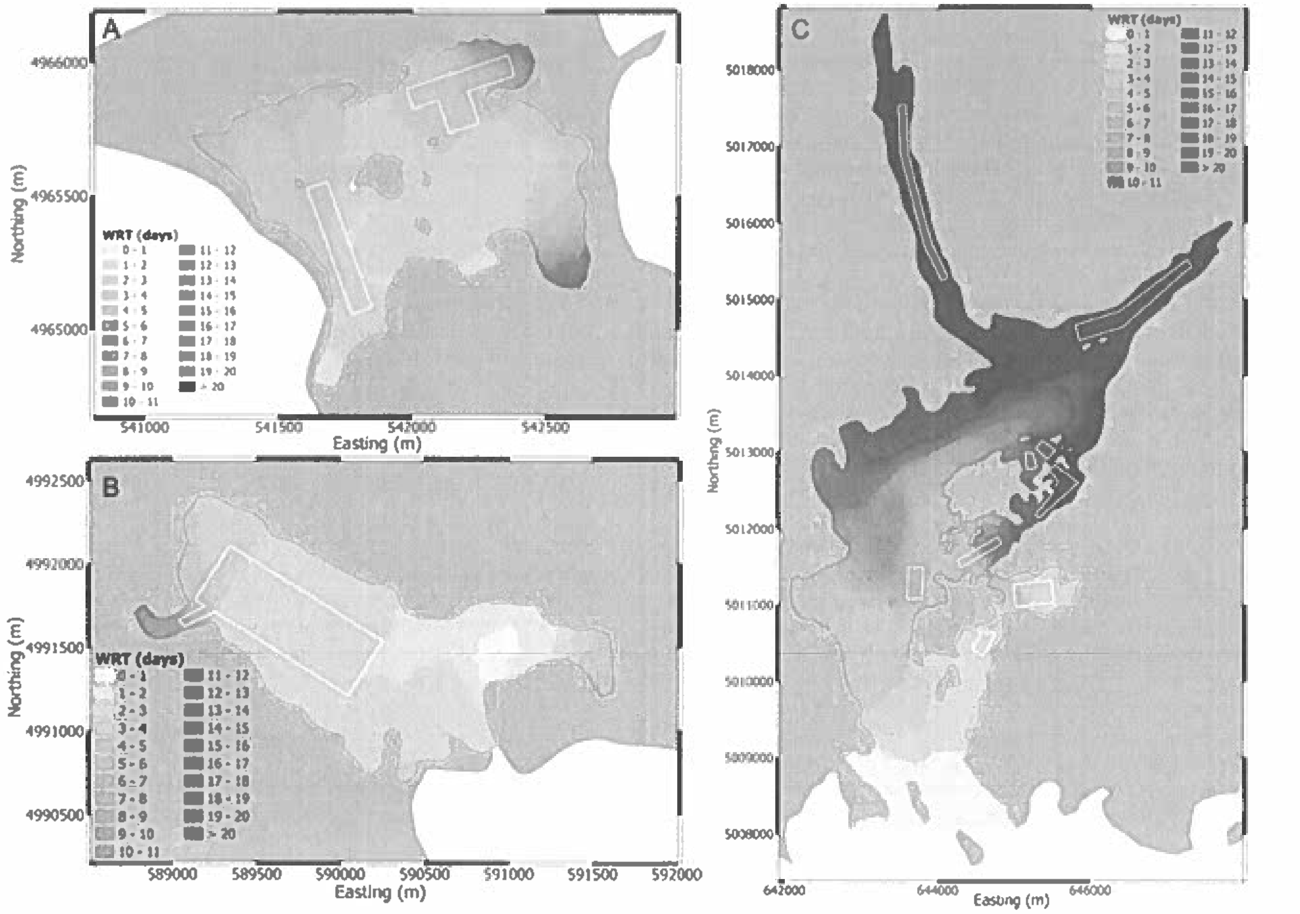

Fig. 2. Water Renewal Time (WRT, days) for the three study sites: Sober Island Pond (A), Wine Harbour (B), and Whitehead (C). Current oyster leases in white polygons.

reached with current leased area, using technical guidelines for maximum density in oyster cage farms. Regarding feeding activity, the assumed constant clearance rate of 5 L h^{-1} aims to simulate the maximum feeding pressure that an oyster of 57 mm can exert on the ecosystem. The combination of maximum biomass and clearance rate represents the worst-case scenario for the estimation of oyster feeding pressure, which embraces the precautionary principle that is needed to account for uncertainty, and provide a precautionary estimation of the ecological carrying capacity.

A total of six different scenarios were simulated per embayment that varied in the percentage of area that was occupied with oyster leases (five scenarios) and stocking density (1 scenario). These scenarios included one that represented a system without aquaculture, which was used to represent the background conditions without aquaculture, one that represented the current leases in the embayment, three additional scenarios with a leased area of 10, 20, and 30% of the bay, and an additional scenario with the current leases but stocked at the maximum oyster density (37.5 ind m^{-2}). The distribution of the leased area in the three hypothetical scenarios followed the most realistic approach for a potential expansion of current leases, as well as potential reduction in the case of Wine Harbour. Furthermore, four additional scenarios were explored in each embayment to evaluate the sensitivity of the model to changes in the parameters α, primary production, and β, oyster clearance rate. These four scenarios tested the impact of an increase and decrease of these two parameters by 10% on the average SRI at the bay scale using the current aquaculture scenario as a reference.

3. Results

3.1. Hydrodynamic model

Model spinup period was 5 days and only the last 25 days were analyzed for model verification purposes. The comparison between observed and simulated tidal elevations for the main constituents resulted in a normalized root mean squared error of 6.6% (Table A1). At Sober Island, the model predicted a daily maximum tidal range of around 0.7 m (Figure A4). Due to the malfunctioning of the pressure sensor on the single point current meter deployed close to the mouth of the lagoon, a full quantitative validation of tidal elevation could not be performed; however, this maximum tidal range matched the qualitative observations from the farmer in this location (Trevor Munroe, personal communication). Although the qualitative observation from the farmer cannot replace the quantitative validation from the current meter, his experience is valuable to constraint uncertainty. The magnitude of simulated velocity at the mouth was in good agreement with observations, although directionality did not match perfectly (Figure A5). This was not considered problematic given that observations included the effect of the wind, which was not included as forcing in the model, and, more importantly, velocity at this location is highly affected by the sedimentary dynamics of the barrier of the lagoon, which changes in shape and depth over short periods of time (Trevor Munroe, personal communication). Therefore, the observed velocities in this shallow and dynamic area are highly affected by local climatology, detailed bathymetry, and the precise location of the current meter deployment, which cannot be easily prescribed in the model. Accordingly, the good agreement in the magnitude of the observed and simulated velocities rather than the directionality was deemed to be sufficient to validate the model.

Regarding Wine Harbour, the model was successfully able to simulate the water elevation within the harbour (Figure A6). In terms of water velocity, the model successfully predicted magnitude and direction right outside and in the innermost location of the harbour, as well as magnitude close to the entrance, but direction was not well predicted at this location (Figure A7). This mismatch could be caused by the same reasons mentioned for Sober Island given that the location close to the entrance is subjected to strong currents, influence by climatology, fine-scale bathymetry, and a precise deployment location. Furthermore, the North of the compass of the current meter flipped 180° at the end of the deployment. These data were not used for validation and it was ascribed to potential physical damage, but raises uncertainties regarding the compass. Therefore, more weight was put on the magnitude than on the directionality of this deployment. Finally, the model was able to successfully simulate both the tidal elevation (Figure A8) and magnitude and direction of water velocity (Figure A9) in the three current profiler deployments for Whitehead.

The calculation of water renewal time for the three embayments revealed differences among them, with Wine Harbour and Whitehead showing the shortest and longest time, respectively (Fig. 2). Sober Island and Wine Harbour presented similar patterns with most of the water body being renewed in under three days, and only small sections in the inner parts of the system having renewal times longer than 12 and 10 days for Sober Island (Fig. 2A) and Wine Harbour (Fig. 2B), respectively. In contrast, the renewal time at Whitehead is longer than 20 days for the innermost parts of the system (Fig. 2C). Whitehead is the only system with large oyster leases in areas with a renewal time longer than 3–4 days. Although no leases are present at the entrance of the system, the estimated water renewal time of under 1 day reveals a high exchange of water with the open ocean.

3.2. Current aquaculture scenarios

The Seston Reduction Index (SRI) calculations for Sober Island under the current aquaculture scenario revealed a maximum SRI of 50% at the head of the lagoon where the main oyster lease is located (Fig. 3A). The SRI was rapidly diluted following a spatial gradient towards the mouth of the lagoon where the second lease is located. Due to the proximity of the mouth, the SRI dropped to 18% in this lease. Under this scenario, the percentage of the bay with an SRI over 35%, which has been used as a proxy for ecological carrying capacity (see discussion), was 3.4% (Table 2). Considering the bay as a whole, the mean SRI was 15.6% (Table 2).

Regarding Wine Harbour under the current aquaculture scenario, the maximum SRI reached 42% in a small portion of the leased area on the western arm of the system (Fig. 3B). Due to the dimensions of the lease and its emplacement following the main longitudinal axis of the harbour, a strong SRI gradient was predicted, with a 10% SRI at the edge of the lease close to the mouth of the harbour. The predicted percentage of the bay with an SRI above 35% was 2.2%, and the mean bay-scale SRI averaged 20.1% (Table 2). The low percentage of the harbour with an SRI over 35% suggests a strong mixing within the system compared to Sober Island.

The size and complexity of Whitehead resulted in a very heterogenous system in terms of SRI (Fig. 3C). The maximum SRI of the three systems under current aquaculture scenarios was predicted for a small inlet on the Eastern side of Whitehead, reaching an SRI of 58%. This area of the embayment has a limited exchange of water with the open ocean. Furthermore, both connections with the main body of Whitehead have oyster leases, further increasing SRI. Accordingly, this area could be dominated by oyster filtration. The narrow arm on the Northern part of Whitehead was the second most affected area, with an SRI of 50%. The percentage of the bay with an SRI above 35% reached 12.1%, the highest of the three simulated systems (Table 2). However, due to the size and depth of Whitehead, the SRI at the bay-scale was the lowest of the three systems, averaging 9.2% (Table 2).

3.3. Development scenarios

A series of scenarios for the hypothetical expansion of the aquaculture operations were simulated (Table 2). In the case of Wine Harbour, and for the sake of comparison, some scenarios simulated a reduction in leased area. These simulations where the percentage of leased area is common for the three systems allows a better comparison of their performance under similar aquaculture pressure. It is important to note that the outcomes of the model could be affected by the position of the leases. The locations chosen for this hypothetical expansion followed the expected pattern based on current operations.

The location of new leases played a differential role in SRI dynamics depending on the site. For example, in the case of Sober Island, an increase of the leased area up to 20% of the lagoon would not affect the maximum predicted SRI compared to the current aquaculture scenario (Fig. 4A). Similarly, the new lease would only increase the percentage of area with an SRI above 35% up to 4.4%, and the bay-scale SRI would average 24.0% (Table 2). In Wine Harbour, the 20% leased area scenario implies a minimal reduction of the current operations, resulting in a very similar SRI distribution (Fig. 4B). Under this scenario, the whole system would be under the 35% SRI threshold, and the bay-scale SRI would average 18.9%, making Wine Harbour the least affected system in terms of SRI by the 20% development scenario (Table 2). Contrarily, Whitehead would be the most affected system by oyster filtration under the 20% development scenario. The development of new leases on the Western shore of Whitehead would cause localized SRI of 58% (Fig. 4C). The expansion would bring the percentage of the bay with an SRI over 35% up to 29.5%, and the bay-scale averaged SRI up to 28.7% (Table 2).

When summarizing all current and development scenarios (Table 2) in terms of averaged bay-scale SRI, the differences among systems emerge (Fig. 5A). In general, for the same level of development, Wine Harbour seems to be the system that is able to keep the bay-scale SRI at the lowest level; which is probably a consequence of having the main farming area close to the mouth of harbour, which ensures a quick renewal of water. Sober Island and Whitehead were similar; however, it is important to highlight that the pattern of bay-scale SRI with increasing leased area changed for both systems. While the SRI was lower at Whitehead than at Sober Island for the 10% development scenario, this was the opposite for the 20 and 30% scenarios, suggesting a larger effect of oyster filtration on seston dynamics at Whitehead compared to Sober Island under future and similar farming expansion.

3.4. Oyster stocking density

Given the uncertainty on aquaculture practices in terms of stocking density, all previous simulations were carried out

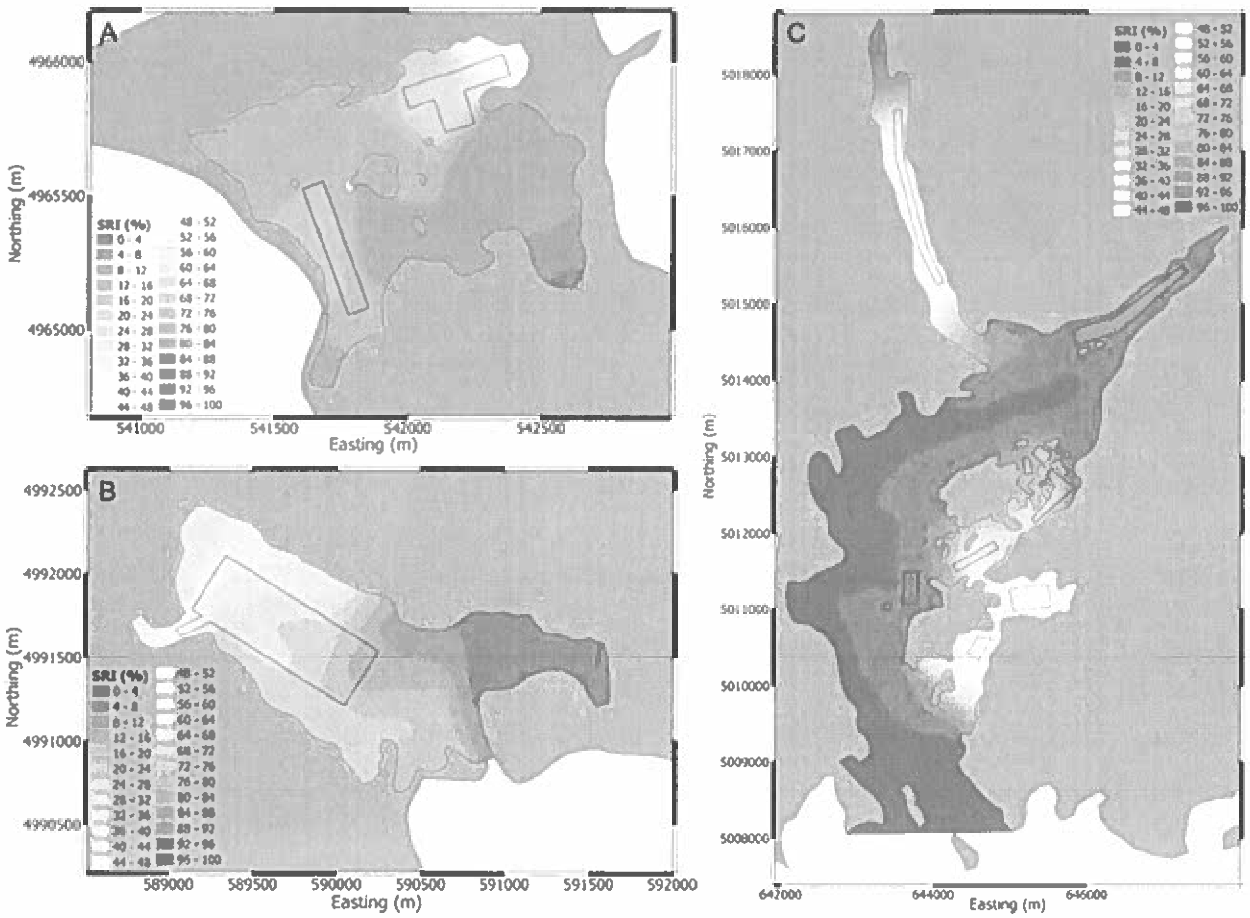

Fig. 3. Daily averaged Seston Reduction Index (SRI, %) using the standard aquaculture scenario in Sober Island Pond (A), Wine Harbour (B), and Whitehead (C). Current oyster leases in black polygons.

Table 2
Simulated scenarios in terms of percentage of leased area, total number of oysters using 25 oysters m^{-2}, and modelled Seston Reduction Index (SRI, %) summarized as a bay-scale average (mean, minimum, and maximum), and as the percentage of the bay with a SRI above 35%.

Embayment	Leased area (%)	Oysters (million)	Averaged Bay-scale SRI			Area with SRI > 35% (%)
			Mean (%)	Min (%)	Max (%)	
Sober Island	9.6	2.2	15.6	14.3	16.9	3.4
	10	2.2	15.6	14.3	16.9	3.4
	20	4.5	24.0	22.6	25.7	4.4
	30	6.7	34.6	32.0	37.7	46.6
Wine Harbour	21.7	10.6	20.1	19.5	21.0	2.2
	10	4.9	11.3	10.8	11.9	0.0
	20	9.7	18.9	18.3	19.7	0.0
	30	14.6	25.1	24.5	26.1	16.9
Whitehead	7.3	25.8	9.2	8.6	9.7	12.1
	10	35.3	11.5	11.0	12.2	12.8
	20	70.6	28.7	28.0	29.2	29.5
	30	105.9	36.6	35.8	37.4	47.9

assuming a constant density of 25 oysters m^{-2} for 57 mm oysters (Table 2). A worst-case scenario was further simulated increasing the density up to 37.5 oysters m^{-2} for the current farm coverage (Table 3). The effects of this increase in stocking density on seston dynamics was heterogeneous across the three systems. While the bay-scale averaged SRI increased more or less proportionally for the three systems, the percentage of the area with an SRI above the 35% threshold differed among embayments (Fig. 5B). The change caused by oyster density in the area with an SRI above 35% was steeper in Wine Harbour than in Sober Island and Whitehead, while the latter two followed a similar pattern. The change in Wine Harbour from 2.2% up to 24.6% with the increase in stocking density from 25 up to 37.5 oysters m^{-2} can be seen as a consequence of the already higher level of development in this system (i.e. coverage-wise). Furthermore, the change also highlights the relevance of aquaculture practices on seston dynamics.

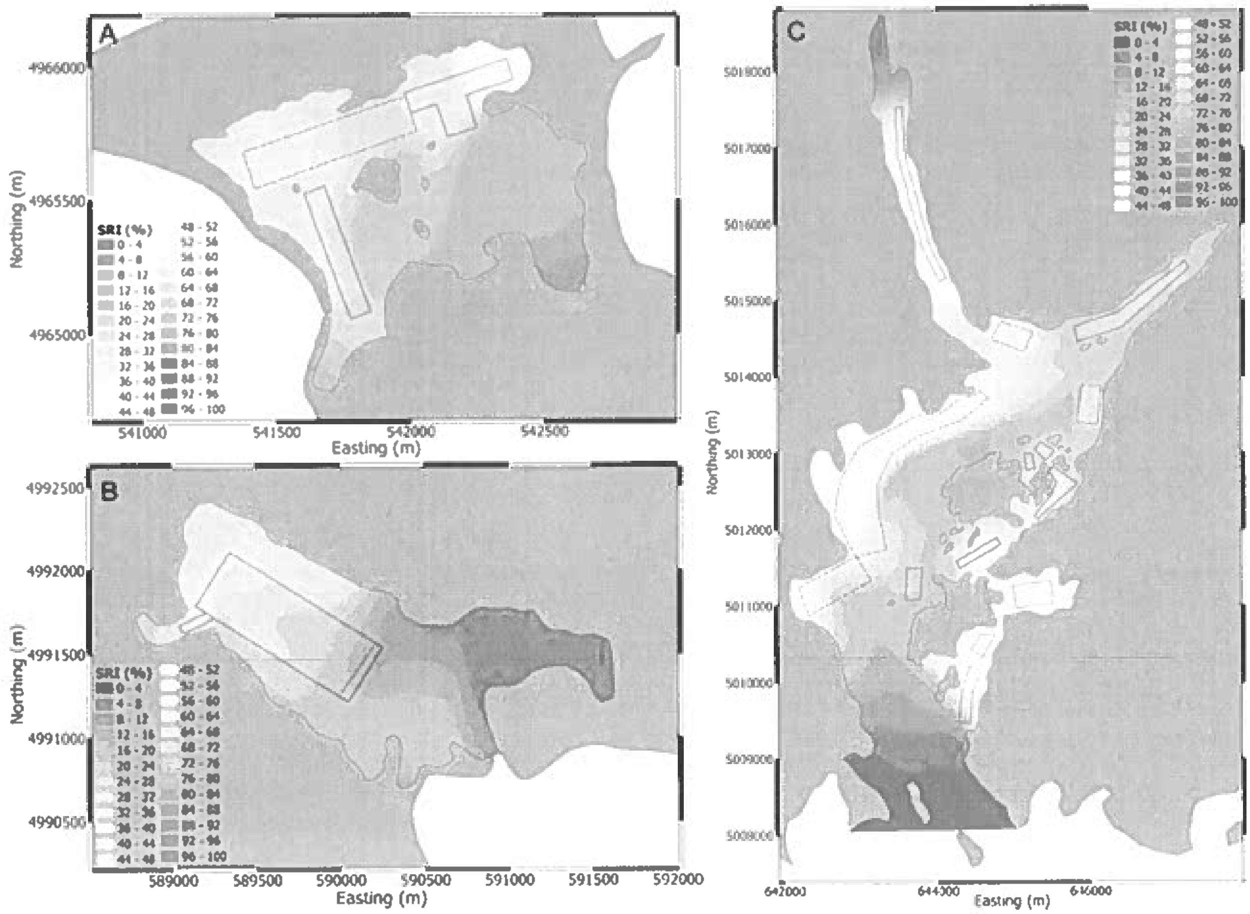

Fig. 4. Daily averaged Seston Reduction Index (SRI, %) using the development aquaculture scenario 20% in Sober Island Pond (A), Wine Harbour (B), and Whitehead (C). Current and hypothetical oyster leases are identified with black and red polygons, respectively. Note that the current lease in Wine Harbour is larger than 20%. Consequently, for the sake of comparison, the development lease implies a reduction in the current lease. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

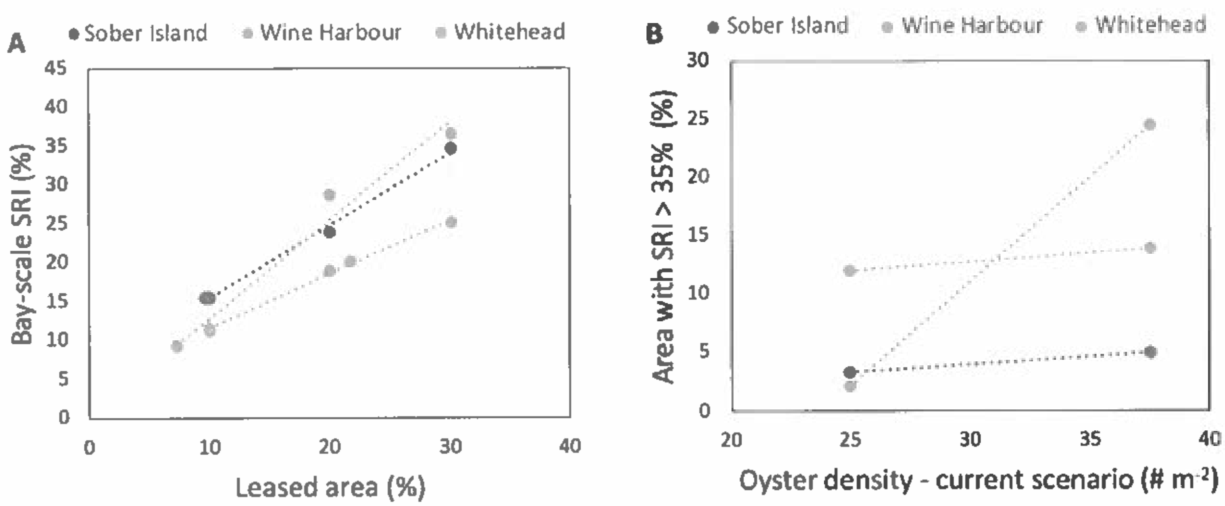

Fig. 5. Relationship between leased area (%) and bay-scale averaged Seston Reduction Index (SRI, %) for current and development aquaculture scenarios for the three embayments (A). Percentage of the bay with an SRI above 35% for the current aquaculture scenario in terms of leased area under different oyster stocking density for the three embayments (B). Dotted lines are for visualization purposes only.

