2022

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

Nova Scotia Aquaculture Review Board

Between:

TOWN POINT CONSULTING INC.

APPLICANT

- and -

MINISTER OF NOVA SCOTIA DEPARTMENT 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, ANTIGONSH 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 LIASION COMMITTEE

INTERVENOR GROUP THREE

Affidavit of Peter Cranford
Sworn on May 19, 2023

I, Peter Cranford, of [redacted] Saint Andrews, in the Province of New Brunswick affirm as follows:

1. I have personal knowledge of the evidence affirmed in this Affidavit except where otherwise stated to be based on information and belief.

2. 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.

3. I have been asked to review and provide an expert opinion regarding the impacts of the proposed Town Point Consulting Inc., aquaculture lease application for locations in Antigonish Harbour enumerated as AQ#1442, AQ#1443, and AQ#1444 ("the Application"), on the oceanographic and biophysical characteristics of the public waters surrounding the proposed aquaculture operation, including, without limitation, on marine plant and aquatic life and habitat, oyster viability and ecological and environmental issues arising or potentially arising in connection with the Application on behalf of the Intervenor Friends of Antigonish Harbour.

4. I have authored a report detailing my analysis and conclusions regarding the impacts of the proposal set out in the Application, on Antigonish Harbour ("**the Report**"), attached hereto as **Exhibit "A"**.

5. My qualifications as a subject matter expert on oceanographic and biophysical characteristics of ocean waters, including the impact of these characteristics and/or changes to these characteristics on fish habitat, oyster viability, ecology and environment are set out in my Curriculum Vitae attached to my Report at page 19.

6. Based on my education and experience my areas of expertise are aquaculture environment interactions, environmental monitoring and management, shellfish physiological ecology, benthic ecology, biological oceanography and environmental sensing.

7. The Report attached to this affidavit as **Exhibit "A"** represents my professional opinion with respect to the impacts of the proposed aquaculture operation as set out in the Application, on Antigonish Harbour.

8. I have also reviewed the Community Aquatic Monitoring Program data for the Southern Gulf of St. Lawrence Dataset, this dataset is publicly available and accessible via the Government of Canada Website https://open.canada.ca/data/en/dataset/c4474517-3d9b-e581-a6e2-e95273f2058e a copy of the website page is attached hereto as **Exhibit "B"**.

SWORN TO at Saint. Andrews, Province of New Brunswick, this 19 day of May 2023, before me:	))))))))	
David A. Bartlett K.C. Notary Public Province of New Brunswick		Peter Cranford

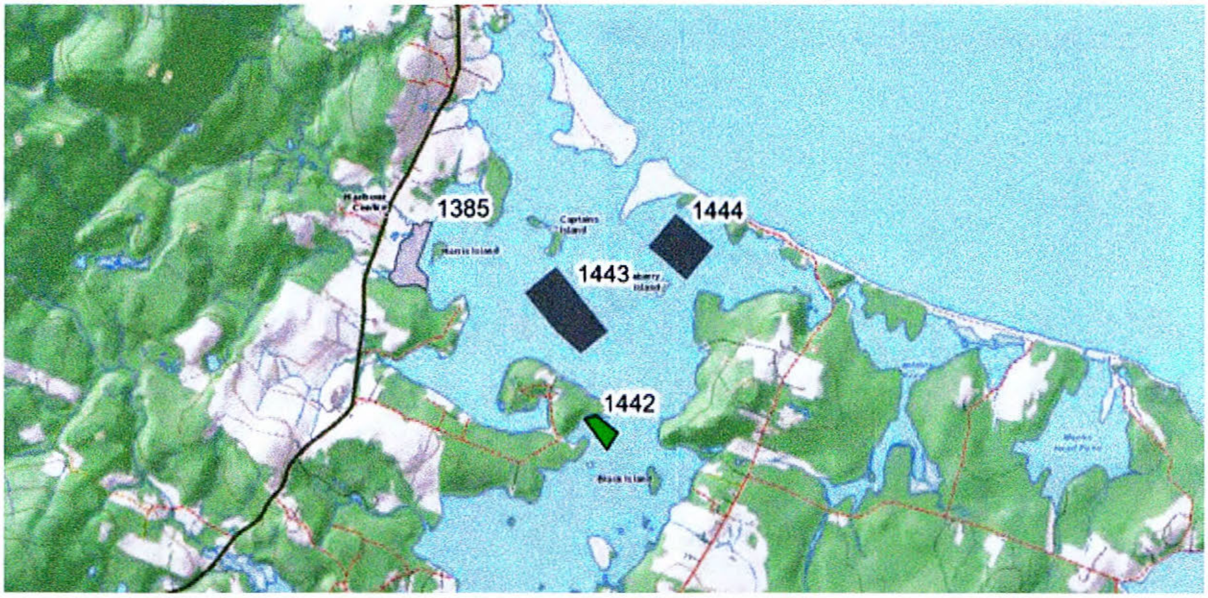
DAVID A. BARTLETT, K.C. NOTARY PUBLIC NEW BRUNSWICK

2022	NSUARB 2022-001 NSUARB 2022-002 NSUARB 2022-003

This is Exhibit "A" referred to in the Affidavit of Peter Cranford sworn to before me this 19th day of May 2023

David A. Bartlett, K.C.
Notary Public Province of New Brunswick

DAVID A. BARTLETT, K.C.
NOTARY PUBLIC
NEW BRUNSWICK



Oceanographic and Biophysical Characteristics of New Marine Aquaculture Lease Locations in Antigonish Harbour Proposed by Town Point Consulting Inc. (AQ#1442, 1443 and 1444):

Evidence Related to Project Suitability

Peter J. Cranford, B.Sc., Ph.D.