Table 3
Simulated scenarios in terms of percentage of leased area, total number of oysters using 37.5 oysters m^{-2}, and modelled Seston Reduction Index (SRI, %) summarized as a bay-scale average (mean, minimum, and maximum), and as the percentage of the bay with a SRI above 35%.

Embayment	Leased area (%)	Oysters (million)	Averaged Bay-scale SRI			Area with SRI > 35% (%)
			Mean (%)	Min (%)	Max (%)	
Sober Island	9.6	3.2	20.3	18.7	21.9	5.0
Wine Harbour	21.7	15.9	26.2	25.4	27.4	24.6
Whitehead	7.4	38.6	11.5	10.8	12.3	14.0

Table 4
Percentage of change in Seston Reduction Index (SRI) when modifying the primary productivity and feeding rate by +10 and −10% under the current aquaculture scenario in terms of leased area and oyster density of 25 oysters m^{-2}.

Embayment	Primary productivity, α, +10%	Primary productivity, α, −10%	Feeding rate, β, +10%	Feeding rate, β, −10%
Sober Island	−2.0	+1.9	+6.7	−7.0
Wine Harbour	−1.2	+1.1	+6.8	−7.2
Whitehead	−1.4	+1.3	+5.4	−5.7
Average	−1.5	+1.4	+6.3	−6.6
Absolute average	1.5		6.5	

3.5. Sensitivity analysis

The sensitivity tests carried out to evaluate the impact of the most relevant parameters revealed that the influence was very similar across the three embayments (Table 4). As expected, the increase in primary productivity (+10%) and reduction in feeding rate (−10%) caused an average reduction in SRI of −1.5 and −6.6%, respectively. Similarly, the reduction in primary productivity (−10%) and increase in feeding rate (+10%) caused an average increase in SRI of +1.4 and + 6.3%, respectively. In absolute terms, the 10% change in primary productivity and feeding rate terms had an impact on SRI of 1.5 and 6.5%, respectively.

4. Discussion

The purpose of this study was to explore the effect of hydrodynamics on Ecological Carrying Capacity (ECC) estimations on oyster aquaculture sites using the simplest modelling approach that can precisely account for an accurate representation of a given embayment. The coupling of a three-dimensional FVCOM hydrodynamic model to a tracer model that represented the dynamics of organic seston using only two main parameters, namely primary productivity and oyster feeding rate, was determined as the simplest approach based on the scientific literature (Dowd, 2003; Guyondet et al., 2013; Filgueira et al., 2015). The outcomes of this modelling framework applied to three different embayments in Nova Scotia (Canada) revealed the relevance of water circulation on the ECC of the systems, suggesting that local hydrodynamics should be considered in leasing assessments.

The optimization of trade-offs in ecosystem modelling requires focusing on the key processes that drive most of the variance of the system. Focusing only on the primary productivity of the embayment and feeding rates limits the number of ecosystem-level interactions, but increases the operationalization of the method to data-poor environments where ecosystem level unknowns can jeopardize the parameterization of a complex ecosystem model. On the other hand, seston renewal is only dependent on local production and exchange with the open ocean, which limits other sources of food for the bivalves. For example, resuspension of organic matter or terrestrial inputs could be used by bivalves (Bacher and Gagnery, 2006), but they are neglected in this simple approach. Neglecting food sources could introduce uncertainty in the calculation of production carrying capacity due to the potential effect on bivalve growth. However, it should not constitute a major handicap for the estimation of ECC given that neglecting sources effectively acts as increasing sinks for organic seston, which represents the worst-case scenario for ECC estimations. Accordingly, the outcomes of the model should be understood as a theoretical simulation of relative changes of organic seston within the embayment with the ultimate aim of identifying the most sensitive areas affected by current bivalve aquaculture (e.g. Fig. 3) or hypothetical aquaculture scenarios (e.g. Fig. 4).

The fact that the assumptions of the model bias the outcomes towards representing the worst-case scenario could be considered an advantage when the goal is to generate management advice in the context of the precautionary principle. In the field of bivalve ECC, most of the ecosystem interactions to determine sustainability have been explored in the context of phytoplankton or seston utilization (see McKindsey, 2013). However, while most of these studies have discussed the implications of bivalve aquaculture on phytoplankton or seston dynamics, few of them have defined a quantitative threshold for ECC. Grant and Filgueira (2011) suggest that this threshold could be defined based on the bounds of natural variation of food availability. This threshold is grounded in the concept of ecological resilience by assuming that the natural variability of a component of the ecosystem sets the tipping points beyond which the resilience of the ecosystem is compromised. Accordingly, the natural variability of phytoplankton or seston concentration could be considered a precautionary threshold that preserves ecological sustainability (Grant and Filgueira, 2011). This threshold has been previously defined based on chlorophyll concentration, a proxy for phytoplankton concentration, by analyzing *in situ* and/or remotely-retrieved data using satellites and is established to be ~35% (average value from Filgueira and Grant (2009) Filgueira et al. (2013a, 2015), and Bricker et al. (2016)). Accordingly, an average SRI at the bay scale above 35% would indicate that the aquaculture activity could compromise the resilience of the ecosystem by impacting the dynamics of organic seston.

Using this threshold as a benchmark, the aquaculture levels carried out in the three embayments considered in this study are within the ecological carrying capacity, attending to the impact on organic seston. The model predicted that in some areas of the systems the filtration activity would cause a reduction of organic seston above this threshold, reaching values over 40% in all systems (Fig. 3). These values match previous studies carried out in other farming areas. For example, localized reductions in phytoplankton up to 45% and 72% were reported in mussel rafts in Galician Rías, Petersen et al. (2008) and Cranford et al. (2014), respectively. Similarly, reductions of 30% and 50% were measured in long-line mussel farms in Norwegian and Danish fjords (Strohmeier et al., 2005; Nielsen et al., 2016). While this localized reduction is relevant at the local scale due to potential negative effects on oyster growth, it could be argued that the reduction in a small area could be less relevant at the ecosystem scale. At the ecosystem scale, the three systems were below the 35% threshold (Table 2), which suggests that the feeding pressure of the aquaculture farms is not depleting the overall amount of organic seston in the embayments beyond a precautionary threshold. Looking at the embayment-scale rather than localized effects is recommended when aiming to manage in the context of an ecosystem approach to aquaculture (Soto et al., 2008). This is even more relevant when the criterion for ECC is affected by water circulation, given that the localized effects could spread beyond the domain of the farm.

A series of scenarios was carried out to explore the potential for expansion, and simultaneously compare the performance of the systems under the same level of aquaculture. The simulations suggest that moderate expansion of aquaculture on Sober Island and Whitehead is feasible and would not exceed the ECC of the system as the SRI would be under 35% (Table 2). However, the specific location of the leases during the expansion within each bay could greatly affect the bay scale SRI; accordingly, the scenarios generated in this study should be considered hypothetical situations to explore the performance of the systems rather than a plan for expansion. The simulations highlighted that the three embayments are different in terms of resilience capacity to hold oyster aquaculture, with Wine Harbour being the system that provided the lowest level of seston reduction under the same percentage of leased area (Table 2). Not surprisingly, Wine Harbour was the system with the shortest water renewal time (Fig. 2). It is well known that the dynamics of phytoplankton, a key component of organic seston and the main food source for bivalves (Bourlès et al., 2009; Rosland et al., 2011), are affected by water circulation, in turn affecting local production and advective exchange with the open ocean (Lucas et al., 1999; Paerl et al., 2006). Furthermore, it has been demonstrated that advection plays a critical role in ECC at bivalve aquaculture sites. Filgueira et al. (2013b) predicted an increase in the carrying capacity of Tracadie Bay (Prince Edward Island, Canada) for mussel aquaculture after a storm opened an additional breach in the barrier that protects the bay, shortening the water renewal time. The dynamics of bay barriers can be critical for Wine Harbour and Sober Island. As it was stated above, the highest uncertainty in the hydrodynamic model predictions were observed in the directionally of velocity at the entrance of both systems (Figure A5 and A7) due to the impact of coastal geomorphology and bathymetry on water circulation, and consequently organic seston advection. The uncertainty in directionality would be very relevant in farming areas because it would directly affect the propagation and location of the area affected by seston reduction, which could potentially result in an underestimation of SRI. The fact that the highest uncertainty in the hydrodynamic model occurs in the entrances of the system minimizes the impact on the predictions of the coupled model given that these areas do not suffer from high SRI. Nevertheless, further assessment of the condition of the bay barriers of these systems is important for bay-scale sustainability as they could impact the net exchange of water with the open ocean.

The bay-scale reduction in organic seston at Sober Island and Whitehead changed with the level of aquaculture development, with Whitehead being more resilient (lower SRI) than Sober Island at low aquaculture development but reversing this pattern at higher development (Fig. 5a). This outcome further exemplifies the relevance of coastal complexity and water circulation on the functioning of coastal systems. At low development, the size and depth of Whitehead could dominate the bay-scale assessment of ECC. However, at higher development, the shorter water residence time of Sober Island (Fig. 2) minimizes the reduction of seston by replenishing the seston faster than for Whitehead, resulting in a lower SRI (Fig. 5a). Another important aspect to consider is the heterogeneity within each system. The spatial complexity of Whitehead generates areas with different capacity to hold bivalves that are very close in terms of seaway distance, but very different in terms of water circulation, emphasizing the value of the spatially-explicit model for ECC estimations. This spatial heterogeneity not only affects the advection of seston, but it could also affect the local primary productivity, which is known to be influenced by horizontal transport (Lucas et al., 1999). Given the simplification adopted in this study, in which primary productivity is similar everywhere, the potential effects of local hotspots of primary production are not considered. Although the sensitivity test suggests that the uncertainty in primary productivity is smaller than the uncertainty in oyster feeding activity (Table 4), further refinement of the model could include a more precise spatial description of primary productivity.

5. Conclusions

The outcomes of this study are aligned with the broader literature highlighting the crucial role of water circulation for the functioning and resilience of coastal systems (Wolanski et al., 2004; Elliot and Whitfield, 2011), and particularly on bivalve aquaculture sites (e.g. Dame and Prins, 1998). The modelling framework used in this study allows for the exploration of ecological carrying capacity in bivalve aquaculture sites using the dynamics of organic seston as a benchmark. The application to Sober Island, Wine Harbour, and Whitehead suggests that the current aquaculture operations are within the ecological carrying capacity of the ecosystem for bivalve aquaculture. Given the differences among these three embayments in terms of water circulation, the model allowed to infer the relevance of spatial planning in aquaculture sites, suggesting that including a circulation model is critical for reliable estimations of carrying capacity. Although the model complexity could be increased to explore other ecosystem level effects, its simplicity could be considered a virtue for further operationalization, and consequently for informing aquaculture managers. The model has the capability to explore different aquaculture scenarios and inform the leasing process, which could be easily implemented in the context of marine spatial planning. The inherent limitations of a modelling exercise result in uncertainties during the decision-making process; however, this uncertainty could be overcome during the implementation stage by applying the precautionary principle to management. For example, a sensible recommendation for expansion would be a step-by-step expansion framed in the context of a robust monitoring program that ensures a sustainable development of the farming activity. In fact, the application of the precautionary principle should be cornerstone in all marine management processes that involve human intervention.

CRediT authorship contribution statement

Ramón Filgueira: Conceptualization, Funding acquisition, Investigation, Methodology, Writing - original draft, Writing - review & editing. **Thomas Guyondet:** Conceptualization, Investigation, Methodology, Writing - original draft, Writing - review & editing. **Pramod Thupaki:** Investigation, Methodology, Writing - original draft, Writing - review & editing. **Takashi Sakamaki:**

Investigation, Writing - review & editing. **Jon Grant:** Conceptualization, Funding acquisition, Investigation, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2020.125739.

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2022	NSARB-2022-001 NSARB-2022-002 NSARB-2022-003

This is Exhibit "D" referred to in the Affidavit of Nathaniel Feindel ~~sworn~~ affirmed before me this 11th day of May, 2023.

Alison W. Campbell
A Barrister of the Supreme Court of Nova Scotia

ALISON CAMPBELL
A Commissioner of the Supreme Court of Nova Scotia

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Town Point Oysters lease application: consideration of bird interactions

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Appendices

Executive Summary

The Canadian Wildlife Service (CWS) has recommended 300 m buffers around piping plover (*Charadris melodus)* habitat and historical nesting areas of two gull species, the herring gull (*Larus argentatus*) and great black-backed gull (*Larus marinus*), relative to a proposed oyster lease in Antigonish Harbour, Nova Scotia. Piping plovers are known to nest on Dunns Beach, within 300 m of the northern boundary of one of the proposed lease areas (#1444). The two gull species have historically nested on Gooseberry Island within 300 m of the southern boundary of the proposed lease area, but do not appear to have nested there the previous few years.

While there are knowledge gaps on how proximate oyster aquaculture practises could affect piping plovers or the two gull species, there is some information on effects of other anthropogenic activities on these species, which could guide interpretation of possible oyster farm interactions. All three bird species are protected under the Nova Scotia Migratory Bird Convention Act, Wildlife Act, or the Forests Act, with piping plovers additionally protected under the federal Species at Risk Act. However, there are no legal buffers or set back distances from their defined critical habitat, for which to exclude human activities.

There are three possible options for the potential implementation of these buffers. The first option would be to implement both buffers out of an abundance of caution. This option would make culture on proposed lease #1444 untenable as only 16% of the proposed lease could be used for culture. The second option would be to implement only the buffer around the piping plover habitat. This would enable culture on a smaller portion of the lease area (7.72 hectares) and provide opportunity to study possible interactions with the piping plovers to inform future buffer status. Finally, the third option would be to negate both buffers, ensure aquaculture best practices and mitigation steps are followed, while studying potential interactions with the piping plovers to inform any future management decisions including buffers.

Introduction

Town Point Consulting Inc has applied for three marine shellfish leases (#1442, #1443, and #1444) to culture American oysters (*Crassostrea virginica*) in Antigonish Harbour, Nova Scotia. The proposed sites are posted on the Nova Scotia Department of Fisheries and Aquaculture (NSDFA) Site Mapping Tool (Figure 1) These site proposals are currently under review by the Nova Scotia Department of Fisheries and Aquaculture and their network partners as a prior step to filing the application to the Nova Scotia Aquaculture Review Board in accordance with Section 48 of the *Fisheries and Coastal Resources Act* and the *Aquaculture Licence and Lease Regulations* (Province of Nova Scotia, 1996; Province of Nova Scotia, 2015). Network partners include provincial and federal government entities whose mandates may have overlap with aquaculture activities.

The Canadian Wildlife Service (CWS) of Environment and Climate Change Canada (ECCC), one network partner, noted many bird species in the vicinity of the proposed sites. They have recommended a 300 m buffer around specific nesting habitat in the area of the proposed leases, including piping plover (*Charadrius melodus*) habitat on Dunns Beach and historical gull nesting areas for herring gulls (*Larus argentatus*) and great black-backed gulls (*Larus marinus*) on Gooseberry Island, both of which overlaps proposed shellfish lease #1444.

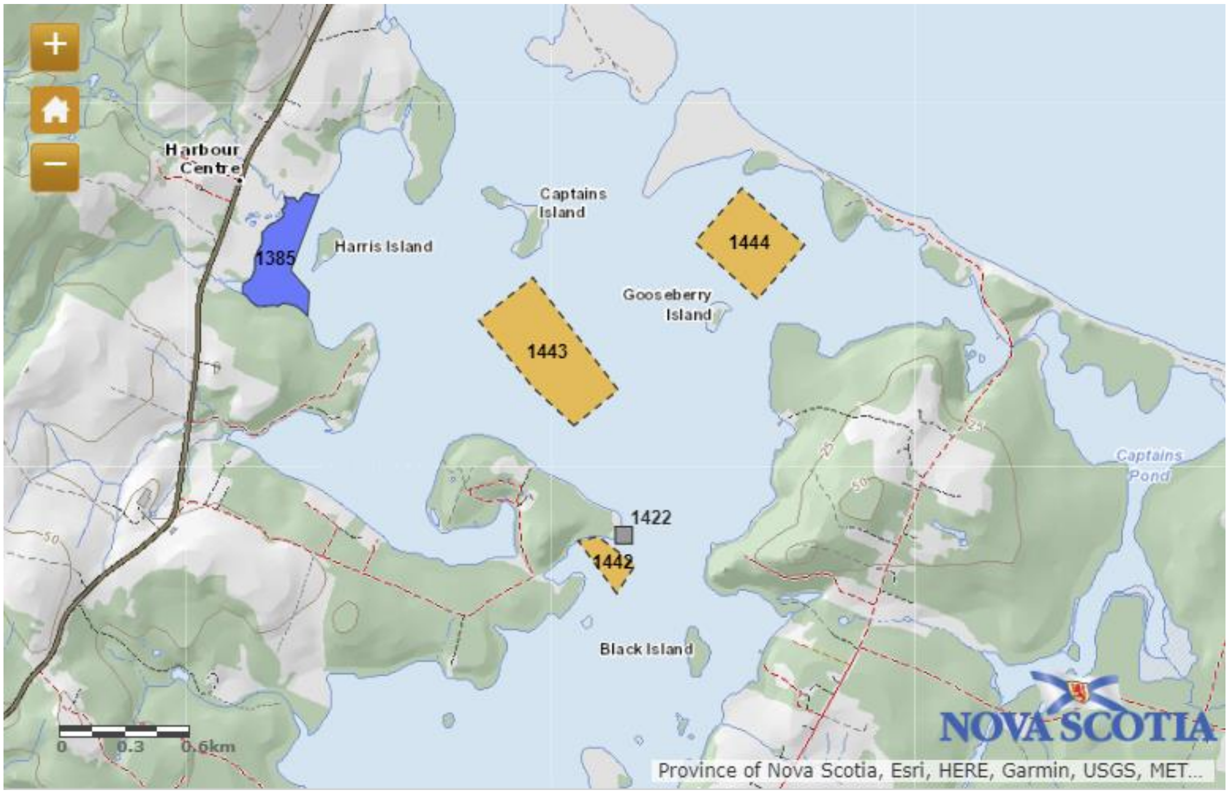

Figure 1. American oyster marine leases and land-based facility in Antigonish Harbour, Nova Scotia. Marine leases are in orange (proposed) and blue (issued) while the land-based facility is in gray.

In response to the CWS recommended buffers, the NSDFA requested the Centre for Marine Applied Research (CMAR) to evaluate the state of knowledge regarding application of buffers to critical habitat or geographic locations of known rare bird species. This includes population status, local distribution, and known anthropogenic factors that may disturb piping plovers and gulls. Potential mitigative efforts to minimize disturbance to birds are also reviewed and implications of buffers on the proposed aquaculture lease application are discussed.

Known interactions between aquaculture and bird species

Bird species and shellfish aquaculture interactions

Bivalve aquaculture, including American oyster (*Crassostrea virginica*) and blue mussel (*Mytilus edulis*), tends to have minimal environmental impacts as growth does not require the addition of feed or deleterious substances such as antibiotics or pesticides (Hilborn et al., 2018). An altering of bird behaviour (e.g., migration, nesting, feeding, and roosting) is a concern when siting an aquaculture lease near a known area utilized by a species of concern. There is significant variation in the literature on aquaculture interactions with birds and this is likely due to differences between bird species and operational intensity.

Suspended bivalve aquaculture may cause displacement of bird populations due to alterations to habitat and food sources (Forrest et al., 2009), auditory and visual disturbances caused by the operation (Burger and Niles, 2017), and habitat destruction from lost gear (Mengak et al., 2019) that may only affect bird distribution during certain seasons (Roycroft et al., 2004) or short periods. These disturbances have been argued to only affect birds on a small local scale, with minimal impact on bird population sizes (Roycroft et al., 2004). Conversely, all interactions are not necessarily negative. Evidence suggests suspended bivalve aquaculture may benefit avian, marine, and terrestrial bird populations by providing safe refuge (Anderson and Shlepr, 2016), perching platforms (Anderson and Shlepr, 2016), and epifaunal food sources growing on site infrastructure (Roycroft et al., 2004).

Despite the extensive literature on human disturbance and their impacts on colonial waterbirds (including gulls), it is difficult to quantify a cause-and-effect relationship as factors do not occur in isolation and cannot be easily, if at all, controlled in the wild (Nisbet, 2000). This suggests a concerted effort is required to design and implement disturbance studies. Nevertheless, while aquaculture leases have the potential to impact local avian species at risk, there are many examples of existing aquacultures leases throughout Nova Scotia being close to gull breeding colonies (Appendix A) with no known documented negative interactions.

Tern and finfish aquaculture interaction in Nova Scotia

The Brothers Islands west of Middle West Pubnico, Nova Scotia, have hosted the largest roseate tern (*Sterna dougalli*) colony in Canada since at least the 1990s. The two islands (North Brother Island and South Brother Island) and the water within a 250 m radius circle around the centre of each island was designated by the Nova Scotia Department. of Natural Resources and Renewables as The Brothers Islands Wildlife Management Area in 2007. These islands and the water within 200 m of the mean high tide line of each island is identified as Federal critical habitat for the roseate tern (EC 2006).

A steelhead trout (*Oncorhynchus mykiss*) aquaculture operation with license number #0769 began production on May 9, 1994, east of North Brother Island (Dietz and Chiasson 2000). Only one pen was installed at first, but by 1999 there were three 70 m pens and a smaller pen (Dietz and Chiasson 2000, Royden d'Eon pers. comm.). The aquaculture pens near North Brother Island were dismantled during summer 1999 (D'Eon 1999). The exact placement of the pens within the lease is unknown, however, it is estimated the nearest pen was likely about 115 m from the mean high tide line on North Brother Island. The farthest corner of the lease polygon from the high tide line of North Brother Island was about 230 m away.

No direct adverse effects were documented on the terns due to aquaculture operations and nesting success was not affected (Dietz and Chiasson 2000). Gulls were also not noted to be attracted to the area when the fish were being fed (Dietz and Chiasson 2000). Biologist Donald Sam of the Nova Scotia Department of Natural Resources and local steward Ted d'Eon visited North Brother Island on July 20, 1995, to assess the direct effects of the nearby aquaculture project (D'Eon 1995). There were no indicators of tern distress as the aquaculture boat passed within a few metres of the island with the motor on idle (D'Eon 1995). In addition to the aquaculture pens in the 1990s, fishing activities (mostly lobster fishing during May) near The Brothers Islands have not had a measurable effect on the Roseate terns (ECCC 2006).

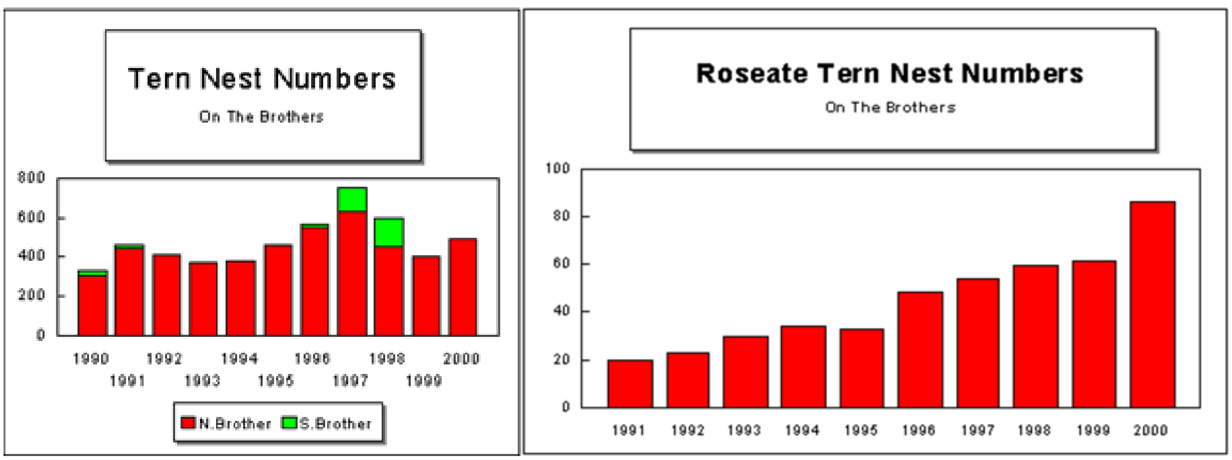

Figure 4. Tern nesting on 'The Brothers' Island. Left panel: Tern nest numbers on The Brothers Islands, Lower West Pubnico, Nova Scotia. Year to year fluctuations in nest numbers are common and can also be seen in the longer-term nest trends. Right panel: Roseate Tern nest numbers on The Brothers Islands, Lower West Pubnico, Nova Scotia. See D'Eon (2000) for source material.

Habituation

Some of the previous examples of apparent bird tolerance to proximate aquaculture activities, may be a function of habituation. Habituation occurs when species exhibit decreasing response to repeated exposure to a disturbance and habituation in avian species are both species and landscape dependent (Environment and Climate Change Canada, 2014). Birds that nest in areas with sparse vegetation or little topographic relief (e.g., piping plover) are less tolerant of visual / auditory disturbances than birds nesting in areas which are more protected (Environment and

Climate Change Canada, 2014). Conversely, herring gulls and other large ground-nesting gulls (e.g., great black-back gulls) have been known to habituate to predictable human activity (Burger, 1981; Martinez-Abrain et al., 2008; Chatwin et al., 2013; Weseloh et al., 2020). This behaviour promotes co-existence with human activities, especially in urban and recreational areas (Moller et al., 2013). While habituation to the presence of an aquaculture site may occur, it should not be assumed or be factored into the establishment of setback areas or the management of species at risk.

Potential Mitigation Measures

Operational best practices for aquaculture

In Nova Scotia, aquaculture sites must implement operational best practices to protect wildlife, including all bird species and their habitat surrounding an aquaculture site. Several mandatory criteria are required by federal or provincial department policy or to comply with third party sustainable and responsible aquaculture certification. These are summarized below and are detailed in Appendix B.

- The Federal *Aquaculture Activities Regulations (AAR)*: outlines permitted procedures regarding the deposit of drugs, pest control products, faeces, and feed, and monitoring for deleterious effects (Fisheries and Oceans Canada, 2015).
- The Nova Scotia Farm Management Plan (FMP) requires the operator to have a wildlife interaction plan approved by the Nova Scotia Department of Fisheries and Aquaculture, NSDFA (Province of Nova Scotia, 2021a).
- Avoid attracting birds:
  - Minimize areas that could provide roosting, feeding, and defecation surfaces (i.e., use of netting, mesh, fencing) and the use of non-lethal scaring devices (Government of Canada, 1994; Government of Canada, 2020); and
  - Deter birds and other predators which could increase predation on species of concern (i.e., eggs, chicks, and adult birds) by storing garbage in buildings or closed containers (Best Aquaculture Practices, 2016; Best Aquaculture Practices, 2017; Best Aquaculture Practices, 2021a; Best Aquaculture Practices, 2021b).
- Avoid entanglement and entrapment:
  - Reduce the risk of entanglement and entrapment to avoid harm or death of migratory birds and bird species at risk by installing anti-perching devices over potential nesting surfaces (Aquaculture Stewardship Council, 2019b; Aquaculture Stewardship Council, 2019a); and
  - Establish and implement a wildlife interaction and predator control plan that complies with government regulations (Olsen, 1991; Best Aquaculture Practices, 2016; Best Aquaculture Practices, 2017; Best Aquaculture Practices, 2021a; Best Aquaculture Practices, 2021b; Province of Nova Scotia, 2021a).
- Avoid chemical contamination:

    - Implement a Hazardous Materials Plan to manage waste and chemicals, including a spill prevention and response plan (Province of Nova Scotia, 2021a).
- Minimize sensory disturbance:
    - Reduce impedance to breeding and nesting in surrounding areas due to excessive noise from farm operations (i.e., sharp or loud noises such as horns or whistles) (Government of Canada, 2018).
- Minimize light pollution:
    - Use low intensity, energy saving lighting; prevent illumination, particularly during dusk and dawn (U.S. Fish and Wildlife Service, 2016), and all lights should be shielded and aimed downwards (Province of Nova Scotia, 2021b).
- Minimize collision:
    - Avoid collision with any vessel (see below) or attract birds to site with light (Province of Nova Scotia, 2021b).

Vessel operation

To minimize disturbance from operating vessels near critical bird habitat, literature recommends the following:

- Travel at steady, slow speeds when close to seabird and waterbird colonies, moving parallel to the shore, rather than approaching the colony directly (Burger, 1998; Government of Canada, 2018);
- Avoid any sharp or loud noises, do not blow horns or whistles, and maintain constant engine noise levels (Government of Canada, 2018);
- Do not pursue seabirds or waterbirds swimming on the water surface and avoid concentrations of these birds on the water;
- Anchor large vessels, at a suitable distance to avoid disturbance;
- Do not disturb birds when approaching colonies in small vessels; and
- All operational activities near breeding colonies, including boating, should be at a distance that prevents birds from flushing their nests or engaging in defense behaviour, such as diving at boats (Environment and Climate Change Canada, 2014).

Buffer zones and setback distances

Disturbance (e.g., human presence, noise from machinery / vehicles, and proximity to marine activities) can result in negative bird reactions such as breeding disruption (Environment and Climate Change Canada, 2014), alteration in distribution (Burger and Niles, 2017), and in extreme cases, leaving or even aborting their nests (Environment and Climate Change Canada, 2014). This can result in exposure of the eggs and nestlings which can increase predation and exposure to adverse environmental conditions, increased physiological stress, premature fledging, and reduced feeding (Environment and Climate Change Canada, 2014).

Setback distances

Setback distances are a common management tool to minimize potential disturbance to birds. These setback distance are often based on alert distance (distance at which the bird displays an alert response such as posturing or alarm calls) and flushing distance (distance at which the bird takes flight, performs distraction displays such as feigning injury, or defends the nest) and is determined on a case-by-case basis (Environment and Climate Change Canada, 2014; Government of Canada, 2021). Expert advice is often used to establish conservative experimental setback distances in the absence of scientific data which is primarily based on alert and flush distances (Government of Canada, 2021).

For piping plover there are a wide range of setback distances used across jurisdictions in Canada for land-based activities:

- 100 to 200 m in Alberta (Alberta Sustainable Resource Development (ASRD), 2011);
- 50 to 300 m in the Prairies and Northern region (Environment Canada - Canadian Wildlife Service, 2009);
- 100 to 600 m in Saskatchewan (Ministry of Environment, 2017); and
- 200 to 600 m in Manitoba (Manitoba Conservation Data Centre (MBCDC), 2014).

The range of individual jurisdiction setback distances incorporates season (breeding vs. non-breeding) and disturbance levels (low to high). Nationally, Environment and Climate Change Canada (2014) preliminary recommendations are 100 – 150 m up to 300 m setback distance for piping plover and 10 – 30 m up to 100 m for other waterfowl. However, setback distances can be increased in response to increased disturbance and species at risk (Environment and Climate Change Canada, 2014).

Recommended setback distances for herring and great black-backed gulls in these documents were not identified.

Buffer zones

A buffer zone is an area within a setback distance to protect nests of migratory bird or bird species of concern; areas utilized for pre-migration congregation, resting, feeding, moulting, breeding, and nesting; and critical habitat for bird species. The size of these zones is determined by larger setback distances which vary according to the following (Rodgers and Schwikert, 2002; Ruddock and Whitfield, 2007; Government of Canada, 2021).

- Degree of tolerance of the species, which may vary between groups of birds;
- Previous exposure of birds to disturbance;
- Level of disturbance; and
- Landscape context (e.g., birds nesting in exposed locations are less tolerant).

Overall, guidelines on establishing buffer zones and setback distances are described by ECCC (Government of Canada, 2021) and assists in reducing risks to birds and bird habitat while still permitting economic and social activities (Ruddock and Whitfield, 2007). Setback distances have historically been designed in the context of land-based activities, not marine activities.

There are only two documents detailing buffer zones in relation to shellfish aquaculture sites that the authors are aware of (Transport Canada, 2007; Transport Canada, 2013). In 2007 and 2013, Transport Canada, Fisheries and Oceans, and the Canadian Environmental Assessment Agency jointly published a report outlining a consistent, streamlined federal environmental assessment process to evaluate oyster aquaculture facilities in New Brunswick (Transport Canada, 2007). In consultation with the Canadian Wildlife Service (CWS), Bay Management Areas (BMAs) were established for Eastern New Brunswick which included buffer zones to protect marine migratory birds. A 100 m buffer from the high water mark and a 300 m buffer from conservation areas known for sensitive bird species (i.e., species at risk, colonial nesters, and concentration of birds during the non-breeding season), and sensitive habitat (Transport Canada, 2013). In addition to the recommended buffer zones, the report also states aquaculture stock and infrastructure must not be moved between October 15th and November 15th to reduce potential interactions with migratory birds during the fall staging and migration period (Transport Canada, 2013).

CWS recommended buffers for select bird species near the proposed lease area

The CWS has recommended 300 m buffers around piping plover habitat and historical nesting areas of two gull species, the herring gull and great black-backed gull, relative to a proposed oyster lease in Antigonish Harbour. This section describes population status, local presence, and known disturbances from anthropogenic stressors for each bird species of concern.

Piping plover

Population status

A query with Atlantic Canada Conservation Data Centre (ACCDC, Appendix C) identified 30 rare bird species within 5 km of the proposed leases, 5 of which are considered endangered, threatened, or species of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Species at Risk Act (SARA), or other Provincial Legal Protection (Appendix D). These species include piping plover, melodus spp., bank swallow (*Riparia riparia*), bobolink (*Dolichonyx oryzivorus*), olive-sided flycatcher (*Contopus cooperi*), and the eastern wood-pewee (*Contopus virens*). Of these 5 (gulls are not listed as 'endangered', 'threatened', or 'species of special concern' within 5 km), the proximity of piping plovers was the only species identified by CWS as requiring consideration for the implication of oyster culture lease #1444.

The piping plover nests only in North America and is divided into two breeding subspecies: the mid-continent *Charadrius melodus circumcinctus* and the Atlantic coast *Charadris melodus*

melodus. In 2021, the coastal population consisted of 54 breeding pairs or a total of 110 adults including non-paired adults (Laura Bartlett – Bird Studies Canada, *pers. comm.*, 2022) (Figure 2). This number of adults falls below the joint provincial/federal recovery goal of 60 pairs (Environment and Climate Change Canada, 2021). The coastal piping plover is globally classified as 'Near-Threatened' by the IUCN Red List (BirdLife International, 2020) and nationally endangered by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Environment and Climate Change Canada, 2021). The ACCDC rare and endangered species report (Appendix C) indicated the presence of piping plover at a nearby beach, Dunns Beach, as close as 0.2 km from located N45.685166, W61.883737 (identified as queried point 7177 by ACCDC), which is within the proposed lease (#1444).

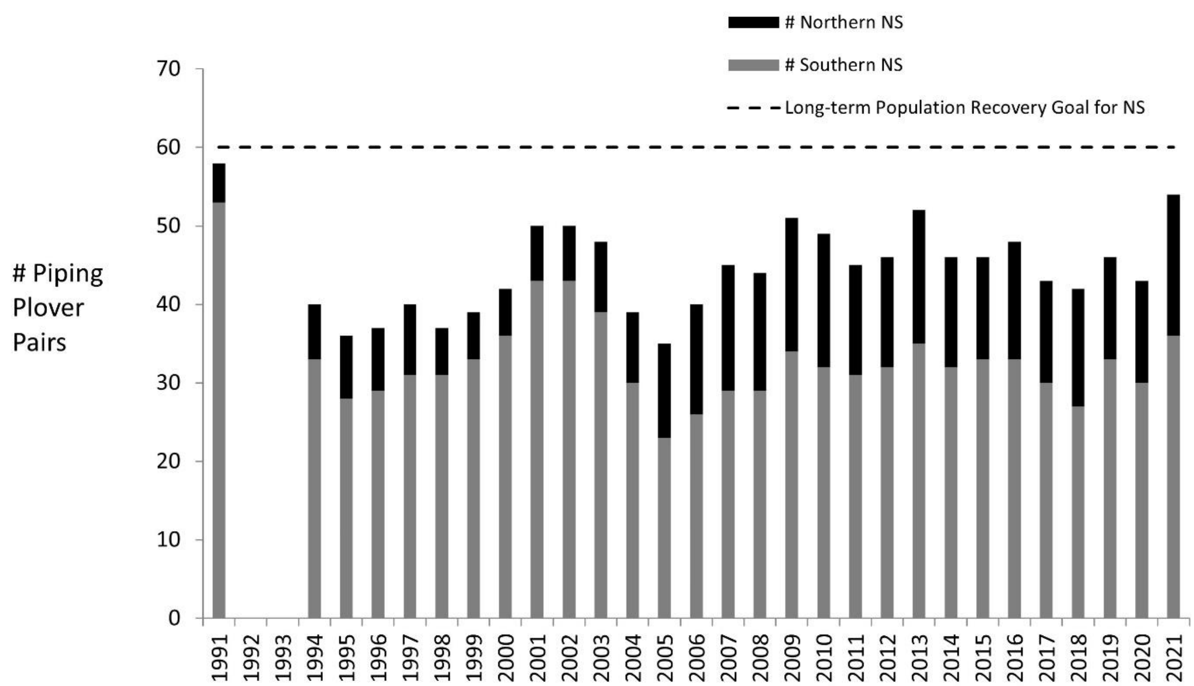

Figure 2. Number of annual pairs of piping plovers in Nova Scotia (Source: Laura Bartlett, Bird Studies Canada)

Local presence

Mahoneys and Dunns Beaches form the barrier between Antigonish Harbour and the Northumberland Strait and are known to be used by piping plover as breeding sites (Figure 3). This species typically begins arriving in the region in early April and is gone by early September (eBird, 2022b). The current classification of critical habitat in the proposed Recovery Strategy and Action Plan for the coastal subspecies of piping plover has defined both beaches as containing critical habitat for this subspecies (Environment and Climate Change Canada 2021). Dunns Beach is the closest to the proposed aquaculture leases, specifically proposed lease #1444 (Figure 1), which is located at a minimum distance of approximately 100 m (at low tide) from the critical habitat at this beach (Nova Scotia Department of Fisheries and Aquaculture Map Viewer).

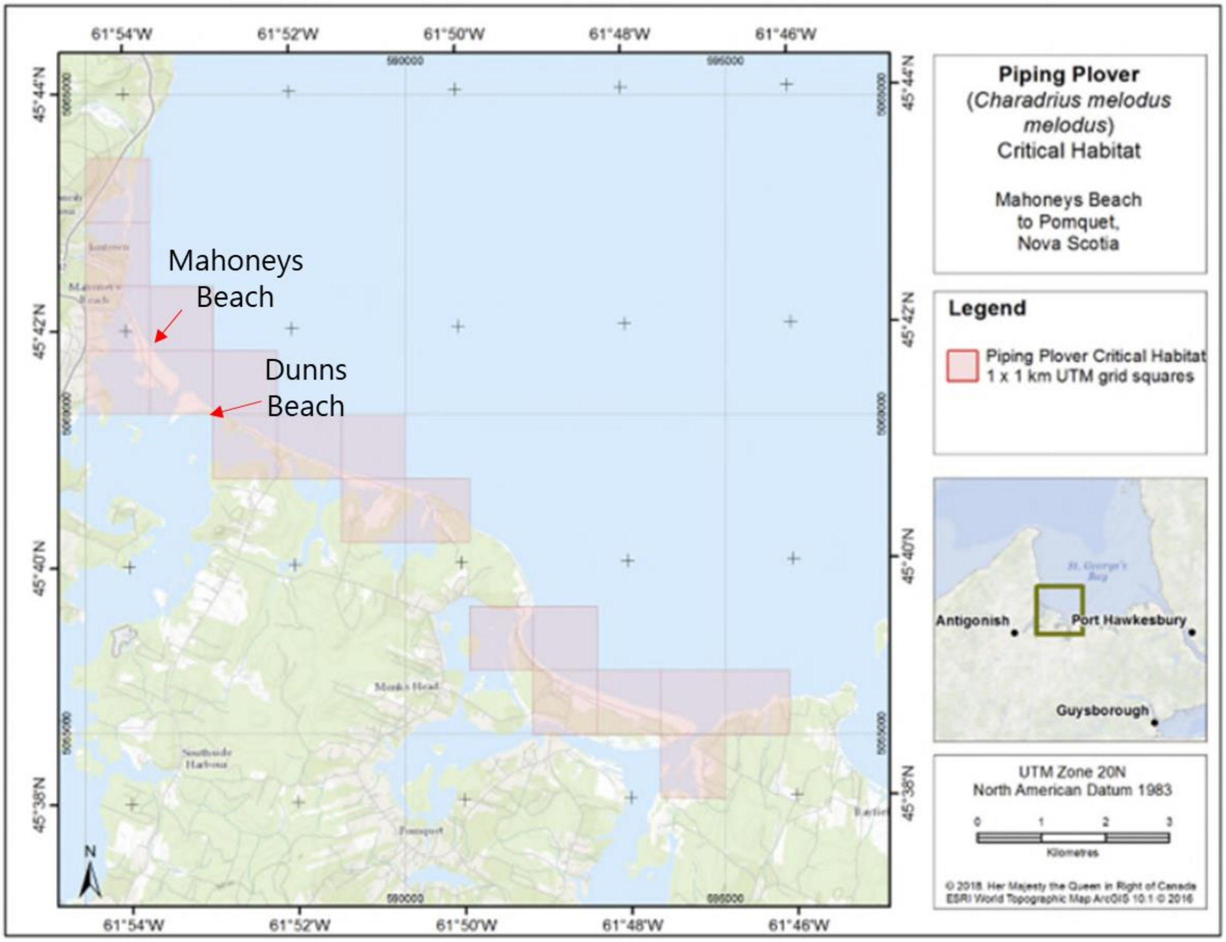

Figure 3. Grid squares containing proposed critical habitat for piping plovers from Mahoneys Beach to Pomquet, Antigonish county (Environment and Climate Change Canada, 2021).

Environment and Climate Change Canada defines critical habitat as suitable habitat within defined 1 km x 1 km squares (Figure 3). Suitable piping plover habitat includes wide stretches of beach that afford protection from flooding at normal high tide; sand, gravel, or cobble, or some combination of these; and foredune vegetation density as sparsely vegetated or relatively free of vegetation (Boyne and Amirault, 1999). The area of beach considered suitable for nesting, feeding, and/or shelter includes the area of the coastal zone from the low water mark, the intertidal zone, and up to the crest or peak of the vegetated dune (Environment and Climate Change Canada 2021). Consequently, forests, solid rock, or densely vegetated terrain within the critical habitat squares are not expected to host piping plover nesting sites. See Appendix E for a high-resolution image of habitat in the area of interest.

Monitoring piping plover at Dunns Beach commenced in 2008 when one breeding pair was present. Since then, monitoring has occurred yearly with only one to two pairs present during four of the past 13 seasons (Laura Bartlett, *pers. comm.* 2022). In comparison, plover pairs have been present at nearby Mahoneys Beach in higher numbers and more consistently than at Dunns Beach. The lease proponent has reported that nesting appears to only occur on the north side of the beach peninsula (the side furthest away from the proposed aquaculture leases), suggesting nesting habitat may be less suitable on the south side of the beach, facing the proposed lease area.