14 May, 2023

Emeritus Marine

[redacted] **St. Andrews, New Brunswick,** [redacted]

Contents

1. Statement of Substance

Key considerations are presented herein that are relevant to decisions related to the new marine aquaculture lease locations in Antigonish Harbour (AQ#1442, 1443 and 1444) proposed by Town Point Consulting Inc. New evidence is provided on the oceanographic and biophysical characteristics of the public waters surrounding the proposed aquaculture operation that contradicts information contained in the lease application. This new evidence supports a conclusion that the environmental conditions at these proposed lease locations are not optimal for oyster aquaculture in general and are unsuitable for the proposed oyster development in Antigonish Harbour. The operation also poses a threat to fish habitat, species, populations, communities, fisheries, and ecosystem function and there is a high likelihood that these ecological impacts will result if the development plan is approved. These impacts cannot be mitigated through known measures.

2. Introduction

Oyster aquaculture is often described as "green" culture because no feed is used in the husbandry process. However, even devoted promoters of shellfish culture recognize that not all coastal habitats are suitable for growing oysters and that adverse impacts can occur if the oceanographic and biophysical conditions are unfavourable (Shumway, 2011; McKindsey et al., 2011).

Predicting impacts from shellfish aquaculture is complex owing to the many pathways by which shellfish interact with the surrounding environment (Newell, 2004, Cranford et al., 2006). The capacity of the local environment to support shellfish production without leading to significant changes to ecological processes, species, populations, or communities can also differ markedly between aquaculture locations. Aquaculture site suitability depends on a wide array of site-specific factors including hydrographic characteristics, water depth, sediment type, natural biogeochemical conditions, and culture density (Burkholder and Shumway, 2011). A Canadian Science Advisory Secretariat (CSAS) process confirmed the scientific basis for the Aquaculture Pathways of Effects model (DFO, 2009), which identifies major stressors and potential effects from aquaculture. The potential effects from suspended oyster aquaculture include:

(a) the alteration, disruption or destruction of seabed habitat and communities resulting from physical alterations and/or the deposition and degradation of organic matter in feces and pseudofaeces (reviewed by Burkholder and Shumway, 2011; Cranford et al., 2020 and 2022),
(b) a change in food availability for resident biological communities resulting from the overgrazing of suspended phytoplankton, zooplankton and detritus by the stocked shellfish (reviewed by Cranford, 2019),
(c) a change in oxygen concentration in water and/or sediment from the increased Biological Oxygen Demand (BOD) of both the stocked shellfish and the degradation of organic matter in their biodeposits (DFO, 2019), and
(d) change in the health or abundance of wild fish populations/communities from all, or any of the above stressors (DFO, 2019).

The Antigonish Harbour oyster aquaculture application (referred to herein as the "application") concluded, based on limited site-specific data, that oceanographic and biophysical conditions at the proposed lease sites would counteract these types of environmental perturbations. Additional oceanographic and biophysical data were collected from within the proposed Town Point oyster leases (leases 1442, 1443 and 1444) towards providing an alternative, evidence-based assessment of project suitability. This new information relates solely to the proposed application and to considerations of; (1) the suitability of local oceanographic and biophysical conditions for oyster culture, (2) potential adverse effects on fish habitat and species, and (3) the optimum use of marine resources.

In addition to stating that the application sites would not cause negative impacts, the application claimed that positive environmental effects would result from the proposed aquaculture operation (cleaner water, net benefit to eelgrass beds, and help combat climate change). Supplemental information is presented herein that addresses these claims.

3. Oceanographic Conditions Around the Proposed Oyster Leases

Knowledge of the local hydrography is critically important for assessing the potential for environmental effects from oyster aquaculture and for determining the suitability of the region for growing oysters (Campbell and Hall, 2018). A consensus exists among most experts that significant oyster culture impacts are unlikely if tidal currents are sufficient to both supply the oysters with sufficient food particles and to disperse waste products over a large area (Burkholder and Shumway, 2011). For example, the Bay Management Framework for suspended oyster culture in New Brunswick, which was developed jointly by Transport Canada, Fisheries and Oceans Canada, Environment Canada, and the N.B. Department of Agriculture and Aquaculture, estimated that current velocities of 20 to 25 cm/s are required to disperse oyster deposits and limit the potential for adverse impacts from seabed organic enrichment (Transport Canada, 2007). This conclusion was recently verified by Gadeken et al. (2021) during a study of the transport of biodeposits from an oyster farm in Maine.

Section 1 of the application package addressed the importance of flow conditions for minimizing negative impacts associated with their proposal on page 13 with the following statement:

> *"Close proximity of the farm to the harbour entrance provides high tidal flow through the proposed sites. These sites experience flow rates of 19-22 cm/s through them which both carries the food supply to the farm and flushes the sites to prevent possible negative impacts from excess bio-deposition."*

Published estimates of the bay-wide flushing rate for Antigonish Harbour is less than 0.8 days (Gregory et al. 1993), indicating that tidal and freshwater flow rates are high, at least within the main channel of the Harbour. However, the proposed oyster lease sites are all located in shallow waters (< 2.5 m average depth) where current speeds may be expected to be relatively low. Section 4.1 of the application (page 136) states that current speed measurements were made on each lease site using an uncalibrated method (homemade drifter consisting of a surface buoy attached to a brick) of unknown accuracy and which could have been prone to biases from wind.

The claim of "...high tidal flow through the proposed sites" was evaluated by directly measuring current speeds using a moored oceanographic sensor. A JFE Infinity-EM current meter was moored 0.5 m above the seabed in the centre of all three leases. Details regarding the location and timing of the instrument deployments are included in Table 1. Current speed measurements were conducted at 2-min intervals (a 10-sample burst was recorded at 1-sec intervals on each occasion) for approximately 24-h to include two tidal-cycles. Measurements were made in Lease 1444 during spring tide (highest tides when solar and lunar tides combine) and neap tide (lowest tides when the earth, sun and moon are perpendicular to each other) to include the major tidal forcing periods. Measurements in Leases 1442 and 1443 were conducted during neap tide only. Results are shown in Figures 1 to 3.

Table 1. Current meter deployment details for oyster lease sites in Antigonish Harbour (Atlantic Standard Time).

Lease # - Stage	Latitude	Longitude	Time start	Time end
1442 – Neap tide	45.6715 N	61.8935 W	11/7/2021 17:20	11/8/2021 13:48
1443 – Neap tide	45.6801 N	61.8970 W	11/8/2021 11:56	11/8/2021 12:48
1444 – Neap tide	45.6848 N	61.8852 W	11/8/2021 12:56	11/10/2021 9:38
1444 – Spring tide	45.6848 N	61.8850 W	9/21/2021 10:00	9/22/2021 9:42

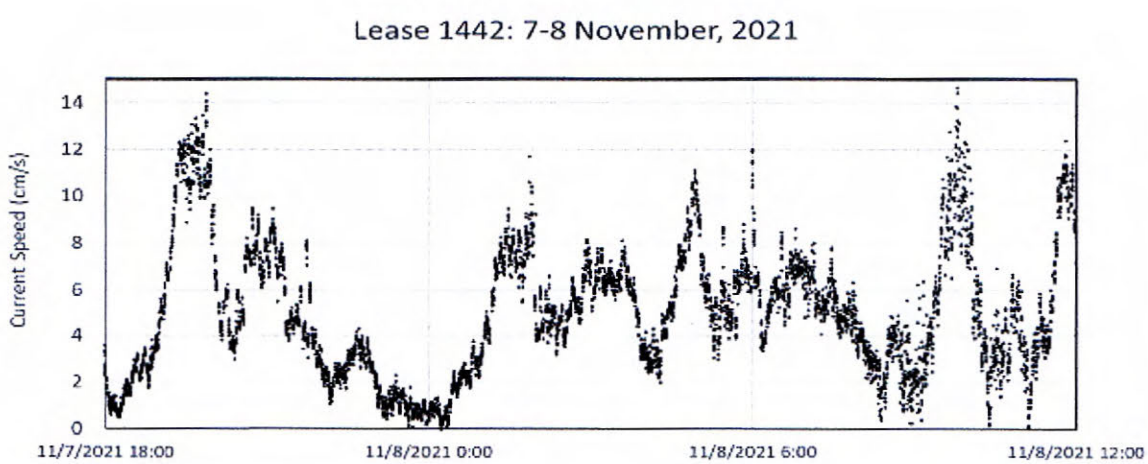


Figure 1. Current speed record for proposed oyster aquaculture Lease 1442 in Antigonish Harbour (Table 1). Times shown are Atlantic Standard.

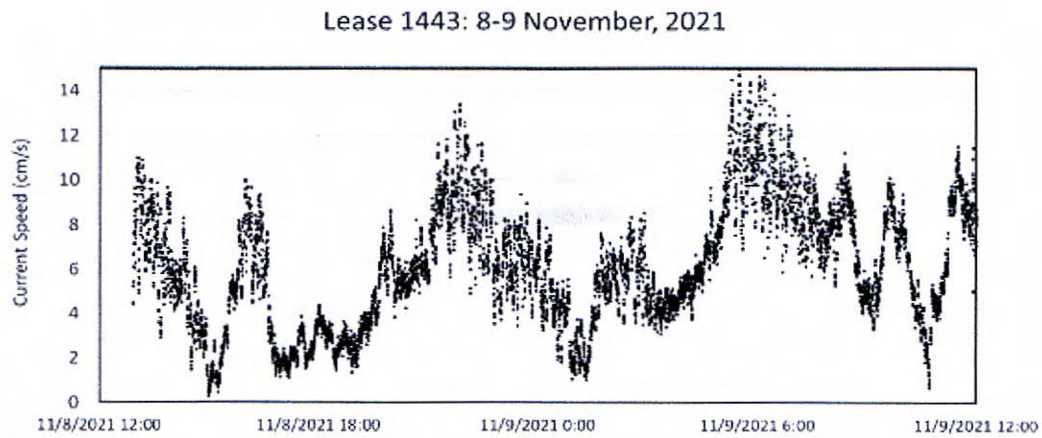


Figure 2. Current speed record for proposed oyster aquaculture Lease 1443 in Antigonish Harbour (Table 1). Times shown are Atlantic Standard.