Disturbance from anthropogenic factors

Activities reported to impact piping plover habitat include coastal development, beach or shoreline stabilization, beach mining and cleaning, and discharge of oil and toxic chemicals (Environment and Climate Change Canada, 2021). Disturbances to piping plovers, which can impact populations include motorized land vehicles, off-leash dogs, and beachgoers / pedestrians (BirdLife International, 2020). Flemming et al. (1988) studied piping plover flushing (i.e., sudden flight) in Nova Scotia related to approaching walkers and found that adults usually flushed from the nest / brood when walkers were less than 40 m away. Distances that elicited any kind of reaction varied substantially with the earliest reaction occurring at 210 m. Chick behaviour was not found to change until approaching humans were within at least 160 m. Flemming et al. (1988) also found that vehicular traffic was less impactful to both adults and chicks than foot traffic. It should be noted that boat activity was not studied by Birds Canada's Nova Scotia Piping Plover Conservation Program observers, however, a link between the presence of boats and disturbance to piping plovers is not considered to be strong (Laura Bartlett – Birds Canada, *pers. comm.*, 2022). There are no known impacts on piping plover behaviour from aquaculture activities, including boating.

Herring and Great black-backed Gulls

Population status

Globally, herring and great black-backed gulls are both classified as species of 'Least Concern' on the International Union for Conservation of Nature's (IUCN) Red List (BirdLife International, 2018). The regional population of these two large gulls expanded during most of the 1900s, partly due to increased access to waste from the fishing industry and garbage dumps (Stewart et al., 2015). However, between the late 1980s and early 2000s, a decline in the abundance of both species in Eastern Canada is thought to be at least partly due to decreases in food supply following factors such as the 1992 groundfish fishing moratorium (Wilhelm et al., 2016). Studies subsequent to the population decline immediately following the moratorium suggest that their breeding population have stabilized (Wilhelm et al., 2016). In summary, the number of great black-backed gulls declined by 80.1 % (from 32,504 to 6,439 breeding pairs) and herring gulls by 69.6 % (from 28,646 to 8,696 breeding pairs) in Nova Scotia between the late 1980s and early 2010's (Wilhelm et al., 2016).

Local presence

CWS has identified both gull species to have nested on Gooseberry Island in Antigonish Harbour, in the past. Breeding at this site was last confirmed in 2013 when nine pairs of great black-backed gulls and one pair of herring gulls were found on the island (Table 1) (Wilhelm, 2017). The aquaculture lease applicant has reported that there have been no nesting gulls on the island in the past two years.

Table 1. Gull counts on Gooseberry Island

Assessment dates	Species	Counts
May 27, 1987	Great Black-backed Gull	151 individuals
May 24, 2002	Great Black-backed Gull	57 pair
May 13, 2013	Great Black-backed Gull	9 pair
May 27, 1987	Herring Gull	23 individuals
May 13, 2013	Herring Gull	1 pair

In Nova Scotia, herring gulls generally begin to visit their breeding colonies in early March (Gustowski, 2022), with peak nesting in nearby Maine, USA, occurring in early June (Johnson and Krohn, 2001). In southwest Nova Scotia, great black-backed gulls have been reported to begin visiting their breeding colonies in late February (eBird, 2022a) with peak nesting occurring in late May in Maine (Johnson and Krohn, 2001).

Disturbance by anthropogenic factors

Both gull species are large, ground-nesting and share similar life histories. In general, gulls have been found to be most vulnerable to human disturbance prior to egg laying and become less wary once incubation has commenced (Conover and Miller, 1979; Burger, 1981; Burger and Gochfeld, 1981). In the case of these two species, the most sensitive period is likely March through May in Nova Scotia.

No known studies have directly investigated the impacts of aquaculture on herring and great black-backed gulls. However, some research exists on visual / auditory disturbances to gulls and related species by boats and other marine activities. Generally, there appears to be a high level of tolerance. For instance, a study in Maine showed lobster fishing boat activity had no discernible effects on breeding herring and great black-backed gulls located as close as 100 m away (Parsons et al., 2011). Chatwin et al. (2013) also noted no observable disturbance to seabirds on Vancouver Island, British Columbia in response to passing motorboats. In this study, the seabirds were less agitated by motorboats than kayaks which could approach closer than the motorboats. In general, colonial waterbirds are more tolerable to marine activities than human presence (e.g., a person walking towards a colony) (Rodgers and Smith, 1995; Parsons et al., 2011).

Application of buffers around proposed aquaculture lease #1444

While all three bird species are protected under the Nova Scotia Migratory Bird Convention Act, Forests Act and Wildlife Act with piping plovers additionally protected under the federal Species at Risk Act, there are no legal buffers or set back distances from their defined critical habitat which exclude human activities. Network partners, however, can advise on distances to minimize disturbance. CWS has recommended a 300 m buffer around historical nesting areas of gulls and piping plover critical habitat. This distance is often applied as a precautionary default value, for all bird species (Transport Canada, 2007; Transport Canada, 2013) despite known differences to disturbance tolerance between species.

Minimum distance to piping plover critical habitat on Dunns Beach to the proposed #1444 lease boundary is approximately 100 m at low tide. A 300 m buffer from suitable piping plover habitat within the critical habitat area overlaps the proposed lease #1444 by approximately 43%, approximately 5.82 hectares of the proposed lease area (Figure 4). The minimum distance to Gooseberry Island, a historical nesting location for the two gull species, is approximately 50 m. A 300 m buffer from this island overlaps 5.55 hectares of the proposed lease area which is approximately 41%. Total coverage from both buffers covers is close to 84 % of the proposed lease area.

Option 1: Both buffers could be implemented out of an abundance of caution.

Implementing a 300 m buffer around historical nesting areas of gulls and piping plover habitat will make culture on proposed lease #1444 untenable as only 16 % of the proposed lease could be used for culture.

Option 2: Implement a 300 m buffer around piping plover habitat

If only the buffer around piping plover habitat was implemented, the only critical habitat currently occupied in the vicinity of the proposed lease, this would enable culture on the lease portion beyond the 300 m buffer boundary (7.72 hectares). This option would not apply the recommended buffer to the two historical gull species nesting habitat, therefore utilization of only the lease area beyond the piping plover buffer could be conditional as part of the licencing approval. NSDFA could determine whether the buffer would be enforced through allowable culture area under the Farm Management Plan or by adjusting the proposed lease boundary. Regardless, it would be expected that operational best practices, as described above, would be implemented to minimize bird interactions as part of the Farm Management Plan[1].

Given the limited data on the influence of aquaculture operations on piping plover and gull activities, this option would allow opportunity for a scientific study to further explore potential interactions between these species of birds and an operational oyster lease. Study outcomes could provide guidance as to whether the full lease could ultimately be utilized in the future, or the buffer would need to be maintained or modified.

Option 3: No buffers implemented.

The aquaculture lease only operates within the lease area (i.e., do not approach the beach), follow best practises as discussed[2], and conduct monitoring studies to assess potential negative interactions with the bird species of concern. Implemented procedures would be documented under the Farm Management Plan, which is reviewed on an annual basis by the Provincial aquaculture regulator, NSDFA. This would be with the understanding that mitigation is possible and activities and culture distances on the lease could require adjustment as dictated by NSDFA and/or other network partners, such as CWS.

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[1] The Farm Management Plan is a mandatory document legally required by all aquaculture operators that is subject to auditing.
[2] Mitigation strategies have also been proposed by aquaculture lease application by Town Point Consulting Inc.

Figure 4. CWS recommended 300 m buffer around piping plover critical habit and historical gull nesting areas on Gooseberry Island. Proposed 2021 critical habitat 1km x 1km squares for piping plover is overlayed in pink. The current 2012 defined critical habitat, encompasses the full area in the image. A 300 m buffer from the nearest suitable piping plover habitat (i.e., beach) within the critical habitat area is outlined in red. The proposed lease is 13.48 hectares and the 300 m buffer overlap for piping plover is 5.80 hectares, covering approximately 43% of the lease. There is less than 2% lease coverage difference between applying the 2012 critical habit criteria (all suitable beach habitat within the above image) or proposed 2021 critical habitat area (all suitable beach habitat within the pink overlap in the above image). There is slightly more piping plover suitable habitat with the 2012 iteration as this includes the small section of beach protruding southwest beyond the pink overlay boundary. The 300 m recommended buffer around Gooseberry Island is bordered in green. This buffer overlaps 5.55 hectares of the proposed lease area which is approximately 41%.

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Appendix A: Nova Scotia Aquaculture Leases Near Gull Breeding Colonies

Nova Scotia aquaculture leases near gull breeding colonies

Lease #	Aquaculture Species	Distance to nearest high-water mark (m)	Location	Latitude	Longitude	Bird Species	Presence	Maximum Number of Individuals
0672	American oyster, Blue mussel	281	Lead Island	46.9119	-60.4693	herring gull great black-backed gull	1982 – 2013 1978 – 2013	128 240
1229	American oyster	14	Indian Island	45.7148	-60.7682	great black-backed gull	1987 - 1987	2
1230	American oyster	45	Indian Island	45.7148	-60.7682	great black-backed gull	1987 - 1987	2
0716	Atlantic salmon, Rainbow trout	239	Poule Island	45.4974	-61.0376	herring gull great black-backed gull	2008 – 2008 2008 – 2008	Present Present
0716	Atlantic salmon, Rainbow trout	237	Jerserman Island Rock	45.4978	-61.0411	herring gull great black-backed gull	2013 – 2013 2013 – 2013	3 5
0995	Blue mussel, Sea scallop	60	Snake Island	44.5403	-64.1743	herring gull great black-backed gull	1987 – 1987 1987 – 1987	1 3
0900	Rainbow trout	66	Canoe Island	43.6765	-65.8279	herring gull great black-backed gull	1987 – 2013 1987 – 2013	220 41
0899	Rainbow trout	27	Ram Island	43.6824	-65.83945	herring gull great black-backed gull	1971 – 2013 1987 - 2013	450 319
0912	Rainbow trout	62	Big Gooseberry Island	43.7001	-65.8381	herring gull great black-backed gull	1971 - 2013 1971 - 2013	66 167

Details from CWS: Waterbird colony database (CWS, 2021). Distance to water mark neared by Alix d'Entremont.

Appendix B: Summary of Mitigation Strategies to Minimize Potential Impacts from Aquaculture Sites

Summary of mitigation strategies to minimize potential impacts from aquaculture sites

Potential Impacts	Goal	Mitigation Strategies	Regulations or Certifications
Attraction to sites	Minimize areas that could provide roosting, feeding, and defecating surfaces. Reduce unwanted attention from birds. The birds themselves can be endangered, it can also injure site staff, potentially contaminate the growing area, and product may be eaten.	Increase barriers through the use of netting, mesh, fencing, wire, line, or screens to prevent birds being attracted to the site. Use of equipment, other than an aircraft or firearms, to scare birds that are causing or are likely to cause damage (i.e., lights, mirrors, reflectors, water spray devices, "scarem" kites, aerial and underwater autonomous vehicle) – method must be non-lethal. Note: CWS does not permit acoustic scaring devices (Transport Canada, 2007) Use of zip ties on equipment, questionable in long-term effectiveness (Barnes, 2019). Use of poles strung with line and "scarem" kites which are easily installed, cheap and effective, however they require maintenance and increases risk of bird entanglement (Barnes, 2019).	Government of Canada, 1994 Friend of the Sea, 2016 U.S. Fish and Wildlife Service, 2016 GlobalG.A.P., 2019 Aquaculture Stewardship Council, 2019b Government of Canada, 2020e Best Aquaculture Practices, 2021a, 2021b
	Deter birds and other predators which can otherwise increase predation of eggs and chicks of migratory birds and species at risk located in nearby coastal habitat.	Contain fish feed, food scraps, and other garbage inside a building or maintained in closed containers.	Best Aquaculture Practices, 2016; 2017; 2021a; 2021b U.S. Fish and Wildlife Service 2016
Entanglement/Entrapment	Reduce entanglement and entrapment incidence to avoid harm	Handling or harming of migratory birds protected under MBCA and Species at Risk Act.	Government of Canada, 1994 (Government of Canada, 2002)

Summary of mitigation strategies to minimize potential impacts from aquaculture sites

Potential Impacts	Goal	Mitigation Strategies	Regulations or Certifications
	or death of migratory birds and bird species at risk.	is prohibited. Install anti-perching devices on equipment and infrastructure. Cover or enclose all potential nesting surfaces with netting, fencing, or other material with mesh size and must be maintained to ensure integrity. Cap or seal any small spaces	U.S. Fish and Wildlife Service 2016 Aquaculture Stewardship Council, 2019a; 2019b
		Adopt industry's best practices by selecting and modifying gear (e.g., reducing line length, use bird nets and stands) to reduce entanglement risk.	Best Aquaculture Practices, 2021a
		Under the current MBR, permits for the incidental take of migratory birds will not be issued for any developmental and economic activities	Government of Canada, 2020e
		Establish and implement a wildlife interaction and predator control plan that complies with government regulations	Best Aquaculture Practices, 2016; 2017; 2021a; 2021b GlobalG.A.P., 2019 Province of Nova Scotia, 2021a, c
		Contact CWS to obtain a permit or request assistance – ec.environinfo.ec@canada.ca or 1-800-668-6767.	
Chemical contamination	Reduce impact on nutrient inputs and chemical contamination of surrounding habitat. This protects habitat diversity and ecosystem to	Implement a Hazardous Materials Plan to manage waste and chemicals, including a spill prevention and response plan.	Government of Canada, 1994; 2012 Government of Canada, 2015 Fisheries and Oceans Canada, 2015a

Summary of mitigation strategies to minimize potential impacts from aquaculture sites

Potential Impacts	Goal	Mitigation Strategies	Regulations or Certifications
	maintain food sources and suitable habitat for breeding and nesting.	The aquaculture operator must ensure proper containment of chemicals, including oil, to avoid accidental spills which may have detrimental effects on wildlife and surrounding habitat.	U.S. Fish and Wildlife Service, 2016 Friend of the Sea, 2014, 2016 Best Aquaculture Practices, 2016; 2017; 2021a; 2019b Aquaculture Stewardship Council, 2019a, 2019b GlobalG.A.P., 2019
		Use of drugs to treat stock must be approved and administered by a veterinarian, in accordance with government regulation. Must provide an annual report to DFO summarizing the facility's deposits.	Government of Canada, 2015
		Only the use of a registered pest control product may be used. Operator must notify the Minister, at least 72 hours prior to the deposit indicating the product, time/date, and geographic location of the deposit. Must provide an annual report to DFO summarizing the facility's deposits.	Government of Canada, 2015
		Monitor sediment and water quality parameters to ensure no negative effects in surrounding waters.	Government of Canada, 2015 Aquaculture Stewardship Council, 2019a; 2019b
Sensory disturbance	Reduce impedance to breeding and nesting in surrounding areas due to excessive noise from farm operations.	Prevent increase in noise, especially during nesting and breeding season.	U.S. Fish and Wildlife Service, 2016
		Use mufflers and baffle boxes to reduce noise.	

Summary of mitigation strategies to minimize potential impacts from aquaculture sites

Potential Impacts	Goal	Mitigation Strategies	Regulations or Certifications
Disturb bird species from pre-migration congregation, resting, feeding, moulting, breeding, and nesting	Use of buffer zones from known areas of utilized by bird species	Installation, operation, maintenance, and decommissioning activities should occur with minimal noise, avoid using beaches and wetlands for storage or maintenance of equipment Educate staff on mitigation measures to avoid disturbing birds Avoid siting a facility near known bird colonies or suitable ecosystems and habitat to support birds as determined by a risk assessment on possible interactions with local wildlife.	Best Aquaculture Practices, 2016, 2017, 2021a Friend of the Sea 202016 GlobalG.A.P., 2019
		Site mollusk farms outside of an established buffer for critical habitats.	Best Aquaculture Practices, 2021b
Disturbance or destruction of nest or egg(s) of a migratory bird	Activities to be carried out such as maintenance, construction, and beach clean up will occur outside known areas of nesting and/or during nesting and fledging periods as identified in the Environmental Impact and Risk Assessment	USFWS recommends removing non-active nests (without birds or eggs), partially completed nests, or new nests prior to eggs being laid – Not a recommended practice for threatened, protected, or endangered species in Canada. Staff and vessels should not approach wildlife, including seabirds, waterfowl, or shorebirds. Perform high impact activities outside of sensitive breeding and nesting periods and ensure adequate buffers are established from known habitat areas.	U.S. Fish and Wildlife Service, 2016 Government of Canada, 1994; 2002; 2020e

Summary of mitigation strategies to minimize potential impacts from aquaculture sites

Potential Impacts	Goal	Mitigation Strategies	Regulations or Certifications
		Do not utilize beaches and wetlands for construction, operational, or decommissioning activities. This does not include beach clean-up activities which should not coincide with during breeding and nesting activities, or any other wildlife.	
Taking of a nest or egg(s), or be in possession of a live migratory bird, or its carcass skin, nest, or egg		Establish a comprehensive Wildlife Interaction Plan (WIP) to protect migratory birds and bird species at risk in accordance to the Migratory Bird Regulations (Government of Canada, 2020) Educating staff on common practices	Government of Canada, 1994; 2002 Government of Canada, 2020e
		No migratory bird or Species at Risk can be dispatched.	Province of Nova Scotia, 2021d Province of Nova Scotia, 2021d
Light pollution	Bright lights can cause problems for night migrating birds and night-flying birds	Use of low intensity energy saving lighting (e.g., low pressure sodium lamps) Prevent illumination, particularly during dusk and dawn. All lights should be shielded and aimed downwards.	U.S. Fish and Wildlife Service, 2016 Province of Nova Scotia, 2021d
Collision	Minimize collision with infrastructure and boats	Use markings and design features to identify infrastructure	U.S. Fish and Wildlife Service, 2016
	Light attracts birds and could cause them to fly into lit objects which could cause injury and death upon collision	Use of low intensity energy saving lighting (e.g., low pressure sodium lamps) Prevent illumination, particularly during dusk and dawn	Province of Nova Scotia, 2021d

Summary of mitigation strategies to minimize potential impacts from aquaculture sites

Potential Impacts	Goal	Mitigation Strategies	Regulations or Certifications
		All lights should be shielded and aimed downwards	
Human disturbance		No construction or maintenance of equipment or gear within a buffer of "special area" If possible, reduce activities during breeding and nesting times	U.S. Fish and Wildlife Service, 2016

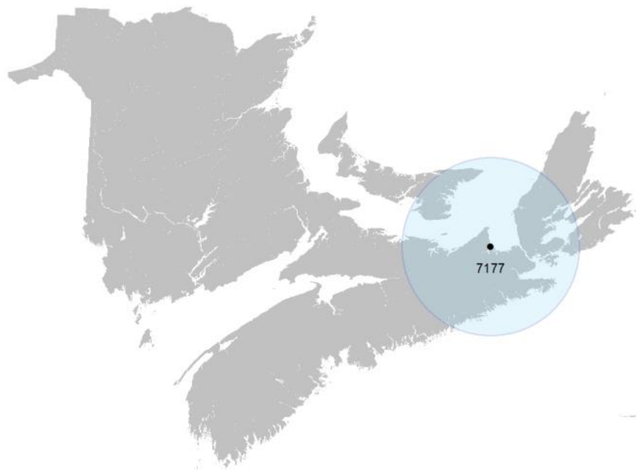
Appendix C: Atlantic Canada Conservation Data Centre (ACCDC), Data Report 7177, Antigonish Harbour, NS

Atlantic Canada Conservation Data Centre
Centre de données sur la conservation du Canada atlantique

DATA REPORT 7177: Antigonish Harbour, NS

Prepared 1 March 2022
by J. Pender, Data Manager

CONTENTS OF REPORT



Map 1. A 100 km buffer around the study area

1.0 PREFACE

The Atlantic Canada Conservation Data Centre (AC CDC; www.accdc.com) is part of a network of NatureServe data centres and heritage programs serving 50 states in the U.S.A, 10 provinces and 1 territory in Canada, plus several Central and South American countries. The NatureServe network is more than 30 years old and shares a common conservation data methodology. The AC CDC was founded in 1997, and maintains data for the jurisdictions of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. Although a non-governmental agency, the AC CDC is supported by 6 federal agencies and 4 provincial governments, as well as through outside grants and data processing fees.

Upon request and for a fee, the AC CDC queries its database and produces customized reports of the rare and endangered flora and fauna known to occur in or near a specified study area. As a supplement to that data, the AC CDC includes locations of managed areas with some level of protection, and known sites of ecological interest or sensitivity.

1.1 DATA LIST

Included datasets:

Filename	**Contents**
AntigonishHrNS_7177ob.xls	Rare or legally-protected Flora and Fauna in your study area
AntigonishHrNS_7177ob100km.xls	A list of Rare and legally protected Flora and Fauna within 100 km of your study area
AntigonishHrNS_7177msa.xls	Managed and Biologically Significant Areas in your study area

1.2 RESTRICTIONS

The AC CDC makes a strong effort to verify the accuracy of all the data that it manages, but it shall not be held responsible for any inaccuracies in data that it provides. By accepting AC CDC data, recipients assent to the following limits of use:

a) Data is restricted to use by trained personnel who are sensitive to landowner interests and to potential threats to rare and/or endangered flora and fauna posed by the information provided.
b) Data is restricted to use by the specified Data User; any third party requiring data must make its own data request.
c) The AC CDC requires Data Users to cease using and delete data 12 months after receipt, and to make a new request for updated data if necessary at that time.
d) AC CDC data responses are restricted to the data in our Data System at the time of the data request.
e) Each record has an estimate of locational uncertainty, which must be referenced in order to understand the record's relevance to a particular location. Please see attached Data Dictionary for details.
f) AC CDC data responses are not to be construed as exhaustive inventories of taxa in an area.
g) The absence of a taxon cannot be inferred by its absence in an AC CDC data response.

1.3 ADDITIONAL INFORMATION

The accompanying Data Dictionary provides metadata for the data provided.

Please direct any additional questions about AC CDC data to the following individuals:

Plants, Lichens, Ranking Methods, All other Inquiries
Sean Blaney
Senior Scientist / Executive Director
(506) 364-2658
sean.blaney@accdc.ca

Animals (Fauna)
John Klymko
Zoologist
(506) 364-2660
john.klymko@accdc.ca

Data Management, GIS
James Churchill
Conservation Data Analyst / Field Biologist
(902) 679-6146
james.churchill@accdc.ca

Billing
Jean Breau
Financial Manager / Executive Assistant
(506) 364-2657
jean.breau@accdc.ca

Questions on the biology of Federal Species at Risk can be directed to AC CDC: (506) 364-2658, with questions on Species at Risk regulations to: Samara Eaton, Canadian Wildlife Service (NB and PE): (506) 364-5060 or Julie McKnight, Canadian Wildlife Service (NS): (902) 426-4196.

For provincial information about rare taxa and protected areas, or information about game animals, deer yards, old growth forests, archeological sites, fish habitat etc., in New Brunswick, please contact Hubert Askanas, Energy and Resource Development: (506) 453-5873.