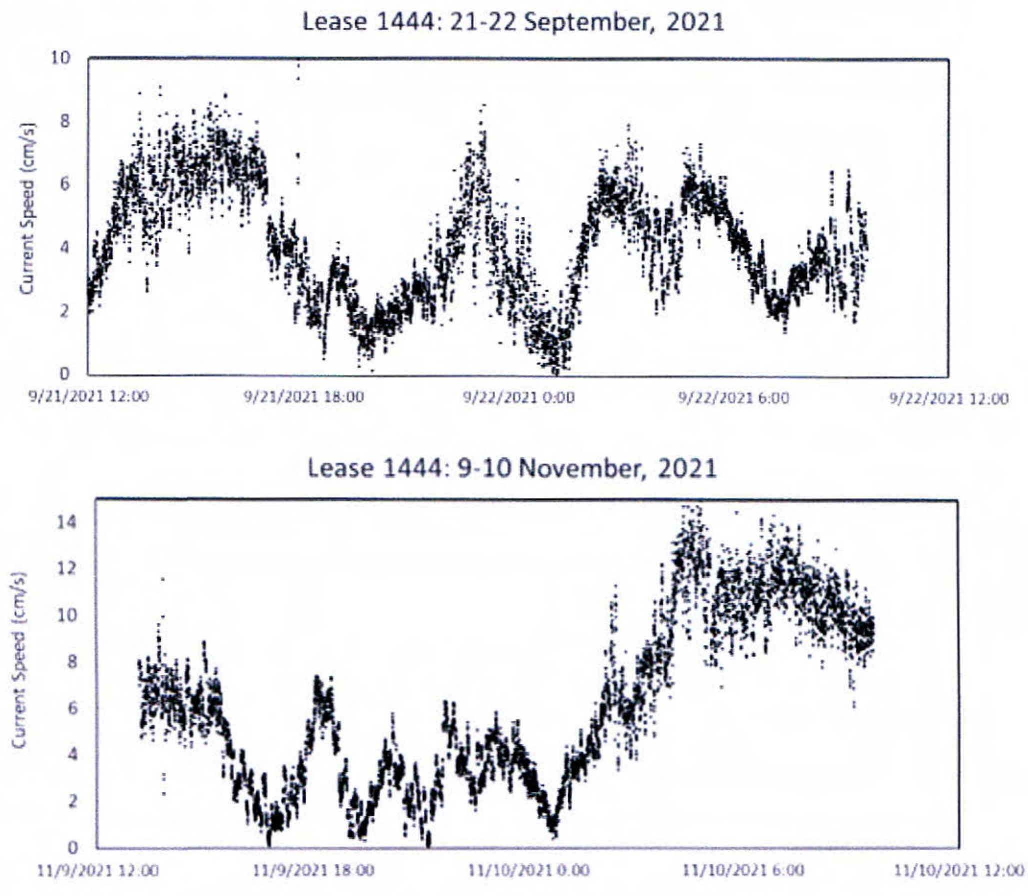


Figure 3. Current speed records measured during spring (top) and neap (bottom) tidal periods for proposed oyster aquaculture Lease 1444 in Antigonish Harbour (Table 1). Times shown are Atlantic Standard Time.

Average current speeds in the center of the three proposed oyster leases ranged from 3.8 to 6.0 cm/s (Table 2) and are considerably lower than reported in the application. These average current speeds are also considerably lower than the 20-25 cm/s minimum speed considered adequate to prevent the local deposition and degradation of feces and pseudofeces on the seabed (Transport Canada, 2007; Gadeken et al., 2021). The potential for oyster biodeposits to impact seabed habitat, resident communities and fish is assessed in Sections 4 and 5 of this report.

Table 2. Summary table of current speed data for the proposed oyster lease sites in Antigonish Harbour. The Infinity-EM instrument has a reported accuracy of ± 1 cm/s.

Lease # - Stage	Maximum (cm/s)	Minimum (cm/s)	Average (cm/s)
1442 – Neap tide	14.2	0.0	5.0
1443 – Neap tide	14.2	0.0	6.1
1444 – Neap tide	14.4	0.1	6.0
1444 – Spring tide	9.5	0.0	3.8

In addition to raising concerns related to the potential for environmental impacts on seabed habitat and communities from biodeposition, the low current speeds measured within the proposed lease sites refute claims in the application that the proposed sites are optimal for the culture of oysters and represent an optimal use of marine resources. The chart shown in Section 1 of the application (see page 13) that summarizes siting criteria thresholds for American oysters (attributed to a Stantec report titled *Road Map for Aquaculture Investment in Nova Scotia*) reports an upper current velocity of 50 cm/s as the threshold for the optimal siting. The lower current speed threshold is equally as important when considering site suitability. Bayne (2017; page 547) reported oyster habitat suitability criteria and stated that oysters require "strong tidal flow, avoiding heavy wave action and stangnant water". Feeding and growth limiting velocities for oysters have been reported within the range of current speeds from 1 to 22 cm/s (Campbell and Hall, 2018). The optimum current speed range for oyster culture was reported by Tung and Son (2019) to be 20-30 cm/s and they concluded that speeds less than 10 cm/s are not suitable for oyster culture. The 2008 New Brunswick Reference Manual for Oyster Aquaculturists (www.gnb.ca/oyster.pdf) states:

> *"If, however, the currents are truly weak, water exchange could be insufficient to meet the requirements of a sizeable rearing operation. Slower growth and silting can result from such a phenomenon."*

In conclusion, claims in Section 1 (page 13) and 4.3a (page 42) of the application of "high tidal flow" and "superior flow conditions" and "...existing conditions in the harbour are suitable for oyster growth" at the proposed lease sites are not substantiated by the new evidence. On the contrary, flow speeds in these shallow water areas are weak (Figs. 1-3 and Table 2) and are within the range known to negatively affect oyster growth and would allow the local accumulation of organic biodeposits on the seabed. The average current speeds measured in proposed lease areas 1442, 1443 and 1444 all fall within a range of flow conditions that are not optimal for oyster aquaculture.

4. Biophysical Conditions Around the Proposed Oyster Leases

Biophysical characteristics of the seabed around the proposed Town Point lease areas define the capacity of the environment to receive oyster biodeposits without impacting fish habitat and fisheries. The applicant stated that this type of background information is not applicable to their proposal because this is not a finfish operation. While not required under the *Aquaculture Activities Regulations*, Nova Scotia regulations (NSDFA, 2021a) require a baseline assessment of proposed shellfish aquaculture leases to determine benthic (seabed) habitat conditions. DFO's mandate also requires the consideration of the biodiversity within the ecosystem, and the habitat of fish species (DFO, 2019).

As part of the present investigation, surficial sediment samples were collected in the proposed lease areas on November 7 and 8, 2021 to determine seabed biogeophysical and habitat conditions. Analysis of these samples was conducted to assess the sensitivity of the seabed to organic enrichment impacts from oyster biodeposits. Shellfish baseline monitoring in Nova Scotia specifies video methods for such assessments (NSDFA 2021a), however, a more robust analysis is reported herein based on the collection of sediment geochemistry data. This approach is comparable to the more stringent baseline monitoring requirements at finfish sites.

Sediment cores were collected by SCUBA diver at nine sampling locations in the three proposed lease sites (Fig. 4). Three replicate core samples were collected at each sampling location and immediately (within 5-min) analysed onboard the boat to determine the total free sulfide (S = hydrogen sulfide + bisulfide + sulfide) concentration and redox potential (Eh_{NHE}) in the surficial sediment layer (0-2 cm depth; Fig. 4) according to methods provided in Cranford et al. (2020 and 2022). Both sediment metrics are widely employed indicators of benthic habitat and community status in Canada (Government of Canada, 2021; NSDFA, 2021b) and abroad. Free sulfides are an end-product of organic matter decomposition, and the concentration in surficial sediments is particularly insightful for assessing sediment ecological quality/health due to the high toxicity of these sulfides to the seabed macrofauna (Cranford et al., 2020). The redox potential data provides information on the degree of oxygen depletion in sediments and the activity of the microbes that produce free sulfides. Sediment quality/health conditions at each sampling location were quantitatively classified using the Oxic Status system employed in Canada (Hargrave, et al., 2008; NSDFA 2021b) and the Ecological Quality Status system described in Cranford et al. (2020).