For provincial information about rare taxa and protected areas, or information about game animals, deer yards, old growth forests, archeological sites, fish habitat etc., in Nova Scotia, please contact Donna Hurlburt, NS DLF: (902) 679-6886. To determine if location-sensitive species (section 4.3) occur near your study site please contact a NS DLF Regional Biologist:

Western: Emma Vost
(902) 670-8187
Emma.Vost@novascotia.ca

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Maureen.Cameron-MacMillan@novascotia.ca

Eastern: Elizabeth Walsh
(902) 563-3370
Elizabeth.Walsh@novascotia.ca

For provincial information about rare taxa and protected areas, or information about game animals, fish habitat etc., in Prince Edward Island, please contact Garry Gregory, PEI Dept. of Communities, Land and Environment: (902) 569-7595.

2.0 RARE AND ENDANGERED SPECIES

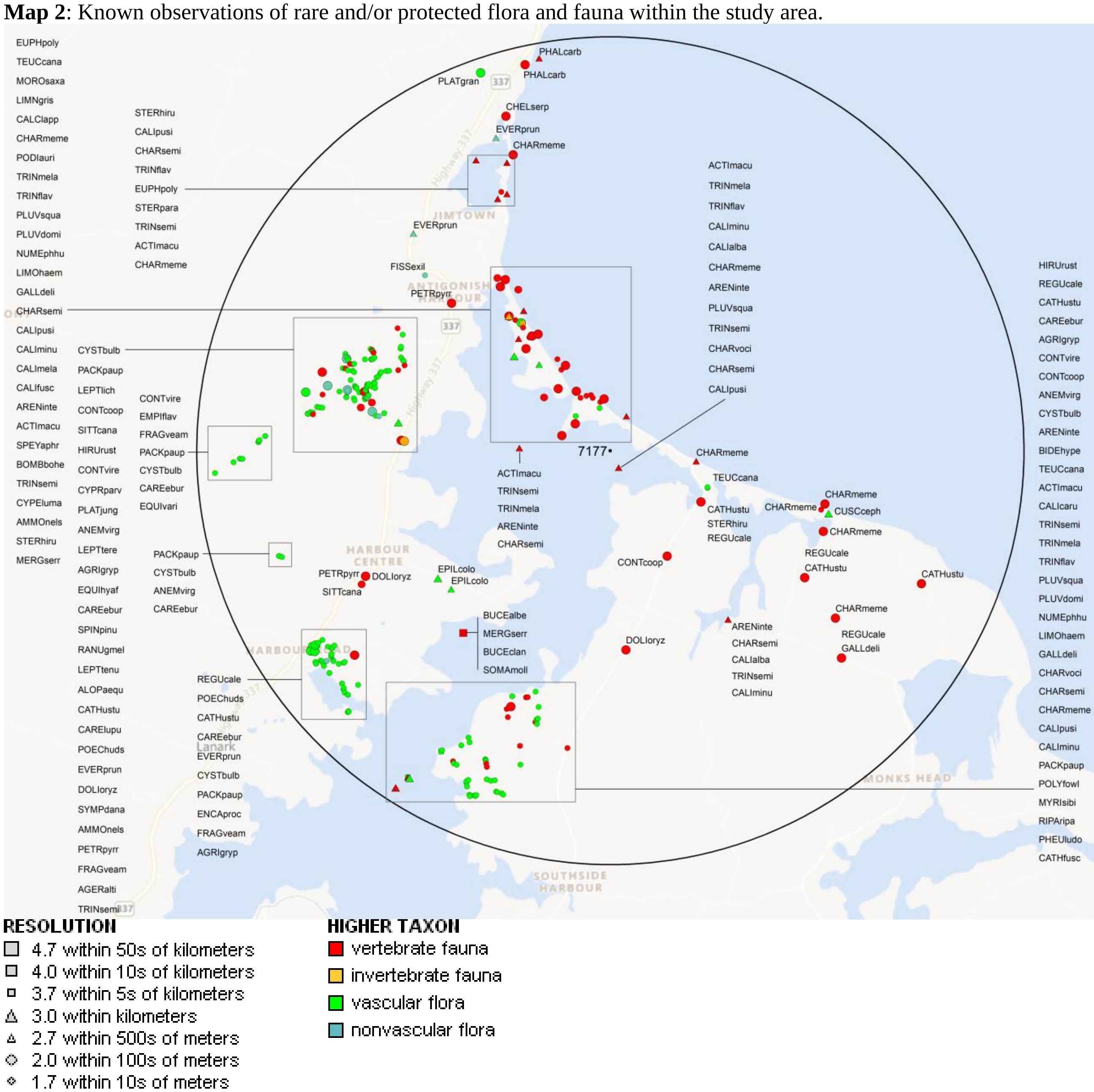
2.1 FLORA

The study area contains 198 records of 22 vascular, 17 records of 7 nonvascular flora (Map 2 and attached: *ob.xls), excluding 'location-sensitive' species.

2.2 FAUNA

The study area contains 468 records of 46 vertebrate, 3 records of 3 invertebrate fauna (Map 2 and attached data files - see 1.1 Data List), excluding 'location-sensitive' species. Please see section 4.3 to determine if 'location-sensitive' species occur near your study site.

Map 2: Known observations of rare and/or protected flora and fauna within the study area.

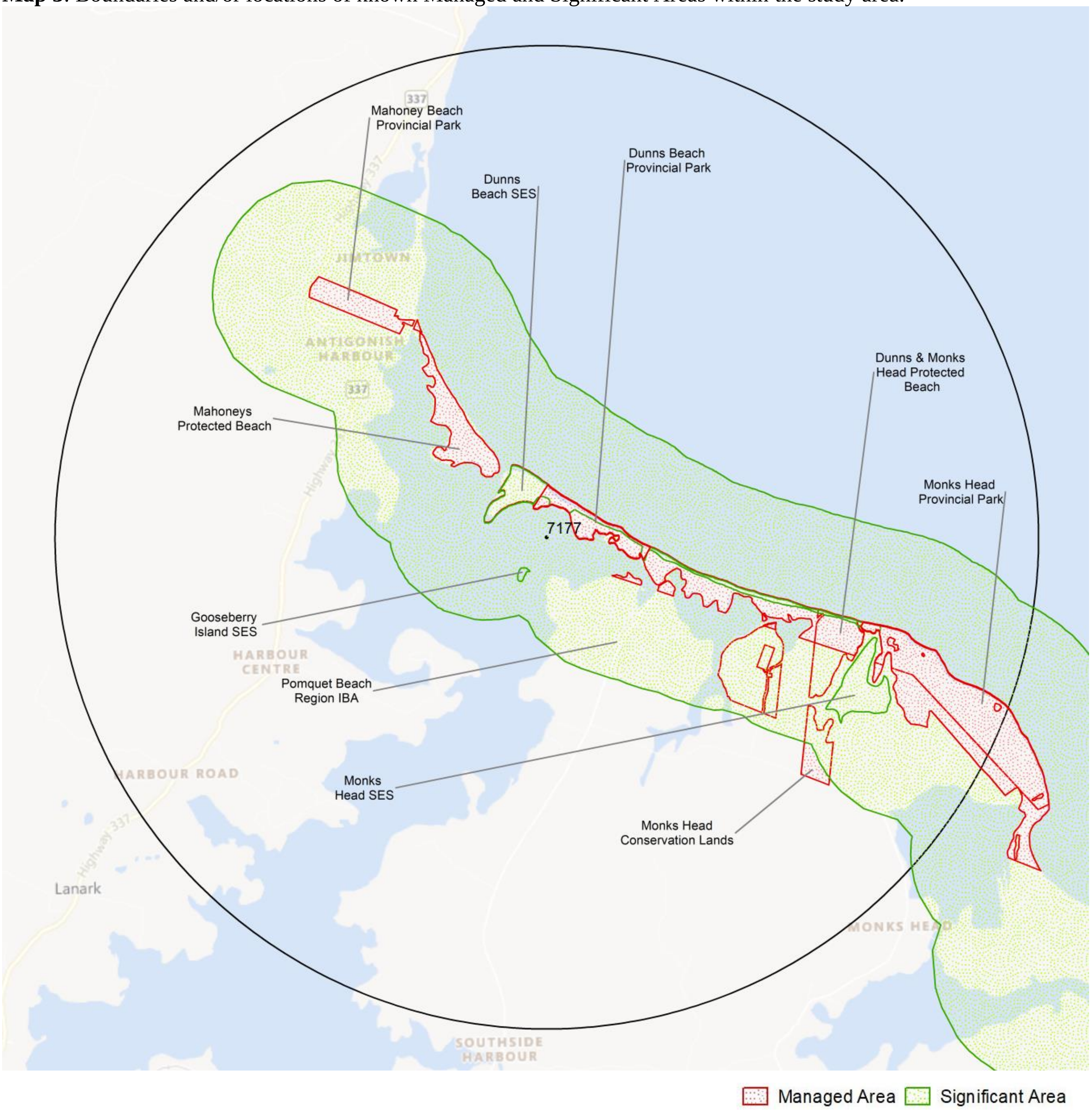


3.0 SPECIAL AREAS

3.1 MANAGED AREAS
The GIS scan identified 6 managed areas in the vicinity of the study area (Map 3 and attached file: *msa.xls).

3.2 SIGNIFICANT AREAS
The GIS scan identified 4 biologically significant sites in the vicinity of the study area (Map 3 and attached file: *msa.xls).

Map 3: Boundaries and/or locations of known Managed and Significant Areas within the study area.



4.0 RARE SPECIES LISTS

Rare and/or endangered taxa (excluding “location-sensitive” species, section 4.3) within the study area listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record). [P] = vascular plant, [N] = nonvascular plant, [A] = vertebrate animal, [I] = invertebrate animal, [C] = community. Note: records are from attached files *ob.xls/*ob.shp only.

4.1 FLORA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
N	*Fissidens exilis*	Pygmy Pocket Moss	Not At Risk			S1S2	1	3.1 ± 0.0
N	*Platydictya jungermannioides*	False Willow Moss				S2?	1	3.0 ± 0.0
N	*Scytinium teretiusculum*	Curly Jellyskin Lichen				S2?	1	3.3 ± 0.0
N	*Scytinium tenuissimum*	Birdnest Jellyskin Lichen				S2S3	5	2.8 ± 0.0
N	*Scytinium lichenoides*	Tattered Jellyskin Lichen				S3	1	3.4 ± 0.0
N	*Encalypta procera*	Slender Extinguisher Moss				S3S4	4	4.3 ± 0.0
N	*Evernia prunastri*	Valley Oakmoss Lichen				S3S4	4	2.9 ± 0.0
P	*Bidens hyperborea*	Estuary Beggarticks				S1	1	4.6 ± 1.0
P	*Ageratina altissima*	White Snakeroot				S1	1	2.6 ± 1.0
P	*Cyperus lupulinus ssp. macilentus*	Hop Flatsedge				S1	4	1.3 ± 0.0
P	*Anemone virginiana*	Virginia Anemone				S2	12	2.9 ± 0.0
P	*Cuscuta cephalanthi*	Buttonbush Dodder				S2?	1	2.7 ± 0.0
P	*Epilobium coloratum*	Purple-veined Willowherb				S2?	2	2.5 ± 0.0
P	*Euphorbia polygonifolia*	Seaside Spurge				S2S3	2	0.5 ± 0.0
P	*Cypripedium parviflorum*	Yellow Lady's-slipper				S2S3	2	3.0 ± 0.0
P	*Packera paupercula*	Balsam Groundsel				S3	24	3.0 ± 0.0
P	*Teucrium canadense*	Canada Germander				S3	10	0.6 ± 0.0
P	*Ranunculus gmelinii*	Gmelin's Water Buttercup				S3	12	3.0 ± 0.0
P	*Agrimonia gryposepala*	Hooked Agrimony				S3	20	2.8 ± 0.0
P	*Carex eburnea*	Bristle-leaved Sedge				S3	22	3.0 ± 0.0
P	*Carex lupulina*	Hop Sedge				S3	5	3.1 ± 0.0
P	*Platanthera grandiflora*	Large Purple Fringed Orchid				S3	1	4.8 ± 0.0
P	*Alopecurus aequalis*	Short-awned Foxtail				S3	2	3.3 ± 0.0
P	*Equisetum variegatum*	Variegated Horsetail				S3	1	4.8 ± 0.0
P	*Myriophyllum sibiricum*	Siberian Water Milfoil				S3S4	1	4.5 ± 0.0
P	*Polygonum fowleri*	Fowler's Knotweed				S3S4	2	4.4 ± 0.0
P	*Fragaria vesca ssp. americana*	Woodland Strawberry				S3S4	10	2.8 ± 0.0
P	*Cystopteris bulbifera*	Bulblet Bladder Fern				S3S4	62	2.7 ± 0.0
P	*Equisetum hyemale ssp. affine*	Common Scouring-rush				S3S4	1	3.7 ± 0.0

4.2 FAUNA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
A	*Charadrius melodus melodus*	Piping Plover melodus ssp	Endangered	Endangered	Endangered	S1B	126	0.2 ± 0.0
A	*Limosa haemastica*	Hudsonian Godwit	Threatened			S1S2M	3	2.0 ± 0.0
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened	Endangered	S2S3B	3	3.3 ± 0.0
A	*Tringa flavipes*	Lesser Yellowlegs	Threatened			S3M	49	0.2 ± 0.0
A	*Dolichonyx oryzivorus*	Bobolink	Threatened	Threatened	Vulnerable	S3S4B	3	2.4 ± 0.0
A	*Contopus cooperi*	Olive-sided Flycatcher	Special Concern	Threatened	Threatened	S2B	3	1.4 ± 0.0
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Endangered	S2S3B	2	2.7 ± 0.0
A	*Chelydra serpentina*	Snapping Turtle	Special Concern	Special Concern	Vulnerable	S3	1	4.2 ± 0.0
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Vulnerable	S3S4B	9	2.7 ± 0.0
A	*Podiceps auritus*	Horned Grebe	Special Concern	Special Concern		S4N	1	2.2 ± 0.0
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B	8	0.5 ± 0.0
A	*Ammospiza nelsoni*	Nelson's Sparrow	Not At Risk			S3S4B	2	1.7 ± 0.0

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)
A	*Calidris canutus rufa*	Red Knot rufa subspecies	E,SC	Endangered	Endangered	S2M	2	4.6 ± 0.0
A	*Morone saxatilis*	Striped Bass	E,SC			S2S3	1	0.6 ± 0.0
A	*Calidris minutilla*	Least Sandpiper				S1B,S3M	7	0.2 ± 0.0
A	*Charadrius semipalmatus*	Semipalmated Plover				S1B,S3S4M	30	0.2 ± 0.0
A	*Pluvialis dominica*	American Golden-Plover				S1S2M	4	2.0 ± 0.0
A	*Bucephala clangula*	Common Goldeneye				S2B,S5N	1	2.8 ± 10.0
A	*Phalacrocorax carbo*	Great Cormorant				S2S3	5	4.8 ± 0.0
A	*Spinus pinus*	Pine Siskin				S2S3	1	3.1 ± 0.0
A	*Tringa semipalmata*	Willet				S2S3B	22	0.2 ± 0.0
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2S3B	4	2.6 ± 0.0
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S2S3B	1	3.1 ± 0.0
A	*Numenius phaeopus hudsonicus*	Hudsonian Whimbrel				S2S3M	4	2.0 ± 0.0
A	*Calidris melanotos*	Pectoral Sandpiper				S2S3M	3	2.0 ± 0.0
A	*Poecile hudsonicus*	Boreal Chickadee				S3	2	3.1 ± 0.0
A	*Sitta canadensis*	Red-breasted Nuthatch				S3	4	2.9 ± 0.0
A	*Calcarius lapponicus*	Lapland Longspur				S3?N	1	2.4 ± 0.0
A	*Charadrius vociferus*	Killdeer				S3B	14	0.2 ± 0.0
A	*Gallinago delicata*	Wilson's Snipe				S3B	3	2.0 ± 0.0
A	*Sterna paradisaea*	Arctic Tern				S3B	2	3.3 ± 0.0
A	*Tringa melanoleuca*	Greater Yellowlegs				S3B,S3S4M	22	0.2 ± 0.0
A	*Pluvialis squatarola*	Black-bellied Plover				S3M	27	0.2 ± 0.0
A	*Arenaria interpres*	Ruddy Turnstone				S3M	10	0.2 ± 0.0
A	*Calidris pusilla*	Semipalmated Sandpiper				S3M	32	0.2 ± 0.0
A	*Calidris fuscicollis*	White-rumped Sandpiper				S3M	1	2.0 ± 0.0
A	*Limnodromus griseus*	Short-billed Dowitcher				S3M	2	2.0 ± 0.0
A	*Calidris alba*	Sanderling				S3M,S2N	2	0.2 ± 0.0
A	*Somateria mollissima*	Common Eider				S3S4	1	2.8 ± 10.0
A	*Actitis macularius*	Spotted Sandpiper				S3S4B	34	0.2 ± 0.0
A	*Empidonax flaviventris*	Yellow-bellied Flycatcher				S3S4B	1	4.4 ± 0.0
A	*Regulus calendula*	Ruby-crowned Kinglet				S3S4B	5	1.3 ± 0.0
A	*Catharus fuscescens*	Veery				S3S4B	1	3.6 ± 0.0
A	*Catharus ustulatus*	Swainson's Thrush				S3S4B	6	1.3 ± 0.0
A	*Mergus serrator*	Red-breasted Merganser				S3S4B,S5N	2	1.0 ± 0.0
A	*Bucephala albeola*	Bufflehead				S3S4N	1	2.8 ± 10.0
I	*Bombus (Psithyrus) bohemicus*	Gypsy Cuckoo Bumble Bee	Endangered	Endangered	Endangered	S1	1	1.9 ± 5.0
I	*Speyeria aphrodite*	Aphrodite Fritillary				S3	1	2.0 ± 2.0
I	*Sympetrum danae*	Black Meadowhawk				S3	1	2.5 ± 0.0

4.3 LOCATION SENSITIVE SPECIES

The Department of Natural Resources in each Maritimes province considers a number of species “location sensitive”. Concern about exploitation of location-sensitive species precludes inclusion of precise coordinates in this report. Those intersecting your study area are indicated below with “YES”.

Nova Scotia

Scientific *Name*	Common Name	SARA	Prov Legal Prot	Known within the Study Site?
Fraxinus nigra	Black Ash		Threatened	No
Emydoidea blandingii	*Blanding's Turtle - Nova Scotia pop.*	Endangered	Vulnerable	No
Glyptemys insculpta	Wood Turtle	Threatened	Threatened	No
Falco peregrinus pop. 1	Peregrine Falcon - anatum/tundrius pop.	Special Concern	Vulnerable	No
Bat hibernaculum or bat species occurrence		**[Endangered][1]**	**[Endangered][1]**	**YES**

1 *Myotis lucifugus* (Little Brown Myotis), *Myotis septentrionalis* (Long-eared Myotis), and *Perimyotis subflavus* (Tri-colored Bat or Eastern Pipistrelle) are all Endangered under the Federal Species at Risk Act and the NS Endangered Species Act.

4.4 SOURCE BIBLIOGRAPHY

The recipient of these data shall acknowledge the AC CDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

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5.0 RARE SPECIES WITHIN 100 KM

A 100 km buffer around the study area contains 35864 records of 150 vertebrate and 787 records of 57 invertebrate fauna; 6233 records of 263 vascular, 2633 records of 120 nonvascular flora (attached: *ob100km.xls).

Taxa within 100 km of the study site that are rare and/or endangered in the province in which the study site occurs (including "location-sensitive" species). All ranks correspond to the province in which the study site falls, even for out-of-province records. Taxa are listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record).