Results from each of the nine sampling locations are shown in Table 3. The total free sulfide concentration at each sampling location was calculated as the average for the three replicate cores and the triplicate analysis per core (9 measurements per sampling location). The lease mean was calculated from all measurements conducted in each of the proposed lease areas (27 measurements within each of the three proposed leases).

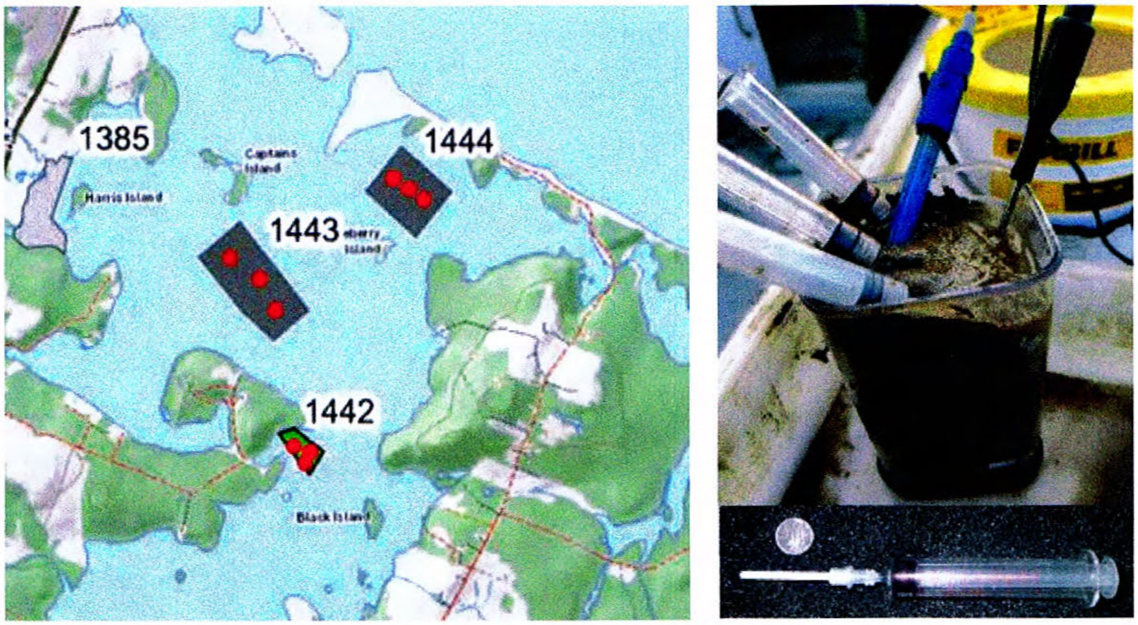


Figure 4. *Left:* Location of sediment sampling sites in Antigonish Harbour on November 7 and 8, 2021. *Right:* Measurement of sediment temperature, redox potential (blue electrode) and pore-water extraction in surficial sediment for total free sulfide analysis by UV spectrophotometry.

Table 3. Summary of average total free sulfide (*S*) concentrations and redox potential (Eh_{NHE}) in surficial sediments within the three proposed oyster lease sampling locations in Antigonish Harbour and the corresponding Ecological Quality Status (EQS; Cranford et al., 2020) and Oxic Status (OS; Hargrave et al., 2008 and NSDFA, 2021) classification for each lease.

Lease	Location	*S* (µM)	Lease Mean *S* (µM)	Eh_{NHE} (mV)	Lease Mean Eh_{NHE} (mV)	EQS Class	OS Class
1442	1	711	913	-146	-146	**Poor**	**Hypoxic B**
	2	1171		-160			
	3	857		-131			
1443	1	1905	2155	-168	-170	**Bad**	**Anoxic**
	2	2043		-175			
	3	2518		-167			
1444	1	277	675	-148	-148	**Poor**	**Hypoxic B**
	2	564		-147			
	3	1146		-148			

Baseline monitoring data presented in Table 3 show that all three of the proposed lease areas currently exhibit a very high degree of disturbance from natural organic enrichment. The *Poor* to *Bad* sediment quality/health classifications of these lease sites apparently results from the inability of the low tidal currents to disperse deposited particulate organic matter entering the sites from natural sources, such as land run-off and eelgrass detritus. The *Poor* and *Bad* EQS classifications are defined as follows:

Poor Status	*Major disturbance:* Evidence of major alterations to the values of the biological quality elements. Diversity is greatly reduced with sensitive and indifferent taxa showing negligible abundance or are absent. Tolerant taxa are sub-dominant to first-order opportunistic taxa. Geochemical quality elements indicate a major increase in anaerobic conditions and sulfide concentrations lethal to most species.
Bad Status	*Severe disturbance:* Evidence of severe alterations to the values of the biological quality elements and in which large portions of the relevant biological communities normally associated with undisturbed conditions are absent. First-order opportunistic taxa dominate but are greatly reduced in abundance. Geochemical quality elements indicate a severe increase in sulfide concentrations that are lethal to all species.

The *Hypoxic B* and *Anoxic* classifications shown in Table 3 for the proposed lease sites, as indicated by the redox potential data, confirm the *Poor* and *Bad* EQS site classes indicated by the high free sulfide levels. These biogeochemical data collectively show that the natural ability of the environment to counteract negative habitat alterations and biological effects associated with organic matter deposition (defined as the assimilative capacity; see Cranford et al., 2022) has already been exceeded. The additional deposition of organic matter in oyster biodeposits within the lease areas would further degrade the biophysical properties of the seabed and alter fish habitat via the impact on resident macrofauna species.

5. Impact on Fish Habitat and Fisheries

5.1 Habitat and Fisheries Impacts from Oyster Biodeposits

Organic matter contained in shellfish biodeposits poses a known risk to fish habitat (Burkholder and Shumway, 2011; Cranford et al. 2020 and 2022). The response of the seabed habitat and resident species to any form of organic enrichment is well known and predictable. Once deposited on the seabed, the excess organic matter stimulates aerobic decomposition processes, resulting in an increase in the Biological Oxygen Demand (BOD) of sediments. If the demand for oxygen is greater than the incoming supply, oxygen concentrations in the sediments will decline, impacting fish habitat and decreasing the abundance and diversity of macrofauna populations (Cranford et al., 2020 and 2022; NSDFA, 2021b). The benthic (seabed) habitat provides many critical ecological services connected with fisheries productivity by providing space for shelter, feeding, and breeding by coastal fishes and motile invertebrates.

Oyster feces and pseudofeces fall under the category of BOD matter, which is classed as a deleterious substance under Section 34(1) of the *Fisheries Act* (Government of Canada, 1985). Consequently, national and provincial aquaculture regulations focus on preventing biodeposition impacts on benthic habitat and associated marine communities (Government of Canada, 2021; NSDFA, 2021a and b). Section 35(1) of the *Fisheries Act* provides protection from possible alterations, disruptions and destruction of fish habitat that may occur from the release of BOD matter by any persons.

The potential for environmental effects from oyster biodeposits is briefly addressed in the application (Section 4.3a, page 43) with the following conclusion:

> *"...with a flushing time of less than a day, the harbour and the proposed sites in particular are not stagnant but rather very dynamic and will not be prone to excessive bio-deposition from farm operations."*

As shown in Section 3 of this report, the weak current speeds measured at the proposed lease sites do not support this conclusion. Oyster biodeposits settle at an average speed of 0.7 cm/s (Gadeken et al., 2021) and will traverse the shallow water depths (< 2.5 m) in under 6 minutes, where they would accumulate and degrade on and in the fine silty sediments. The redistribution and dispersal of this deposited organic matter through tidal action is unlikely to occur. The sediment within the proposed lease sites requires current speeds greater than 20 cm/s to resuspend and disperse oyster biodeposits (Gadeken et al. (2021). As shown above, maximum current speeds at the application sites are well below this erosion threshold (Figs. 1 to 3 and Table 2). Given the oceanographic and geochemical state of the proposed lease sites, BOD matter inputs from oyster biodeposits pose a significant threat to seabed habitat, the abundance and biodiversity of the resident macrofauna community, and the ecological services this habitat provides to fish.

Beyond the impact that the proposed project is expected to have on benthic habitat, there is also a risk that the project will degrade conditions in the water column around the leases. In addition to oyster biodeposits increasing the biological and chemical oxygen demand of sediments, the proposed nine million oysters held on site in the water column, or on the seabed during winter, would greatly increase oxygen demand in the leased areas. Oxygen resupply through tidal flushing would be very limited during stages of the tidal cycle when current speeds are extremely low (Fig. 1 to 3). The cumulative oxygen demand of the oysters and organically enriched sediments could reduce oxygen concentrations in these shallow, poorly flushed waters to the point where there is a high likelihood that hypoxic (low oxygen) conditions detrimental to fish health will occasionally develop in the water column in and around these shallow leased areas.

5.2 Impact on Ecologically and Biologically Significant Habitat

The application noted on page 15 that the proposed oyster lease sites correlate with the presence of eelgrass (*Zostera marina*) beds, but states:

"there has been no indication the density or prevalence of eelgrass is a significant concern".

Potential anthropogenic impacts on eelgrass beds are always an important environmental concern. Eelgrass beds in Atlantic Canada are considered as Ecologically and Biologically Significant Areas (DFO, 2009, Hastings et al., 2014). Eelgrass provides physical structuring in coastal marine environments, contribute primary production, provide shelter, and support an abundance of marine animal and plant communities and waterfowl species (Howarth et al., 2021). Seagrass meadows are one of the most productive and important ecosystems globally (Hemminga, 2000) and provide important nursery habitat and refuge from predation for fish and mobile invertebrates, including commercial species.

Section 1, page 15, of the application concluded that:

"... the farm would have a net beneficial effect on eelgrass in the harbour."

Some insight on the rationale for this conclusion can be found on the Town Point Oysters website, which states that any negative effects on eelgrass from shading will be compensated by greater growth rates due to increased light transmission (cleaner waters) in the harbour from oyster filter-feeding activity (see page 61 of application package). There is no evidence provided in the application to suggest that that the growth of eelgrass outside the proposed lease areas is limited by poor water quality (e.g. light penetration through the water column). Eelgrass meadows historically covered 90% of the bottom in Antigonish Harbour but biomass collapsed by 95% in 2000 due to the foraging behaviour of invasive European green crabs (Garbary et al., 2014). Green crabs reduce eelgrass biomass by damaging roots and rhizomes when burrowing for shelter and digging for prey. The decline in eelgrass habitat in Atlantic Canada was associated with dramatic declines in fish abundance and biomass (Matheson et al., 2016). No evidence was provided in the application to indicate that water clarity in Antigonish Harbour has declined in the past two decades from when the eelgrass beds were prolific. Consequently, there is no evidence to support the claim that eelgrass meadows would benefit from any improvement in water clarity outside the proposed oyster leases. The continued presence of green crab in the Harbour appears to be the primary limitation on the present distribution and level of eelgrass production. This stress on the eelgrass meadows would be compounded by several of the proposed oyster aquaculture activities:

a) The increased production of toxic free sulfides in sediments enriched with oyster biodeposits. An extensive body of literature exists on the phytotoxic effects of these reduced sulfide compounds, including negative effects on eelgrass growth (reviewed by Lamers et al., 2013),
b) Physical disturbance of eelgrass during the winter when the oyster cages are held on the seabed (Hastings et al., 2021).
c) Shading of eelgrass by aquaculture structures (Howarth et al., 2021).

d) Promoting the increased abundance of predatory green crabs in the Harbour through the introduction of sheltering structures and a greater abundance of green crab prey (fall-off and cleaning of fouling organisms from oyster cages).