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Myotis lucifugus*	Little Brown Myotis	Endangered	Endangered	Endangered	S1	68	9.5 ± 0.0	NS
A	*Myotis septentrionalis*	Northern Long-eared Myotis	Endangered	Endangered	Endangered	S1	37	67.8 ± 1.0	PE
A	*Salmo salar pop. 1*	Atlantic Salmon - Inner Bay of Fundy pop.	Endangered	Endangered		S1	2	82.1 ± 0.0	NS
A	*Salmo salar pop. 4*	Atlantic Salmon - Eastern Cape Breton pop.	Endangered			S1	20	46.9 ± 0.0	NS
A	*Salmo salar pop. 6*	Altantic Salmon - Nova Scotia Southern Upland pop.	Endangered			S1	33	31.3 ± 1.0	NS
A	*Eubalaena glacialis*	North Atlantic Right Whale	Endangered	Endangered		S1	1	75.9 ± 1.0	NS
A	*Charadrius melodus melodus*	Piping Plover melodus ssp	Endangered	Endangered	Endangered	S1B	1565	0.2 ± 0.0	NS
A	*Sterna dougallii*	Roseate Tern	Endangered	Endangered	Endangered	S1B	73	65.4 ± 0.0	NS
A	*Dermochelys coriacea (Atlantic pop.)*	Leatherback Sea Turtle - Atlantic pop.	Endangered	Endangered		S1S2N	2	35.9 ± 0.0	NS
A	*Antrostomus vociferus*	Eastern Whip-Poor-Will	Threatened	Threatened	Threatened	S1?B	3	5.7 ± 7.0	NS
A	*Catharus bicknelli*	Bicknell's Thrush	Threatened	Threatened	Endangered	S1S2B	4	78.2 ± 7.0	NS
A	*Asio flammeus*	Short-eared Owl	Threatened	Special Concern		S1S2B	8	42.2 ± 7.0	NS
A	*Limosa haemastica*	Hudsonian Godwit	Threatened			S1S2M	7	2.0 ± 0.0	NS
A	*Glyptemys insculpta*	Wood Turtle	Threatened	Threatened	Threatened	S2	3885	11.0 ± 0.0	NS
A	*Anguilla rostrata*	American Eel	Threatened			S2	3	66.5 ± 0.0	NS
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Endangered	S2B,S1M	194	8.4 ± 0.0	NS
A	*Riparia riparia*	Bank Swallow	Threatened	Threatened	Endangered	S2S3B	1245	3.3 ± 0.0	NS
A	*Oceanodroma leucorhoa*	Leach's Storm-Petrel	Threatened			S3B,S5M	61	35.8 ± 0.0	NS
A	*Tringa flavipes*	Lesser Yellowlegs	Threatened			S3M	276	0.2 ± 0.0	NS
A	*Dolichonyx oryzivorus*	Bobolink	Threatened	Threatened	Vulnerable	S3S4B	649	2.4 ± 0.0	NS
A	*Sturnella magna*	Eastern Meadowlark	Threatened	Threatened		SHB	2	64.9 ± 0.0	NS
A	*Hylocichla mustelina*	Wood Thrush	Threatened	Threatened		SUB	13	12.8 ± 7.0	NS
A	*Salmo salar pop. 12*	Atlantic Salmon - Gaspe - Southern Gulf of St Lawrence pop.	Special Concern			S1	32	6.3 ± 1.0	NS
A	*Passerculus sandwichensis princeps*	Savannah Sparrow princeps ssp	Special Concern	Special Concern		S1B	2	65.2 ± 7.0	NS
A	*Bucephala islandica (Eastern pop.)*	Barrow's Goldeneye - Eastern pop.	Special Concern	Special Concern		S1N	7	57.7 ± 0.0	NS
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Endangered	S2B	226	7.8 ± 0.0	NS
A	*Chordeiles minor*	Common Nighthawk	Special Concern	Threatened	Threatened	S2B	252	9.3 ± 7.0	NS
A	*Contopus cooperi*	Olive-sided Flycatcher	Special Concern	Threatened	Threatened	S2B	1096	1.4 ± 0.0	NS
A	*Histrionicus histrionicus pop. 1*	Harlequin Duck - Eastern pop.	Special Concern	Special Concern	Endangered	S2N	34	57.6 ± 0.0	PE
A	*Hirundo rustica*	Barn Swallow	Special Concern	Threatened	Endangered	S2S3B	1028	2.7 ± 0.0	NS
A	*Morone saxatilis pop. 1*	Striped Bass- Southern Gulf of St Lawrence pop.	Special Concern			S2S3N	1	6.3 ± 1.0	NS
A	*Chelydra serpentina*	Snapping Turtle	Special Concern	Special Concern	Vulnerable	S3	33	4.2 ± 0.0	NS
A	*Cardellina canadensis*	Canada Warbler	Special Concern	Threatened	Endangered	S3B	728	5.1 ± 7.0	NS
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern	Special Concern	Vulnerable	S3S4B	606	2.7 ± 0.0	NS
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern	Special Concern	Vulnerable	S3S4B,S3N	577	5.1 ± 7.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
A	*Phocoena phocoena*	Harbour Porpoise	Special Concern			S4	2	35.9 ± 0.0	NS
A	*Podiceps auritus*	Horned Grebe	Special Concern	Special Concern		S4N	6	2.2 ± 0.0	NS
A	*Chrysemys picta picta*	Eastern Painted Turtle	Special Concern			S4S5	2	26.1 ± 1.0	NS
A	*Lynx canadensis*	Canadian Lynx	Not At Risk		Endangered	S1	10	49.6 ± 1.0	NS
A	*Accipiter cooperii*	Cooper's Hawk	Not At Risk			S1?B	2	71.7 ± 0.0	NS
A	*Fulica americana*	American Coot	Not At Risk			S1B	12	80.0 ± 7.0	NS
A	*Chlidonias niger*	Black Tern	Not At Risk			S1B	3	11.0 ± 0.0	NS
A	*Falco peregrinus pop. 1*	Peregrine Falcon - anatum/tundrius	Not At Risk	Special Concern	Vulnerable	S1B,SNAM	6	34.8 ± 0.0	NS
A	*Sorex dispar*	Long-tailed Shrew	Not At Risk			S2	4	75.6 ± 1.0	NS
A	*Aegolius funereus*	Boreal Owl	Not At Risk			S2?B	13	22.3 ± 0.0	NS
A	*Hemidactylium scutatum*	Four-toed Salamander	Not At Risk			S3	13	31.3 ± 0.0	NS
A	*Megaptera novaeangliae*	Humpback Whale (NW Atlantic pop.)	Not At Risk			S3	2	35.9 ± 0.0	NS
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B	511	0.5 ± 0.0	NS
A	*Sialia sialis*	Eastern Bluebird	Not At Risk			S3B	20	19.4 ± 7.0	NS
A	*Buteo lagopus*	Rough-legged Hawk	Not At Risk			S3N	8	35.8 ± 4.0	NS
A	*Accipiter gentilis*	Northern Goshawk	Not At Risk			S3S4	112	5.1 ± 7.0	NS
A	*Lagenorhynchus acutus*	Atlantic White-sided Dolphin	Not At Risk			S3S4	4	36.5 ± 0.0	NS
A	*Circus hudsonius*	Northern Harrier	Not At Risk			S3S4B	336	5.1 ± 7.0	NS
A	*Ammospiza nelsoni*	Nelson's Sparrow	Not At Risk			S3S4B	122	1.7 ± 0.0	NS
A	*Calidris canutus rufa*	Red Knot rufa subspecies	E,SC	Endangered	Endangered	S2M	23	4.6 ± 0.0	NS
A	*Morone saxatilis*	Striped Bass	E,SC			S2S3	2	0.6 ± 0.0	NS
A	*Martes americana*	American Marten			Endangered	S1	4	74.5 ± 1.0	NS
A	*Alces americanus*	Moose			Endangered	S1	125	15.7 ± 5.0	NS
A	*Picoides dorsalis*	American Three-toed Woodpecker				S1?	11	32.6 ± 0.0	NS
A	*Passerina cyanea*	Indigo Bunting				S1?B	8	16.8 ± 7.0	NS
A	*Uria aalge*	Common Murre				S1?B,S5N	1	79.1 ± 0.0	NS
A	*Nycticorax nycticorax*	Black-crowned Night-heron				S1B	2	5.7 ± 7.0	NS
A	*Anas acuta*	Northern Pintail				S1B	16	10.3 ± 1.0	NS
A	*Oxyura jamaicensis*	Ruddy Duck				S1B	2	15.2 ± 0.0	NS
A	*Gallinula galeata*	Common Gallinule				S1B	2	92.0 ± 7.0	NS
A	*Haematopus palliatus*	American Oystercatcher				S1B	7	76.4 ± 7.0	NS
A	*Myiarchus crinitus*	Great Crested Flycatcher				S1B	4	73.4 ± 7.0	NS
A	*Mimus polyglottos*	Northern Mockingbird				S1B	26	5.7 ± 7.0	NS
A	*Toxostoma rufum*	Brown Thrasher				S1B	4	9.3 ± 7.0	NS
A	*Vireo gilvus*	Warbling Vireo				S1B	6	5.1 ± 7.0	NS
A	*Setophaga pinus*	Pine Warbler				S1B	6	41.2 ± 0.0	NS
A	*Calidris minutilla*	Least Sandpiper				S1B,S3M	189	0.2 ± 0.0	NS
A	*Charadrius semipalmatus*	Semipalmated Plover				S1B,S3S4M	354	0.2 ± 0.0	NS
A	*Vespertilionidae sp.*	bat species				S1S2	77	3.6 ± 0.0	NS
A	*Pluvialis dominica*	American Golden-Plover				S1S2M	28	2.0 ± 0.0	NS
A	*Microtus chrotorrhinus*	Rock Vole				S2	10	75.6 ± 1.0	NS
A	*Vireo philadelphicus*	Philadelphia Vireo				S2?B	36	12.8 ± 7.0	NS
A	*Spatula clypeata*	Northern Shoveler				S2B	7	66.1 ± 0.0	NS
A	*Mareca strepera*	Gadwall				S2B	15	8.0 ± 0.0	NS
A	*Empidonax traillii*	Willow Flycatcher				S2B	5	5.1 ± 7.0	NS
A	*Setophaga tigrina*	Cape May Warbler				S2B	241	11.5 ± 0.0	NS
A	*Piranga olivacea*	Scarlet Tanager				S2B	14	29.9 ± 0.0	NS
A	*Pooecetes gramineus*	Vesper Sparrow				S2B	20	12.8 ± 7.0	NS
A	*Molothrus ater*	Brown-headed Cowbird				S2B	74	5.1 ± 7.0	NS
A	*Alca torda*	Razorbill				S2B,S4N	10	88.8 ± 7.0	NS
A	*Bucephala clangula*	Common Goldeneye				S2B,S5N	209	2.8 ± 10.0	NS
A	*Branta bernicla*	Brant				S2M	1	60.1 ± 16.0	NS
A	*Phalacrocorax carbo*	Great Cormorant				S2S3	373	4.8 ± 0.0	NS
A	*Asio otus*	Long-eared Owl				S2S3	33	5.7 ± 7.0	NS
A	*Spinus pinus*	Pine Siskin				S2S3	452	3.1 ± 0.0	NS

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A	*Cathartes aura*	Turkey Vulture				S2S3B	5	69.8 ± 0.0	NS
A	*Rallus limicola*	Virginia Rail				S2S3B	30	18.9 ± 7.0	NS
A	*Tringa semipalmata*	Willet				S2S3B	694	0.2 ± 0.0	NS
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2S3B	187	2.6 ± 0.0	NS
A	*Pheucticus ludovicianus*	Rose-breasted Grosbeak				S2S3B	467	3.1 ± 0.0	NS
A	*Icterus galbula*	Baltimore Oriole				S2S3B	40	5.1 ± 7.0	NS
A	*Pinicola enucleator*	Pine Grosbeak				S2S3B,S5N	119	5.7 ± 7.0	NS
A	*Numenius phaeopus hudsonicus*	Hudsonian Whimbrel				S2S3M	78	2.0 ± 0.0	NS
A	*Calidris melanotos*	Pectoral Sandpiper				S2S3M	32	2.0 ± 0.0	NS
A	*Perisoreus canadensis*	Canada Jay				S3	528	5.1 ± 7.0	NS
A	*Poecile hudsonicus*	Boreal Chickadee				S3	1114	3.1 ± 0.0	NS
A	*Sitta canadensis*	Red-breasted Nuthatch				S3	1000	2.9 ± 0.0	NS
A	*Alosa pseudoharengus*	Alewife				S3	28	32.9 ± 0.0	NS
A	*Salvelinus fontinalis*	Brook Trout				S3	55	6.3 ± 1.0	NS
A	*Salvelinus namaycush*	Lake Trout				S3	1	81.7 ± 0.0	NS
A	*Menidia menidia*	Atlantic Silverside				S3	3	47.8 ± 0.0	NS
A	*Synaptomys cooperi*	Southern Bog Lemming				S3	4	75.6 ± 1.0	NS
A	*Pekania pennanti*	Fisher				S3	7	5.7 ± 0.0	NS
A	*Calidris maritima*	Purple Sandpiper				S3?N	33	21.7 ± 0.0	NS
A	*Calcarius lapponicus*	Lapland Longspur				S3?N	1	2.4 ± 0.0	NS
A	*Falco sparverius*	American Kestrel				S3B	363	5.1 ± 7.0	NS
A	*Charadrius vociferus*	Killdeer				S3B	307	0.2 ± 0.0	NS
A	*Gallinago delicata*	Wilson's Snipe				S3B	780	2.0 ± 0.0	NS
A	*Sterna paradisaea*	Arctic Tern				S3B	97	3.3 ± 0.0	NS
A	*Coccyzus erythropthalmus*	Black-billed Cuckoo				S3B	71	5.7 ± 7.0	NS
A	*Tyrannus tyrannus*	Eastern Kingbird				S3B	160	5.1 ± 7.0	NS
A	*Dumetella carolinensis*	Gray Catbird				S3B	307	5.1 ± 7.0	NS
A	*Cardellina pusilla*	Wilson's Warbler				S3B	128	8.9 ± 0.0	NS
A	*Tringa melanoleuca*	Greater Yellowlegs				S3B,S3S4M	370	0.2 ± 0.0	NS
A	*Rissa tridactyla*	Black-legged Kittiwake				S3B,S5N	4	40.6 ± 3.0	NS
A	*Fratercula arctica*	Atlantic Puffin				S3B,S5N	9	70.1 ± 0.0	NS
A	*Pluvialis squatarola*	Black-bellied Plover				S3M	251	0.2 ± 0.0	NS
A	*Arenaria interpres*	Ruddy Turnstone				S3M	130	0.2 ± 0.0	NS
A	*Calidris pusilla*	Semipalmated Sandpiper				S3M	267	0.2 ± 0.0	NS
A	*Calidris fuscicollis*	White-rumped Sandpiper				S3M	70	2.0 ± 0.0	NS
A	*Limnodromus griseus*	Short-billed Dowitcher				S3M	141	2.0 ± 0.0	NS
A	*Calidris alba*	Sanderling				S3M,S2N	186	0.2 ± 0.0	NS
A	*Chroicocephalus ridibundus*	Black-headed Gull				S3N	20	10.0 ± 0.0	NS
A	*Somateria mollissima*	Common Eider				S3S4	551	2.8 ± 10.0	NS
A	*Picoides arcticus*	Black-backed Woodpecker				S3S4	127	12.8 ± 7.0	NS
A	*Loxia curvirostra*	Red Crossbill				S3S4	88	13.1 ± 7.0	NS
A	*Sorex palustris*	American Water Shrew				S3S4	2	69.9 ± 0.0	PE
A	*Botaurus lentiginosus*	American Bittern				S3S4B	326	5.1 ± 7.0	NS
A	*Spatula discors*	Blue-winged Teal				S3S4B	204	5.1 ± 7.0	NS
A	*Actitis macularius*	Spotted Sandpiper				S3S4B	770	0.2 ± 0.0	NS
A	*Empidonax flaviventris*	Yellow-bellied Flycatcher				S3S4B	1096	4.4 ± 0.0	NS
A	*Regulus calendula*	Ruby-crowned Kinglet				S3S4B	3566	1.3 ± 0.0	NS
A	*Catharus fuscescens*	Veery				S3S4B	567	3.6 ± 0.0	NS
A	*Catharus ustulatus*	Swainson's Thrush				S3S4B	2594	1.3 ± 0.0	NS
A	*Oreothlypis peregrina*	Tennessee Warbler				S3S4B	482	5.1 ± 7.0	NS
A	*Setophaga castanea*	Bay-breasted Warbler				S3S4B	493	11.7 ± 0.0	NS
A	*Setophaga striata*	Blackpoll Warbler				S3S4B	123	8.9 ± 0.0	NS
A	*Passerella iliaca*	Fox Sparrow				S3S4B	129	9.3 ± 7.0	NS
A	*Mergus serrator*	Red-breasted Merganser				S3S4B,S5N	167	1.0 ± 0.0	NS
A	*Bucephala albeola*	Bufflehead				S3S4N	43	2.8 ± 10.0	NS
A	*Lanius borealis*	Northern Shrike				S3S4N	7	73.4 ± 0.0	NS
A	*Leucophaeus atricilla*	Laughing Gull				SHB	3	65.2 ± 0.0	NS

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A	*Progne subis*	Purple Martin				SHB	4	70.1 ± 0.0	NS
A	*Eremophila alpestris*	Horned Lark				SHB,S4S5N	1	85.0 ± 7.0	PE
A	*Morus bassanus*	Northern Gannet				SHB,S5M	76	19.9 ± 0.0	NS
I	*Bombus (Psithyrus) bohemicus*	Gypsy Cuckoo Bumble Bee	Endangered	Endangered	Endangered	S1	11	1.9 ± 5.0	NS
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Endangered	S2B	74	5.9 ± 0.0	NS
I	*Alasmidonta varicosa*	Brook Floater	Special Concern	Special Concern	Threatened	S1S2	8	27.3 ± 0.0	NS
I	*Bombus terricola*	Yellow-banded Bumblebee	Special Concern	Special Concern	Vulnerable	S3	68	10.7 ± 0.0	NS
I	*Coccinella transversoguttata richardsoni*	Transverse Lady Beetle	Special Concern		Endangered	SH	6	59.7 ± 2.0	NS
I	*Papilio brevicauda bretonensis*	Short-tailed Swallowtail				S1	4	98.5 ± 2.0	NS
I	*Satyrium acadica*	Acadian Hairstreak				S1	7	65.2 ± 2.0	NS
I	*Neurocordulia michaeli*	Broadtailed Shadowdragon				S1	26	50.0 ± 0.0	NS
I	*Lycaena dorcas*	Dorcas Copper				S1?	29	60.0 ± 0.0	NS
I	*Polygonia satyrus*	Satyr Comma				S1?	11	79.6 ± 2.0	PE
I	*Strymon melinus*	Grey Hairstreak				S1S2	2	72.1 ± 1.0	NS
I	*Nymphalis l-album*	Compton Tortoiseshell				S1S2	2	62.4 ± 2.0	NS
I	*Somatochlora kennedyi*	Kennedy's Emerald				S1S2	1	93.6 ± 1.0	PE
I	*Coenagrion resolutum*	Taiga Bluet				S1S2	20	66.5 ± 1.0	PE
I	*Haematopota rara*	Shy Cleg				S1S3	1	92.9 ± 0.0	NS
I	*Lycaena hyllus*	Bronze Copper				S2	16	9.8 ± 0.0	NS
I	*Lycaena dospassosi*	Salt Marsh Copper				S2	7	55.2 ± 0.0	NS
I	*Satyrium calanus*	Banded Hairstreak				S2	1	60.3 ± 2.0	NS
I	*Aglais milberti*	Milbert's Tortoiseshell				S2	4	62.4 ± 2.0	NS
I	*Somatochlora septentrionalis*	Muskeg Emerald				S2	1	90.5 ± 0.0	NS
I	*Margaritifera margaritifera*	Eastern Pearlshell				S2	84	10.3 ± 0.0	NS
I	*Pantala hymenaea*	Spot-Winged Glider				S2?B	2	56.9 ± 1.0	NS
I	*Thorybes pylades*	Northern Cloudywing				S2S3	25	11.2 ± 0.0	NS
I	*Amblyscirtes hegon*	Pepper and Salt Skipper				S2S3	8	43.8 ± 0.0	NS
I	*Satyrium liparops*	Striped Hairstreak				S2S3	9	59.8 ± 2.0	NS
I	*Euphydryas phaeton*	Baltimore Checkerspot				S2S3	57	19.1 ± 0.0	NS
I	*Gomphus descriptus*	Harpoon Clubtail				S2S3	16	44.9 ± 0.0	NS
I	*Ophiogomphus aspersus*	Brook Snaketail				S2S3	5	44.9 ± 0.0	NS
I	*Ophiogomphus mainensis*	Maine Snaketail				S2S3	14	24.0 ± 0.0	NS
I	*Ophiogomphus rupinsulensis*	Rusty Snaketail				S2S3	36	50.0 ± 0.0	NS
I	*Somatochlora forcipata*	Forcipate Emerald				S2S3	9	83.2 ± 0.0	PE
I	*Somatochlora franklini*	Delicate Emerald				S2S3	3	75.7 ± 1.0	PE
I	*Alasmidonta undulata*	Triangle Floater				S2S3	7	30.3 ± 0.0	NS
I	*Naemia seriata*	a Ladybird beetle				S3	1	11.2 ± 0.0	NS
I	*Iphthiminus opacus*	a Darkling Beetle				S3	1	59.7 ± 0.0	NS
I	*Monochamus marmorator*	a Longhorned Beetle				S3	2	44.0 ± 0.0	NS
I	*Callophrys henrici*	Henry's Elfin				S3	2	38.1 ± 0.0	NS
I	*Callophrys lanoraieensis*	Bog Elfin				S3	5	78.9 ± 1.0	NS
I	*Speyeria aphrodite*	Aphrodite Fritillary				S3	7	2.0 ± 2.0	NS
I	*Polygonia faunus*	Green Comma				S3	9	26.8 ± 0.0	NS
I	*Megisto cymela*	Little Wood-satyr				S3	13	60.0 ± 0.0	NS
I	*Oeneis jutta*	Jutta Arctic				S3	11	38.1 ± 0.0	NS
I	*Aeshna clepsydra*	Mottled Darner				S3	3	38.8 ± 0.0	NS
I	*Aeshna constricta*	Lance-Tipped Darner				S3	6	65.2 ± 1.0	NS
I	*Boyeria grafiana*	Ocellated Darner				S3	9	54.4 ± 0.0	NS
I	*Gomphaeschna furcillata*	Harlequin Darner				S3	3	40.5 ± 0.0	NS
I	*Nannothemis bella*	Elfin Skimmer				S3	3	40.5 ± 0.0	NS
I	*Sympetrum danae*	Black Meadowhawk				S3	9	2.5 ± 0.0	NS
I	*Enallagma vernale*	Vernal Bluet				S3	5	38.1 ± 0.0	NS
I	*Amphiagrion saucium*	Eastern Red Damsel				S3	11	60.5 ± 0.0	NS
I	*Cupido comyntas*	Eastern Tailed Blue				S3?	1	80.7 ± 0.0	NS
I	*Polygonia interrogationis*	Question Mark				S3B	29	18.2 ± 0.0	NS