Interactions between cultured oysters and eelgrass are complex and the overall risk of aquaculture to eelgrass remains unclear. However, a quantitative analysis of global data from independent studies on bivalve aquaculture effects on eelgrass concluded that off-bottom culture methods, such as described in the application, resulted in significant decreases in eelgrass density, percent cover, and reproduction (Ferriss et al., 2019).

6. Potential for Positive Ecological Effects from the Proposed Project

It has become common practice for new shellfish aquaculture lease applications to claim that positive ecological benefits will result from the proposed activity. This worldwide industry claim has subsequently been described in the science literature as "greenwashing" (Overton et al., 2022). Shellfish aquaculture ecosystem interactions are highly complex, and effects shown to be positive in one area may be neutral or negative in another. Positive claims do not ensure positive effects in all situations and generally serve to distract from an objective evaluation of the environmental interactions of the proposed activities.

6.1 Water Clarification.

The application includes references to oyster farming resulting in a "cleaner harbour" owing to the oyster feeding activities resulting in "60 million gallons filtered per day". It is possible to quantitatively estimate the capacity of the proposed development plan to significantly affect suspended particulate matter in Antigonish Harbour via the filter-feeding activity of the stocked oysters. A simple and widely employed modelling approach known as at the "Dame depletion index" was utilized herein to assess the potential for the farmed oysters to clarify harbour waters. The flushing time of Antigonish Harbour is reported in Gregory et al. (1993) is 0.76 days, which is relatively rapid compared with many other coastal embayments that support shellfish aquaculture in the Maritimes. Assuming an oyster population filter-feeding rate of 60 million gallons/day, as reported by the applicant, the time for the oysters to clear the bay volume of particles is estimated to be approximately 66 days. Since Antigonish Harbour flushes much faster than the oysters filter the water, it is highly unlikely that the proposed level of oyster culture could result in a cleaner harbour (pages 215 and 230 of application) or greater light transmission (page 61 of application).

The application reported the following conclusion on page 217:

> *"...for a farm of this type if properly managed and occupying not more than 10% of the estuary area the environmental effect will be at worst benign. Our proposed farm would occupy only 2.7% of the harbour."*

This statement was attributed to input received during a public panel discussion reported in the application and appears to be related to the reported water filtration capacity of the stocked oysters. All embayments, including those in Nova Scotia, exhibit a wide range of oceanographic and bathymetric characteristics (Gregory et al., 1993) that are important for determining the maximum area that can sustainably support oyster culture. Consequently, there is no general rule on the percentage of coastal area that can support shellfish aquaculture. It is important to note that the potential negative effects of aquaculture operations are not based solely on the potential for harbour-scale effects but also include an assessment of potential impacts at the farm-scale.

The effect of oyster biofiltration on suspended particles is much more likely at the scale of the individual leases given the low current speeds (i.e., slow lease flushing) in these shallow regions of the outer harbour. Food filtration/depletion within the footprint of the oyster leases could negatively affect the growth of the cultured oysters and other resident filter-feeders, particularly given the slow current speeds in the three proposed leases. Any potential positive effect of water clarification within these leases must also be balanced against the anticipated negative effects of sediment organic enrichment from the defecation of undigested food (see above Section 5.1).

6.2 Mitigation for Climate Change

References are made in the application to the capacity of oyster aquaculture to help combat climate change through carbon sequestering (see page 230). The rationale for this deduction was that because oyster shells contain carbon, it will be stored permanently, and the proposed operation is therefore eco-friendly. As noted in the public dialogue provided in the application, there are many reasons why the proposal may not be carbon neutral (e.g., CO_2 emissions from hatchery, boats and vehicles, the manufacture and transport of farm equipment and product, refrigeration, etc.). The production of shells by the oyster is not carbon neutral because carbon already sequestered in the ocean (the oyster food supply) is released during oyster tissue growth and during digestion of oyster meat by humans. Shell production is only one of many biological and husbandry processes that involve carbon, and a holistic assessment approach is required to determine the net effect on climate change (reviewed in Filgueira et al., 2015).

7. Conclusions

The application provided very limited information to support the following opinion presented on page 15 of the application package:

> *"The oceanographic and biophysical characteristics of the public waters are in many ways ideally suited to the proposed use."*

Site-specific evidence provided in the application is insufficient to support of this statement. The applicant relies largely on previous conclusions on the environmental performance of oyster aquaculture operations located in other regions. This approach fails to recognize that not all coastal habitats are suitable for growing oysters and that negative environmental impacts can occur if the oceanographic and biophysical conditions are unfavourable. Based solely on the current speed data provided herein, it can be concluded that the proposed lease sites are not optimal for oyster aquaculture at the scale proposed and that this operation therefor does not represent an optimal use of marine resources.

The evidence presented herein shows that the proposed lease sites exhibit physical, chemical, biological and geological conditions that are not suitable for supporting the proposed oyster aquaculture project without negatively altering seabed habitat. The threshold for unacceptable harm to fish or fish habitat is any aquaculture activity that is anticipated to cause population-level detrimental effects to fish populations (DFO, 2019). The data reported herein supports a high level of confidence in the conclusion that the proposed project activities will interact with the local environment in ways that are expected to adversely impact fish habitat, ecological processes, species, populations, communities, and fisheries. This assessment is based on the following site-specific evidence, and related conclusions from international research on environmental interactions with oyster aquaculture:

a) Average current speeds in the leased areas are much slower than reported in the application and are substantially lower than the optimal range for oyster growth.
b) The low current speeds around the proposed leases are insufficient to disperse oyster biodeposits, which are classified by DFO (*Fisheries Act*) as a deleterious substance (BOD matter).
c) Oyster biodeposits released from suspended cages will rapidly settle to the seabed in the shallow waters around the proposed lease sites, where they will accumulate and decompose in the fine surficial sediments.
d) The baseline biophysical and geochemical characteristics of the proposed lease sites reveal a very low capacity to naturally disperse and degrade oyster biodeposts, resulting in a high risk for significant adverse impacts to seabed habitat, species, populations, and communities.
e) There is a risk that the proposed oyster project will increase hypoxic and/or anoxic conditions in sediments and the water column in and around the lease areas. Low oxygen concentrations have known direct and indirect negative consequences to fish and fisheries.
f) The reported positive effect on water clarification in Antigonish Harbour via oyster biofiltration is not supported by simple modelling results.
g) The reported positive effect of oyster aquaculture on eelgrass is not supported. The proposed project would increase stress on eelgrass beds through an increase in toxic sulfide levels in the sediment, physical disturbance, and shading.
h) Carbon sequestration in shells does not by itself indicate that the proposed activity would have a positive net effect on climate change.

There are few options available for the risk management and mitigation of the projected impacts from the application. Avoidance of sensitive habitat in Antigonish Harbour is not an option due to the widespread distribution of eelgrass beds. Alternative lease locations of similar size outside the main navigation channels in Antigonish Harbour are expected to exhibit oceanographic and biophysical conditions comparable to those described herein.

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Work History

2021 to present: Proprietor, Emeritus Marine

2020 to present: Benthic Technical Group, Aquaculture Stewardship Council, The Netherlands

2015 – 2020: Contributing Editor, Journal of Aquaculture Environment Interactions. Inter-Research Science Publisher. Germany

2018 to 2020: Research Scientist, National Research Theme Leader on Aquaculture Ecosystem Interactions Program, Coastal Ecosystem Research Division, Fisheries and Oceans Canada, St. Andrews Biological Station.

2017-2018: Acting Head, Habitat Ecology Section, Bedford Institute of Oceanography, Coastal Ecosystems Science Division, Fisheries and Oceans Canada.

2001-2018: Adjunct Professor, Department of Oceanography, Dalhousie University, Canada

1999 to 2018: Research Scientist, Habitat Ecology Section, Ecosystem Research Division, Fisheries and Oceans Canada, Bedford Institute of Oceanography.

2013-2016: Science Advice Chair, Working Group on Aquaculture (WGAQUA), International Council for the Exploration of the Seas, Copenhagen, Denmark

2005-2008: Chair, Working Group on Marine Shellfish Culture (WGMASC), International Council for the Exploration of the Seas, Copenhagen, Denmark

1988 to 1999: Environmental Biologist, Habitat Ecology Division, Fisheries and Oceans Canada, Bedford Institute of Oceanography.

1981 to 1988: Environmental Technician, Marine Ecology Laboratory, Fisheries and Oceans Canada, Bedford Institute of Oceanography.

Education

Bachelor of Science (Honors): Biology, 1981, Dalhousie University, Halifax, Nova Scotia

Ph.D. : Oceanography, 1998, Dalhousie University, Halifax, Nova Scotia

Research Specializations

Aquaculture Environment Interactions, Environmental Monitoring and Management, Shellfish Physiological Ecology; Benthic Ecology, Biological Oceanography; Environmental Sensing

Professional Profile

Dr. Cranford's research over the past 40 years has focused on obtaining science knowledge to provide decision support to the Canadian government for the development of effective area-wide management strategies for promoting the sustainability of marine industries. Since 1998, his multidisciplinary research has focused on aquaculture ecosystem interactions and the resulting expertise has been applied nationally and internationally towards the development of monitoring frameworks for finfish and shellfish aquaculture. Dr. Cranford's research has included leadership and collaborative efforts with scientists in Canada, Norway, Spain, Portugal, The Netherland, Denmark, and New Zealand where he contributed to studies on ecosystem-level interactions with aquaculture. He is currently working with the Aquaculture Stewardship Council to develop new certification standards designed to minimize, mitigate, or eliminate impacts from seabed organic enrichment on benthic habitat, biodiversity and ecosystem function. During his career, he published 59 documents and edited one book (www.SCOPUS.com author profile shows 2360 published citations and an *h*-index of 30).

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2022

NSUARB 2022-001
NSUARB 2022-002
NSUARB 2022-003

This is Exhibit "B" referred to in the Affidavit of Peter Cranford sworn to before me this 19th day of May 2023

David A. Bartlett, K.C.
Notary Public Province of New Brunswick

DAVID A. BARTLETT, K.C.
NOTARY
PUBLIC
NEW BRUNSWICK

Government of Canada Gouvernement du Canada

Community Aquatic Monitoring Program (CAMP) data for the Southern Gulf of St. Lawrence Dataset

Each summer, environmental community groups collect important data to determine if groupings of fish, shrimp and crab – what is called a community- can be used as an indicator of the health status of bays and estuaries. Sampling was conducted from May through September for the first years then from June through August. In 2018 and 2019, the sampling was conducted just once in each estuary. Community group members and staff sample six stations once a month in their designated estuary.

Fish, shrimps and crabs are collected with a beach seine net and later released live back to the water once identified and counted. From this, the community groups provide important information to Fisheries and Oceans Canada, including:

-identification and numbers of fish, shrimp and crab species;

-water conditions and samples;

-information on aquatic plants;

-sediment samples.

With this information, Fisheries and Oceans Canada scientists working with government agencies and universities can conduct analyses to determine the suitability of indicators to assess the health of bays and estuaries.

View on Map

Publisher - Current Organization Name: Fisheries and Oceans Canada

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Geographic Information

Spatial Feature

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☐ Community Aquatic Monitoring Program (CAMP) data for the Southern Gulf of St. Lawrence Dataset

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Subject:

Nature and Environment | Science and Technology

Topic category:

Biota | Oceans

Maintenance and Update Frequency: Annually

Spatial Representation Type: Text Table

Status: Ongoing

Date Published: 2020-03-04

Date Modified: 2020-03-04

Temporal Coverage: 2004-06-01 to undefined

Openness Rating: ★★★

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Record Modified: 2021-05-19

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Metadata:

Link to JSON format

DCAT (JSON-LD)

DCAT (XML)

FGP Metadata: HNAP ISO:19115 Metadata Record

Atom Feed

Spatial Representation Type: Text Table

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