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I	*Erynnis juvenalis*	Juvenal's Duskywing				S3S4	1	11.5 ± 1.0	NS
I	*Amblyscirtes vialis*	Common Roadside-Skipper				S3S4	17	47.0 ± 0.0	NS
I	*Polygonia progne*	Grey Comma				S3S4	31	17.8 ± 0.0	NS
I	*Lanthus parvulus*	Northern Pygmy Clubtail				S3S4	16	5.7 ± 1.0	NS
I	*Lampsilis radiata*	Eastern Lampmussel				S3S4	18	18.8 ± 0.0	NS
N	*Erioderma pedicellatum (Atlantic pop.)*	Boreal Felt Lichen - Atlantic pop.	Endangered	Endangered	Endangered	S1	401	43.7 ± 0.0	NS
N	*Erioderma mollissimum*	Graceful Felt Lichen	Endangered	Endangered	Endangered	S1S2	17	69.5 ± 0.0	NS
N	*Peltigera hydrothyria*	Eastern Waterfan	Threatened	Threatened	Threatened	S1	33	41.6 ± 0.0	NS
N	*Pannaria lurida*	Wrinkled Shingle Lichen	Threatened	Threatened	Threatened	S1S2	23	97.3 ± 0.0	NS
N	*Fuscopannaria leucosticta*	White-rimmed Shingle Lichen	Threatened			S2S3	3	83.8 ± 0.0	NS
N	*Anzia colpodes*	Black-foam Lichen	Threatened	Threatened	Threatened	S3	12	43.6 ± 1.0	NS
N	*Sclerophora peronella (Atlantic pop.)*	Frosted Glass-whiskers (Atlantic population)	Special Concern	Special Concern		S1?	17	30.9 ± 0.0	NS
N	*Pectenia plumbea*	Blue Felt Lichen	Special Concern	Special Concern	Vulnerable	S3	472	32.0 ± 0.0	NS
N	*Fissidens exilis*	Pygmy Pocket Moss	Not At Risk			S1S2	5	3.1 ± 0.0	NS
N	*Pseudevernia cladonia*	Ghost Antler Lichen	Not At Risk			S2S3	3	47.0 ± 0.0	NS
N	*Cinclidium stygium*	Sooty Cupola Moss				S1	2	63.6 ± 0.0	NS
N	*Cladonia brevis*	Short Peg Lichen				S1	1	93.8 ± 0.0	NS
N	*Lathagrium cristatum*	Fingered Jelly Lichen				S1	1	83.9 ± 0.0	NS
N	*Peltigera lepidophora*	Scaly Pelt Lichen				S1	3	78.2 ± 0.0	PE
N	*Hypogymnia hultenii*	Powdered Honeycomb Lichen				S1	15	63.6 ± 0.0	NS
N	*Campylostelium saxicola*	a Moss				S1?	1	89.7 ± 0.0	PE
N	*Conardia compacta*	Coast Creeping Moss				S1?	1	61.1 ± 2.0	NS
N	*Paludella squarrosa*	Tufted Fen Moss				S1?	1	98.3 ± 5.0	NS
N	*Polychidium muscicola*	Eyed Mossthorns Woollybear Lichen				S1?	2	47.9 ± 0.0	NS
N	*Parmeliella parvula*	Poor-man's Shingles Lichen				S1?	10	49.2 ± 0.0	NS
N	*Sphagnum platyphyllum*	Flat-leaved Peat Moss				S1S2	3	65.0 ± 0.0	NS
N	*Tetrodontium brownianum*	Little Georgia				S1S2	1	89.7 ± 0.0	PE
N	*Cyrto-hypnum minutulum*	Tiny Cedar Moss				S1S2	1	81.6 ± 0.0	NS
N	*Hamatocaulis vernicosus*	a Moss				S1S2	1	62.2 ± 0.0	NS
N	*Enchylium bachmanianum*	Bachman's Jelly Lichen				S1S2	1	89.4 ± 0.0	NS
N	*Enchylium limosum*	Lime-loving Tarpaper Lichen				S1S2	1	88.8 ± 0.0	PE
N	*Peltigera ponojensis*	Pale-bellied Pelt Lichen				S1S2	1	72.1 ± 0.0	NS
N	*Sticta limbata*	Powdered Moon Lichen				S1S2	2	72.9 ± 2.0	NS
N	*Barbilophozia lycopodioides*	Greater Pawwort				S1S3	1	99.1 ± 0.0	NS
N	*Peltigera neckeri*	Black-saddle Pelt Lichen				S1S3	2	13.0 ± 0.0	NS
N	*Nephroma resupinatum*	a lichen				S2	1	23.9 ± 0.0	NS
N	*Riccardia multifida*	Delicate Germanderwort				S2?	1	63.3 ± 0.0	NS
N	*Anacamptodon splachnoides*	a Moss				S2?	1	34.1 ± 0.0	NS
N	*Anomodon viticulosus*	a Moss				S2?	1	59.6 ± 0.0	NS
N	*Atrichum angustatum*	Lesser Smoothcap Moss				S2?	1	11.4 ± 3.0	NS
N	*Drepanocladus polygamus*	Polygamous Hook Moss				S2?	2	85.1 ± 0.0	NS
N	*Pseudocampylium radicale*	Long-stalked Fine Wet Moss				S2?	1	58.1 ± 0.0	NS
N	*Dicranum condensatum*	Condensed Broom Moss				S2?	2	79.1 ± 0.0	PE
N	*Ditrichum rhynchostegium*	a Moss				S2?	1	83.3 ± 0.0	PE
N	*Fissidens taxifolius*	Yew-leaved Pocket Moss				S2?	3	59.5 ± 0.0	NS
N	*Philonotis marchica*	a Moss				S2?	2	91.7 ± 0.0	PE
N	*Platydictya jungermannioides*	False Willow Moss				S2?	3	3.0 ± 0.0	NS
N	*Pohlia sphagnicola*	a moss				S2?	2	64.7 ± 0.0	PE
N	*Scorpidium scorpioides*	Hooked Scorpion Moss				S2?	11	58.0 ± 0.0	NS
N	*Sphagnum subnitens*	Lustrous Peat Moss				S2?	2	93.7 ± 0.0	NS
N	*Tetraplodon angustatus*	Toothed-leaved Nitrogen Moss				S2?	2	41.8 ± 0.0	NS

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N	*Tortella fragilis*	Fragile Twisted Moss				S2?	3	77.9 ± 0.0	NS
N	*Scytinium teretiusculum*	Curly Jellyskin Lichen				S2?	13	3.3 ± 0.0	NS
N	*Cladonia labradorica*	Labrador Lichen				S2?	1	46.5 ± 0.0	NS
N	*Rostania occultata*	Crusted Tarpaper Lichen				S2?	4	49.2 ± 0.0	NS
N	*Scytinium imbricatum*	Scaly Jellyskin Lichen				S2?	1	65.3 ± 0.0	NS
N	*Nephroma arcticum*	Arctic Kidney Lichen				S2?	2	95.4 ± 0.0	NS
N	*Peltigera collina*	Tree Pelt Lichen				S2?	64	40.7 ± 0.0	NS
N	*Ephemerum serratum*	a Moss				S2S3	1	79.1 ± 3.0	NS
N	*Tetraplodon mnioides*	Entire-leaved Nitrogen Moss				S2S3	1	80.0 ± 0.0	NS
N	*Scorpidium revolvens*	Limprichtia Moss				S2S3	6	62.2 ± 0.0	NS
N	*Collema leptaleum*	Crumpled Bat's Wing Lichen				S2S3	83	19.7 ± 0.0	NS
N	*Solorina saccata*	Woodland Owl Lichen				S2S3	6	16.1 ± 0.0	NS
N	*Ahtiana aurescens*	Eastern Candlewax Lichen				S2S3	5	47.2 ± 6.0	NS
N	*Usnocetraria oakesiana*	Yellow Band Lichen				S2S3	1	87.1 ± 0.0	PE
N	*Cetraria muricata*	Spiny Heath Lichen				S2S3	2	58.6 ± 1.0	NS
N	*Cladonia incrassata*	Powder-foot British Soldiers Lichen				S2S3	1	69.2 ± 0.0	NS
N	*Scytinium tenuissimum*	Birdnest Jellyskin Lichen				S2S3	13	2.8 ± 0.0	NS
N	*Melanohalea septentrionalis*	Northern Camouflage Lichen				S2S3	1	82.8 ± 0.0	PE
N	*Parmelia fertilis*	Fertile Shield Lichen				S2S3	6	48.8 ± 0.0	NS
N	*Parmeliopsis ambigua*	Green Starburst Lichen				S2S3	3	65.2 ± 1.0	NS
N	*Usnea mutabilis*	Bloody Beard Lichen				S2S3	1	54.7 ± 0.0	NS
N	*Usnea rubicunda*	Red Beard Lichen				S2S3	3	59.8 ± 0.0	NS
N	*Stereocaulon condensatum*	Granular Soil Foam Lichen				S2S3	7	30.0 ± 0.0	NS
N	*Cladonia coccifera*	Eastern Boreal Pixie-cup Lichen				S2S3	4	69.2 ± 0.0	NS
N	*Cladonia deformis*	Lesser Sulphur-cup Lichen				S2S3	1	88.7 ± 0.0	PE
N	*Ramalina thrausta*	Angelhair Ramalina Lichen				S3	11	26.5 ± 0.0	NS
N	*Enchylium tenax*	Soil Tarpaper Lichen				S3	3	18.5 ± 0.0	NS
N	*Collema nigrescens*	Blistered Tarpaper Lichen				S3	4	80.3 ± 0.0	NS
N	*Sticta fuliginosa*	Peppered Moon Lichen				S3	19	48.7 ± 0.0	NS
N	*Scytinium subtile*	Appressed Jellyskin Lichen				S3	21	13.6 ± 0.0	NS
N	*Fuscopannaria ahlneri*	Corrugated Shingles Lichen				S3	57	41.5 ± 0.0	NS
N	*Heterodermia speciosa*	Powdered Fringe Lichen				S3	16	48.8 ± 0.0	NS
N	*Heterodermia squamulosa*	Scaly Fringe Lichen				S3	6	75.6 ± 0.0	NS
N	*Leptogium corticola*	Blistered Jellyskin Lichen				S3	19	70.1 ± 0.0	NS
N	*Scytinium lichenoides*	Tattered Jellyskin Lichen				S3	12	3.4 ± 0.0	NS
N	*Nephroma bellum*	Naked Kidney Lichen				S3	9	23.8 ± 0.0	NS
N	*Placynthium nigrum*	Common Ink Lichen				S3	3	72.3 ± 10.0	NS
N	*Platismatia norvegica*	Oldgrowth Rag Lichen				S3	3	43.1 ± 0.0	NS
N	*Moelleropsis nebulosa ssp. frullaniae*	Blue-gray Moss Shingle Lichen				S3	1	72.6 ± 0.0	NS
N	*Moelleropsis nebulosa*	Blue-gray Moss Shingle Lichen				S3	33	46.5 ± 0.0	NS
N	*Fuscopannaria sorediata*	a Lichen				S3	9	48.1 ± 0.0	NS
N	*Ephebe lanata*	Waterside Rockshag Lichen				S3	2	41.6 ± 0.0	NS
N	*Barbula convoluta*	Lesser Bird's-claw Beard Moss				S3?	1	74.9 ± 0.0	PE
N	*Calliergon giganteum*	Giant Spear Moss				S3?	4	79.8 ± 0.0	NS
N	*Anomodon tristis*	a Moss				S3?	1	79.3 ± 0.0	NS
N	*Elodium blandowii*	Blandow's Bog Moss				S3?	2	85.9 ± 3.0	NS
N	*Phaeophyscia pusilloides*	Pompom-tipped Shadow Lichen				S3?	9	26.6 ± 0.0	NS
N	*Cladonia stygia*	Black-footed Reindeer Lichen				S3?	2	78.8 ± 0.0	NS
N	*Dicranella varia*	a Moss				S3S4	4	54.4 ± 0.0	NS
N	*Dicranum leioneuron*	a Dicranum Moss				S3S4	2	67.8 ± 0.0	NS
N	*Encalypta procera*	Slender Extinguisher Moss				S3S4	6	4.3 ± 0.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
N	*Sphagnum lindbergii*	Lindberg's Peat Moss				S3S4	4	72.4 ± 0.0	NS
N	*Splachnum ampullaceum*	Cruet Dung Moss				S3S4	2	81.6 ± 0.0	NS
N	*Thamnobryum alleghaniense*	a Moss				S3S4	25	96.5 ± 0.0	NS
N	*Schistidium agassizii*	Elf Bloom Moss				S3S4	1	60.1 ± 3.0	NS
N	*Hylocomiastrum pyrenaicum*	a Feather Moss				S3S4	1	79.1 ± 3.0	NS
N	*Arctoparmelia incurva*	Finger Ring Lichen				S3S4	4	81.3 ± 0.0	NS
N	*Hypogymnia vittata*	Slender Monk's Hood Lichen				S3S4	225	37.4 ± 0.0	NS
N	*Leptogium acadiense*	Acadian Jellyskin Lichen				S3S4	31	26.6 ± 0.0	NS
N	*Cladonia floerkeana*	Gritty British Soldiers Lichen				S3S4	1	93.9 ± 0.0	NS
N	*Vahliella leucophaea*	Shelter Shingle Lichen				S3S4	22	28.0 ± 0.0	NS
N	*Melanohalea olivacea*	Spotted Camouflage Lichen				S3S4	3	44.0 ± 0.0	NS
N	*Parmeliopsis hyperopta*	Gray Starburst Lichen				S3S4	5	65.3 ± 0.0	NS
N	*Parmotrema perlatum*	Powdered Ruffle Lichen				S3S4	1	75.8 ± 0.0	NS
N	*Peltigera hymenina*	Cloudy Pelt Lichen				S3S4	2	50.6 ± 0.0	NS
N	*Physconia detersa*	Bottlebrush Frost Lichen				S3S4	7	49.2 ± 0.0	NS
N	*Sphaerophorus fragilis*	Fragile Coral Lichen				S3S4	1	82.2 ± 0.0	NS
N	*Coccocarpia palmicola*	Salted Shell Lichen				S3S4	592	40.9 ± 0.0	NS
N	*Physcia tenella*	Fringed Rosette Lichen				S3S4	3	81.1 ± 3.0	NS
N	*Anaptychia palmulata*	Shaggy Fringed Lichen				S3S4	54	27.9 ± 0.0	NS
N	*Bryoria pikei*	Pike's Horsehair Lichen				S3S4	7	83.0 ± 0.0	PE
N	*Evernia prunastri*	Valley Oakmoss Lichen				S3S4	14	2.9 ± 0.0	NS
N	*Dermatocarpon luridum*	Brookside Stippleback Lichen				S3S4	9	21.4 ± 0.0	NS
N	*Heterodermia neglecta*	Fringe Lichen				S3S4	54	41.2 ± 0.0	NS
P	*Fraxinus nigra*	Black Ash	Threatened		Threatened	S1S2	163	5.1 ± 0.0	NS
P	*Bartonia paniculata ssp. paniculata*	Branched Bartonia	Threatened	Threatened		SNA	1	90.3 ± 10.0	NS
P	*Juncus caesariensis*	New Jersey Rush	Special Concern	Special Concern	Vulnerable	S2	63	91.2 ± 0.0	NS
P	*Floerkea proserpinacoides*	False Mermaidweed	Not At Risk			S2	19	12.0 ± 1.0	NS
P	*Salix candida*	Sage Willow			Endangered	S1	47	67.6 ± 0.0	NS
P	*Thuja occidentalis*	Eastern White Cedar			Vulnerable	S1	5	9.6 ± 0.0	NS
P	*Sanicula odorata*	Clustered Sanicle				S1	8	58.3 ± 0.0	NS
P	*Zizia aurea*	Golden Alexanders				S1	21	8.3 ± 0.0	NS
P	*Antennaria parlinii ssp. fallax*	Parlin's Pussytoes				S1	1	87.1 ± 0.0	NS
P	*Arnica lonchophylla*	Northern Arnica				S1	1	68.2 ± 7.0	NS
P	*Bidens hyperborea*	Estuary Beggarticks				S1	2	4.6 ± 1.0	NS
P	*Ageratina altissima*	White Snakeroot				S1	2	2.6 ± 1.0	NS
P	*Cardamine dentata*	Toothed Bittercress				S1	4	59.8 ± 0.0	NS
P	*Cochlearia tridactylites*	Limestone Scurvy-grass				S1	12	70.5 ± 0.0	NS
P	*Stellaria crassifolia*	Fleshy Stitchwort				S1	2	65.7 ± 2.0	NS
P	*Hudsonia tomentosa*	Woolly Beach-heath				S1	12	7.2 ± 1.0	NS
P	*Desmodium canadense*	Canada Tick-trefoil				S1	10	63.0 ± 0.0	NS
P	*Fraxinus pennsylvanica*	Red Ash				S1	2	74.6 ± 0.0	PE
P	*Bistorta vivipara*	Alpine Bistort				S1	1	77.7 ± 1.0	NS
P	*Montia fontana*	Water Blinks				S1	2	41.7 ± 1.0	NS
P	*Agalinis purpurea var. parviflora*	Small-flowered Purple False Foxglove				S1	2	59.2 ± 0.0	NS
P	*Scrophularia lanceolata*	Lance-leaved Figwort				S1	1	41.0 ± 1.0	NS
P	*Pilea pumila*	Dwarf Clearweed				S1	7	45.0 ± 6.0	NS
P	*Carex alopecoidea*	Foxtail Sedge				S1	2	9.3 ± 0.0	NS
P	*Carex garberi*	Garber's Sedge				S1	1	96.3 ± 0.0	NS
P	*Carex granularis*	Limestone Meadow Sedge				S1	21	60.0 ± 0.0	NS
P	*Carex gynocrates*	Northern Bog Sedge				S1	16	58.1 ± 0.0	NS
P	*Carex haydenii*	Hayden's Sedge				S1	3	27.5 ± 5.0	NS
P	*Carex pellita*	Woolly Sedge				S1	8	62.9 ± 0.0	NS
P	*Carex plantaginea*	Plantain-Leaved Sedge				S1	2	87.5 ± 0.0	NS
P	*Carex tenuiflora*	Sparse-Flowered Sedge				S1	3	69.4 ± 1.0	NS
P	*Carex tincta*	Tinged Sedge				S1	1	9.3 ± 1.0	NS

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P	*Carex viridula var. elatior*	Greenish Sedge				S1	54	58.1 ± 0.0	NS
P	*Carex grisea*	Inflated Narrow-leaved Sedge				S1	6	9.5 ± 0.0	NS
P	*Cyperus lupulinus ssp. macilentus*	Hop Flatsedge				S1	15	1.3 ± 0.0	NS
P	*Eleocharis erythropoda*	Red-stemmed Spikerush				S1	2	70.3 ± 0.0	NS
P	*Rhynchospora capillacea*	Slender Beakrush				S1	8	62.8 ± 1.0	NS
P	*Scirpus atrovirens*	Dark-green Bulrush				S1	1	69.3 ± 0.0	NS
P	*Iris prismatica*	Slender Blue Flag				S1	3	42.8 ± 1.0	NS
P	*Luzula spicata*	Spiked Woodrush				S1	1	9.5 ± 0.0	NS
P	*Allium tricoccum*	Wild Leek				S1	8	95.3 ± 0.0	NS
P	*Triantha glutinosa*	Sticky False-Asphodel				S1	14	67.6 ± 0.0	NS
P	*Malaxis monophyllos var. brachypoda*	North American White Adder's-mouth				S1	1	31.7 ± 7.0	NS
P	*Bromus latiglumis*	Broad-Glumed Brome				S1	15	46.6 ± 0.0	NS
P	*Calamagrostis stricta ssp. inexpansa*	Slim-stemmed Reed Grass				S1	1	91.3 ± 0.0	NS
P	*Elymus wiegandii*	Wiegand's Wild Rye				S1	14	46.9 ± 0.0	NS
P	*Elymus hystrix*	Spreading Wild Rye				S1	1	62.2 ± 1.0	NS
P	*Potamogeton nodosus*	Long-leaved Pondweed				S1	1	76.7 ± 5.0	NS
P	*Sparganium androcladum*	Branching Bur-Reed				S1	3	79.1 ± 1.0	NS
P	*Dryopteris goldiana*	Goldie's Woodfern				S1	1	98.1 ± 0.0	NS
P	*Equisetum palustre*	Marsh Horsetail				S1	8	52.1 ± 0.0	NS
P	*Solidago hispida*	Hairy Goldenrod				S1?	1	75.4 ± 7.0	NS
P	*Carex rostrata*	Narrow-leaved Beaked Sedge				S1?	1	90.1 ± 5.0	PE
P	*Bolboschoenus robustus*	Sturdy Bulrush				S1?	2	98.7 ± 5.0	NS
P	*Dichanthelium lindheimeri*	Lindheimer's Panicgrass				S1?	1	57.8 ± 0.0	NS
P	*Rudbeckia laciniata*	Cut-Leaved Coneflower				S1S2	10	5.1 ± 7.0	NS
P	*Betula minor*	Dwarf White Birch				S1S2	1	64.3 ± 0.0	NS
P	*Cornus suecica*	Swedish Bunchberry				S1S2	2	79.5 ± 0.0	NS
P	*Anemone virginiana var. alba*	Virginia Anemone				S1S2	6	58.5 ± 0.0	NS
P	*Hepatica americana*	Round-lobed Hepatica				S1S2	1	84.9 ± 0.0	NS
P	*Ranunculus sceleratus*	Cursed Buttercup				S1S2	1	87.4 ± 7.0	NS
P	*Parnassia parviflora*	Small-flowered Grass-of-Parnassus				S1S2	11	23.5 ± 1.0	NS
P	*Carex livida*	Livid Sedge				S1S2	23	10.0 ± 0.0	NS
P	*Juncus greenei*	Greene's Rush				S1S2	1	7.1 ± 1.0	NS
P	*Juncus alpinoarticulatus ssp. americanus*	Northern Green Rush				S1S2	12	48.4 ± 0.0	NS
P	*Platanthera huronensis*	Fragrant Green Orchid				S1S2	3	26.4 ± 10.0	NS
P	*Calamagrostis stricta ssp. stricta*	Slim-stemmed Reed Grass				S1S2	4	85.9 ± 0.0	PE
P	*Cinna arundinacea*	Sweet Wood Reed Grass				S1S2	24	46.2 ± 0.0	NS
P	*Sparganium hyperboreum*	Northern Burreed				S1S2	4	57.9 ± 1.0	NS
P	*Cryptogramma stelleri*	Steller's Rockbrake				S1S2	17	59.0 ± 0.0	NS
P	*Selaginella selaginoides*	Low Spikemoss				S1S2	2	86.4 ± 0.0	NS
P	*Carex vacillans*	Estuarine Sedge				S1S3	3	9.3 ± 0.0	NS
P	*Conioselinum chinense*	Chinese Hemlock-parsley				S2	1	81.0 ± 5.0	NS
P	*Osmorhiza longistylis*	Smooth Sweet Cicely				S2	26	20.1 ± 0.0	NS
P	*Erigeron philadelphicus*	Philadelphia Fleabane				S2	9	12.8 ± 7.0	NS
P	*Symphyotrichum ciliolatum*	Fringed Blue Aster				S2	3	36.7 ± 7.0	NS
P	*Impatiens pallida*	Pale Jewelweed				S2	24	5.7 ± 7.0	NS
P	*Caulophyllum thalictroides*	Blue Cohosh				S2	46	18.1 ± 0.0	NS
P	*Draba arabisans*	Rock Whitlow-Grass				S2	3	65.1 ± 1.0	NS
P	*Lobelia kalmii*	Brook Lobelia				S2	89	48.3 ± 0.0	NS
P	*Stellaria humifusa*	Saltmarsh Starwort				S2	7	74.1 ± 0.0	NS

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P	*Stellaria longifolia*	Long-leaved Starwort				S2	4	46.6 ± 0.0	NS
P	*Oxybasis rubra*	Red Goosefoot				S2	4	5.7 ± 7.0	NS
P	*Hudsonia ericoides*	Pinebarren Golden Heather				S2	10	79.0 ± 1.0	PE
P	*Hypericum majus*	Large St John's-wort				S2	4	86.7 ± 1.0	NS
P	*Crassula aquatica*	Water Pygmyweed				S2	2	78.2 ± 7.0	NS
P	*Myriophyllum farwellii*	Farwell's Water Milfoil				S2	4	28.5 ± 7.0	NS
P	*Myriophyllum verticillatum*	Whorled Water Milfoil				S2	4	79.4 ± 0.0	NS
P	*Oenothera fruticosa ssp. tetragona*	Narrow-leaved Evening Primrose				S2	3	62.2 ± 7.0	NS
P	*Persicaria arifolia*	Halberd-leaved Tearthumb				S2	12	22.2 ± 0.0	NS
P	*Rumex triangulivalvis*	Triangular-valve Dock				S2	4	48.4 ± 10.0	NS
P	*Primula mistassinica*	Mistassini Primrose				S2	1	93.3 ± 7.0	NS
P	*Anemonastrum canadense*	Canada Anemone				S2	2	24.9 ± 1.0	NS
P	*Anemone quinquefolia*	Wood Anemone				S2	14	51.2 ± 0.0	NS
P	*Anemone virginiana*	Virginia Anemone				S2	31	2.9 ± 0.0	NS
P	*Caltha palustris*	Yellow Marsh Marigold				S2	58	15.4 ± 0.0	NS
P	*Galium labradoricum*	Labrador Bedstraw				S2	91	54.7 ± 0.0	NS
P	*Salix pedicellaris*	Bog Willow				S2	13	56.2 ± 0.0	NS
P	*Salix sericea*	Silky Willow				S2	1	97.0 ± 0.0	NS
P	*Comandra umbellata*	Bastard's Toadflax				S2	33	5.9 ± 0.0	NS
P	*Saxifraga paniculata ssp. laestadii*	Laestadius' Saxifrage				S2	1	59.7 ± 7.0	NS
P	*Tiarella cordifolia*	Heart-leaved Foamflower				S2	211	51.2 ± 3.0	NS
P	*Viola nephrophylla*	Northern Bog Violet				S2	13	47.1 ± 0.0	NS
P	*Carex bebbii*	Bebb's Sedge				S2	29	14.8 ± 10.0	NS
P	*Carex castanea*	Chestnut Sedge				S2	15	62.1 ± 0.0	NS
P	*Carex comosa*	Bearded Sedge				S2	4	75.5 ± 0.0	PE
P	*Carex hystericina*	Porcupine Sedge				S2	34	9.1 ± 0.0	NS
P	*Carex tenera*	Tender Sedge				S2	5	24.5 ± 1.0	NS
P	*Carex tuckermanii*	Tuckerman's Sedge				S2	1	73.5 ± 0.0	NS
P	*Carex atratiformis*	Scabrous Black Sedge				S2	2	65.5 ± 1.0	NS
P	*Eleocharis quinqueflora*	Few-flowered Spikerush				S2	23	48.7 ± 0.0	NS
P	*Juncus stygius ssp. americanus*	Moor Rush				S2	28	81.1 ± 7.0	NS
P	*Allium schoenoprasum*	Wild Chives				S2	1	65.2 ± 3.0	NS
P	*Allium schoenoprasum var. sibiricum*	Wild Chives				S2	1	69.6 ± 7.0	NS
P	*Lilium canadense*	Canada Lily				S2	70	13.2 ± 1.0	NS
P	*Cypripedium parviflorum var. pubescens*	Yellow Lady's-slipper				S2	39	8.9 ± 0.0	NS
P	*Cypripedium parviflorum var. makasin*	Small Yellow Lady's-Slipper				S2	14	35.7 ± 0.0	NS
P	*Cypripedium reginae*	Showy Lady's-Slipper				S2	378	27.9 ± 0.0	NS
P	*Platanthera flava var. herbiola*	Pale Green Orchid				S2	9	39.8 ± 1.0	NS
P	*Platanthera macrophylla*	Large Round-Leaved Orchid				S2	8	88.8 ± 5.0	NS
P	*Spiranthes lucida*	Shining Ladies'-Tresses				S2	41	21.6 ± 1.0	NS
P	*Calamagrostis stricta*	Slim-stemmed Reed Grass				S2	7	86.1 ± 0.0	PE
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S2	1	63.6 ± 7.0	NS
P	*Potamogeton friesii*	Fries' Pondweed				S2	17	46.9 ± 0.0	NS
P	*Potamogeton richardsonii*	Richardson's Pondweed				S2	10	45.7 ± 1.0	NS
P	*Cystopteris laurentiana*	Laurentian Bladder Fern				S2	6	65.3 ± 1.0	NS
P	*Dryopteris fragrans*	Fragrant Wood Fern				S2	3	40.8 ± 7.0	NS
P	*Polystichum lonchitis*	Northern Holly Fern				S2	5	51.9 ± 100.0	NS
P	*Woodsia glabella*	Smooth Cliff Fern				S2	3	65.3 ± 0.0	NS
P	*Symphyotrichum boreale*	Boreal Aster				S2?	97	58.0 ± 0.0	NS
P	*Cuscuta cephalanthi*	Buttonbush Dodder				S2?	7	2.7 ± 0.0	NS
P	*Epilobium coloratum*	Purple-veined Willowherb				S2?	8	2.5 ± 0.0	NS

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P	*Rumex persicarioides*	Peach-leaved Dock				S2?	1	88.1 ± 0.0	NS
P	*Crataegus submollis*	Quebec Hawthorn				S2?	2	22.4 ± 7.0	NS
P	*Eleocharis ovata*	Ovate Spikerush				S2?	3	40.6 ± 0.0	NS
P	*Scirpus pedicellatus*	Stalked Bulrush				S2?	6	46.5 ± 0.0	NS
P	*Hieracium robinsonii*	Robinson's Hawkweed				S2S3	1	92.8 ± 7.0	NS
P	*Senecio pseudoarnica*	Seabeach Ragwort				S2S3	9	41.7 ± 1.0	NS
P	*Betula michauxii*	Michaux's Dwarf Birch				S2S3	19	59.8 ± 0.0	NS
P	*Sagina nodosa*	Knotted Pearlwort				S2S3	3	74.7 ± 1.0	NS
P	*Sagina nodosa ssp. borealis*	Knotted Pearlwort				S2S3	1	81.3 ± 5.0	PE
P	*Ceratophyllum echinatum*	Prickly Hornwort				S2S3	1	98.6 ± 0.0	PE
P	*Hypericum x dissimulatum*	Disguised St. John's-wort				S2S3	1	46.6 ± 1.0	NS
P	*Triosteum aurantiacum*	Orange-fruited Tinker's Weed				S2S3	178	8.7 ± 0.0	NS
P	*Shepherdia canadensis*	Soapberry				S2S3	38	48.2 ± 0.0	NS
P	*Empetrum atropurpureum*	Purple Crowberry				S2S3	2	79.6 ± 3.0	NS
P	*Euphorbia polygonifolia*	Seaside Spurge				S2S3	14	0.5 ± 0.0	NS
P	*Halenia deflexa*	Spurred Gentian				S2S3	23	37.1 ± 0.0	NS
P	*Hedeoma pulegioides*	American False Pennyroyal				S2S3	2	18.8 ± 5.0	NS
P	*Polygonum aviculare ssp. buxiforme*	Box Knotweed				S2S3	1	59.6 ± 0.0	NS
P	*Polygonum oxyspermum ssp. raii*	Ray's Knotweed				S2S3	11	37.2 ± 3.0	NS
P	*Amelanchier fernaldii*	Fernald's Serviceberry				S2S3	5	64.7 ± 1.0	NS
P	*Potentilla canadensis*	Canada Cinquefoil				S2S3	1	58.1 ± 2.0	NS
P	*Galium aparine*	Common Bedstraw				S2S3	3	9.3 ± 0.0	NS
P	*Salix pellita*	Satiny Willow				S2S3	4	41.4 ± 1.0	NS
P	*Carex adusta*	Lesser Brown Sedge				S2S3	1	76.4 ± 5.0	NS
P	*Carex hirtifolia*	Pubescent Sedge				S2S3	28	20.6 ± 0.0	NS
P	*Eleocharis flavescens var. olivacea*	Bright-green Spikerush				S2S3	3	10.7 ± 5.0	NS
P	*Eriophorum gracile*	Slender Cottongrass				S2S3	9	55.9 ± 0.0	NS
P	*Oreojuncus trifidus*	Highland Rush				S2S3	2	80.0 ± 0.0	NS
P	*Cypripedium parviflorum*	Yellow Lady's-slipper				S2S3	93	3.0 ± 0.0	NS
P	*Poa glauca*	Glaucous Blue Grass				S2S3	9	65.2 ± 1.0	NS
P	*Stuckenia filiformis*	Thread-leaved Pondweed				S2S3	53	49.9 ± 0.0	NS
P	*Botrychium lanceolatum ssp. angustisegmentum*	Narrow Triangle Moonwort				S2S3	13	51.3 ± 3.0	NS
P	*Botrychium simplex*	Least Moonwort				S2S3	3	19.0 ± 1.0	NS
P	*Ophioglossum pusillum*	Northern Adder's-tongue				S2S3	1	92.1 ± 0.0	NS
P	*Angelica atropurpurea*	Purple-stemmed Angelica				S3	29	46.5 ± 0.0	NS
P	*Erigeron hyssopifolius*	Hyssop-leaved Fleabane				S3	48	9.1 ± 0.0	NS
P	*Hieracium paniculatum*	Panicled Hawkweed				S3	6	89.3 ± 0.0	NS
P	*Bidens beckii*	Water Beggarticks				S3	9	20.3 ± 0.0	NS
P	*Packera paupercula*	Balsam Groundsel				S3	125	3.0 ± 0.0	NS
P	*Betula pumila var. pumila*	Bog Birch				S3	1	66.1 ± 7.0	NS
P	*Betula pumila*	Bog Birch				S3	31	57.5 ± 0.0	NS
P	*Campanula aparinoides*	Marsh Bellflower				S3	19	26.9 ± 0.0	NS
P	*Viburnum edule*	Squashberry				S3	2	85.3 ± 0.0	NS
P	*Empetrum eamesii*	Pink Crowberry				S3	4	79.0 ± 0.0	PE
P	*Vaccinium boreale*	Northern Blueberry				S3	8	59.7 ± 7.0	NS
P	*Vaccinium cespitosum*	Dwarf Bilberry				S3	46	50.2 ± 0.0	NS
P	*Bartonia virginica*	Yellow Bartonia				S3	1	78.6 ± 0.0	NS
P	*Proserpinaca palustris*	Marsh Mermaidweed				S3	50	15.4 ± 0.0	NS
P	*Proserpinaca pectinata*	Comb-leaved Mermaidweed				S3	2	83.9 ± 1.0	NS
P	*Teucrium canadense*	Canada Germander				S3	69	0.6 ± 0.0	NS
P	*Decodon verticillatus*	Swamp Loosestrife				S3	5	66.1 ± 7.0	NS
P	*Epilobium hornemannii*	Hornemann's Willowherb				S3	2	95.1 ± 7.0	NS
P	*Epilobium strictum*	Downy Willowherb				S3	58	23.9 ± 0.0	NS

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P	*Polygala sanguinea*	Blood Milkwort				S3	6	50.2 ± 0.0	NS
P	*Persicaria pensylvanica*	Pennsylvania Smartweed				S3	17	5.7 ± 2.0	NS
P	*Fallopia scandens*	Climbing False Buckwheat				S3	26	5.1 ± 7.0	NS
P	*Plantago rugelii*	Rugel's Plantain				S3	2	68.1 ± 0.0	NS
P	*Samolus parviflorus*	Seaside Brookweed				S3	31	9.0 ± 0.0	NS
P	*Pyrola asarifolia*	Pink Pyrola				S3	14	53.0 ± 0.0	NS
P	*Pyrola minor*	Lesser Pyrola				S3	6	67.6 ± 10.0	NS
P	*Ranunculus gmelinii*	Gmelin's Water Buttercup				S3	126	3.0 ± 0.0	NS
P	*Endotropis alnifolia*	alder-leaved buckthorn				S3	566	18.1 ± 0.0	NS
P	*Agrimonia gryposepala*	Hooked Agrimony				S3	250	2.8 ± 0.0	NS
P	*Amelanchier spicata*	Running Serviceberry				S3	9	20.0 ± 5.0	NS
P	*Galium kamtschaticum*	Northern Wild Licorice				S3	9	60.8 ± 1.0	NS
P	*Geocaulon lividum*	Northern Comandra				S3	76	37.4 ± 2.0	NS
P	*Limosella australis*	Southern Mudwort				S3	11	62.0 ± 0.0	PE
P	*Lindernia dubia*	Yellow-seeded False Pimperel				S3	24	23.1 ± 0.0	NS
P	*Laportea canadensis*	Canada Wood Nettle				S3	28	20.2 ± 0.0	NS
P	*Verbena hastata*	Blue Vervain				S3	62	9.3 ± 0.0	NS
P	*Carex cryptolepis*	Hidden-scaled Sedge				S3	12	23.4 ± 1.0	NS
P	*Carex eburnea*	Bristle-leaved Sedge				S3	103	3.0 ± 0.0	NS
P	*Carex lupulina*	Hop Sedge				S3	12	3.1 ± 0.0	NS
P	*Carex rosea*	Rosy Sedge				S3	10	21.4 ± 0.0	NS
P	*Carex tribuloides*	Blunt Broom Sedge				S3	14	22.2 ± 0.0	NS
P	*Carex wiegandii*	Wiegand's Sedge				S3	3	45.2 ± 0.0	NS
P	*Carex foenea*	Fernald's Hay Sedge				S3	2	28.8 ± 0.0	NS
P	*Schoenoplectus americanus*	Olney's Bulrush				S3	1	9.5 ± 0.0	NS
P	*Elodea canadensis*	Canada Waterweed				S3	9	73.4 ± 0.0	NS
P	*Juncus subcaudatus*	Woods-Rush				S3	5	51.3 ± 0.0	NS
P	*Juncus dudleyi*	Dudley's Rush				S3	94	48.3 ± 0.0	NS
P	*Goodyera oblongifolia*	Menzies' Rattlesnake-plantain				S3	6	81.1 ± 10.0	NS
P	*Goodyera repens*	Lesser Rattlesnake-plantain				S3	29	47.6 ± 0.0	NS
P	*Neottia bifolia*	Southern Twayblade				S3	51	42.6 ± 0.0	NS
P	*Platanthera grandiflora*	Large Purple Fringed Orchid				S3	101	4.8 ± 0.0	NS
P	*Platanthera hookeri*	Hooker's Orchid				S3	3	8.6 ± 0.0	NS
P	*Platanthera orbiculata*	Small Round-leaved Orchid				S3	30	27.5 ± 0.0	NS
P	*Spiranthes ochroleuca*	Yellow Ladies'-tresses				S3	17	59.0 ± 0.0	NS
P	*Alopecurus aequalis*	Short-awned Foxtail				S3	10	3.3 ± 0.0	NS
P	*Dichanthelium clandestinum*	Deer-tongue Panic Grass				S3	81	49.8 ± 0.0	NS
P	*Potamogeton obtusifolius*	Blunt-leaved Pondweed				S3	26	14.1 ± 1.0	NS
P	*Potamogeton praelongus*	White-stemmed Pondweed				S3	25	19.6 ± 1.0	NS
P	*Potamogeton zosteriformis*	Flat-stemmed Pondweed				S3	8	70.1 ± 0.0	NS
P	*Sparganium natans*	Small Burreed				S3	21	15.4 ± 0.0	NS
P	*Asplenium trichomanes*	Maidenhair Spleenwort				S3	4	39.9 ± 0.0	NS
P	*Asplenium viride*	Green Spleenwort				S3	20	38.1 ± 0.0	NS
P	*Equisetum pratense*	Meadow Horsetail				S3	20	49.2 ± 0.0	NS
P	*Equisetum variegatum*	Variegated Horsetail				S3	43	4.8 ± 0.0	NS
P	*Isoetes tuckermanii ssp. acadiensis*	Acadian Quillwort				S3	3	44.6 ± 0.0	NS
P	*Diphasiastrum sitchense*	Sitka Ground-cedar				S3	22	18.9 ± 1.0	NS
P	*Huperzia appressa*	Mountain Firmoss				S3	1	54.2 ± 1.0	NS
P	*Sceptridium dissectum*	Dissected Moonwort				S3	4	35.5 ± 1.0	NS
P	*Polypodium appalachianum*	Appalachian Polypody				S3	9	69.4 ± 0.0	NS
P	*Bidens vulgata*	Tall Beggarticks				S3?	1	62.9 ± 0.0	NS
P	*Persicaria amphibia var. emersa*	Long-root Smartweed				S3?	1	23.1 ± 0.0	NS
P	*Diphasiastrum x sabinifolium*	Savin-leaved Ground-cedar				S3?	10	25.8 ± 5.0	NS
P	*Atriplex glabriuscula var.*	Frankton's Saltbush				S3S4	5	43.9 ± 0.0	NS

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	# recs	Distance (km)	Prov
	franktonii								
P	*Suaeda calceoliformis*	Horned Sea-blite				S3S4	9	37.9 ± 0.0	NS
P	*Myriophyllum sibiricum*	Siberian Water Milfoil				S3S4	14	4.5 ± 0.0	NS
P	*Nuphar microphylla*	Small Yellow Pond-lily				S3S4	1	69.2 ± 2.0	NS
P	*Sanguinaria canadensis*	Bloodroot				S3S4	197	9.0 ± 0.0	NS
P	*Polygonum fowleri*	Fowler's Knotweed				S3S4	2	4.4 ± 0.0	NS
P	*Rumex fueginus*	Tierra del Fuego Dock				S3S4	6	59.7 ± 0.0	NS
P	*Fragaria vesca ssp. americana*	Woodland Strawberry				S3S4	57	2.8 ± 0.0	NS
P	*Fragaria vesca*	Woodland Strawberry				S3S4	1	69.3 ± 0.0	NS
P	*Salix petiolaris*	Meadow Willow				S3S4	8	56.2 ± 0.0	NS
P	*Agalinis neoscotica*	Nova Scotia Agalinis				S3S4	3	54.3 ± 0.0	NS
P	*Carex argyrantha*	Silvery-flowered Sedge				S3S4	2	70.2 ± 5.0	PE
P	*Eriophorum russeolum*	Russet Cottongrass				S3S4	5	29.9 ± 5.0	NS
P	*Triglochin gaspensis*	Gasp├⌐ Arrowgrass				S3S4	9	51.6 ± 0.0	NS
P	*Juncus acuminatus*	Sharp-Fruit Rush				S3S4	4	22.4 ± 0.0	NS
P	*Luzula parviflora ssp. melanocarpa*	Black-fruited Woodrush				S3S4	5	53.7 ± 0.0	NS
P	*Liparis loeselii*	Loesel's Twayblade				S3S4	19	41.9 ± 0.0	NS
P	*Panicum philadelphicum*	Philadelphia Panicgrass				S3S4	1	61.3 ± 0.0	NS
P	*Trisetum spicatum*	Narrow False Oats				S3S4	2	64.7 ± 0.0	NS
P	*Cystopteris bulbifera*	Bulblet Bladder Fern				S3S4	299	2.7 ± 0.0	NS
P	*Equisetum hyemale ssp. affine*	Common Scouring-rush				S3S4	42	3.7 ± 0.0	NS
P	*Equisetum scirpoides*	Dwarf Scouring-Rush				S3S4	67	48.2 ± 0.0	NS
P	*Diphasiastrum complanatum*	Northern Ground-cedar				S3S4	4	63.6 ± 9.0	NS
P	*Schizaea pusilla*	Little Curlygrass Fern				S3S4	11	45.2 ± 0.0	NS
P	*Viola canadensis*	Canada Violet				SH	1	59.1 ± 0.0	NS

5.1 SOURCE BIBLIOGRAPHY (100 km)

The recipient of these data shall acknowledge the AC CDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

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9	Knapton, R. & Power, T.; Williams, M. 2001. SAR Inventory: Fortress Louisbourg NP. Parks Canada, Atlantic, SARINV01-13. 157 recs.
9	Neily, T.H. Atlantic Canada Conservation Data Centre botanical fieldwork 2018. T.H. Neily, Atlantic Canada Conservation Data Centre.
9	Ogden, K. Nova Scotia Museum butterfly specimen database. Nova Scotia Museum. 2017.
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8	Belland, R.J. Maritimes moss records from various herbarium databases. 2014.
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8	NS DNR. 2017. Black Ash records from NS DNR Permanent Sample Plots (PSPs), 1965-2016. NS Dept of Natural Resources.
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7	Amirault, D.L. 1997-2000. Unpublished files. Canadian Wildlife Service, Sackville, 470 recs.
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6	Benjamin, L.K. 2009. Boreal Felt Lichen, Mountain Avens, Orchid and other recent records. Nova Scotia Dept Natural Resources, 105 recs.
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2	Gillis, J. 2007. Botanical observations from bog on Skye Mountain, NS. Pers. comm., 8 recs.
2	Hill, N. 2003. Floerkea proserpinacoides at Heatherdale, Antigonish Co. 2002. , Pers. comm. to C.S. Blaney. 2 recs.
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1	Anderson, D.G. 2011. New site for showy ladyslipper on Cape Breton. Nova Scotia Department of Natural Resources, pers.comm. to R. Lautenschlager, Jul 5, 2011.
1	Baechler, Lynn. 2016. Plant observations & photos, 2016. Pers. comm. to S. Blaney, May 2016, 2 recs.
1	Bagnell, B.A. 2001. New Brunswick Bryophyte Occurrences. B&B Botanical, Sussex, 478 recs.
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1	Christie, D.S. 2000. Christmas Bird Count Data, 1997-2000. Nature NB, 54 recs.
1	Clayden, S.R. 1998. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, 19759 recs.
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1	New York Botanical Garden. 2006. Virtual Plant Herbarium - Vascular Plant Types Catalog. Sylva, S.; Kallunki, J. (ed.) International Plant Science Centre, Web site: http://sciweb.nybg.org/science2/vii2.asp. 4 recs.
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1	Newell, R.E. 2001. Fortress Louisbourg Species at Risk Survey 2001. Parks Canada, 4 recs.
1	Oehlke, W. 1999. Record of Polygonia satyrus from Prince Edward Island. http://www.silkmoths.bizland.com/ppsatyr.htm.
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1	Webster, R.P. Atlantic Forestry Centre Insect Collection, Maritimes butterfly records. Natural Resources Canada. 2014.
1	White, S. 2019. Notable species sightings, 2018. East Coast Aquatics.
1	Whittam, R.M. 2000. Senecio pseudoarnica on Country Island. , Pers. comm. to S. Gerriets. 1 rec.
1	Zahavich, J.L. 2017. Locations of Round-leaved Orchid (Platanthera orbiculata) at Townshend Woodlot and Bird Island. Island Nature Trust, 2 records.

Appendix D: Endangered, Threatened, and Special Concern Bird Species within 5 km of Proposed Lease #1444

Endangered, Threatened, and Special Concern Bird Species within 5 km of Proposed Lease #1444

Common Name	**Scientific Name**	**COSEWIC**	**SARA**	**Provincial Legal Protection**	**Reported Distance (km)**
Piping Plover melodus spp.	*Charadrius melodus melodus*	Endangered	Endangered	Endangered	0.2 ± 0.0
Bank Swallow	*Riparia riparia*	Threatened	Threatened	Endangered	3.3 ± 0.0
Bobolink	*Dolichonyx oryzivorus*	Threatened	Threatened	N/A	2.4 ± 0.0
Olive-sided Flycatcher	*Contopus cooperi*	Special Concern	Threatened	Threatened	1.4 ± 0.0
Eastern wood-pewee	*Contopus virens*	Special Concern	Special Concern	Special Concern	2.7 ± 0.0

[1] Table data derived from the ACCDC data report (Appendix C)

Appendix E: High resolution imagery of Dunns Beach near proposed lease #1444