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The Honourable Minister Gordon Wilson
Nova Scotia Environment
Barrington Tower, 1894 Barrington St., Suite 1800
P.O. Box 442
Halifax, NS B3J 2P8

November 8th, 2019

Dear Minister Wilson:

I am counsel for three fishing industry organizations representing the fishing industry in the Northumberland Strait: Gulf Nova Scotia Fleet Planning Board, PEI Fishermen's Association, and Maritime Fishermen's Union. These organizations represent some 3,000 fishers working in this region, and have been active participants in the environmental assessment process for Northern Pulp Nova Scotia's (NPNS) proposed effluent treatment system since the project was proposed.

Please find herein the submissions on behalf of these fishing industry associations, including concerns expressed by these three industry associations and four independent expert technical reports regarding the environmental, social and economic impacts of NPNS's proposed effluent treatment system.

We note that the 30-day public comment period is hardly adequate to enable a robust assessment by the public, including the fishing industry, given the volume of materials submitted by NPNS.

Furthermore, we are deeply concerned that there is an appearance of bias on part of the Province in this matter given, as the Nova Scotia Court of Appeal noted in Pictou Landing First Nation v Nova Scotia (Minister of Aboriginal Affairs), that the Province is attempting to be both investor in and regulator of the Effluent Treatment System. Given the Province's contractual approval of and payment for the ETS design, how can we have any confidence that the Province will provide an impartial assessment of the environmental impacts of the ETS?

In summary, based on the review conducted by these associations and the independent technical reviews, it is clear that NPNS has failed to provide a complete response to the terms of reference for the required Focus Report, and furthermore, that information provided by NPNS, incomplete as it is, raises concern for significant and unacceptable adverse impact risks for the Northumberland Strait marine ecosystem, local communities and the fishing industry sector. The health of the marine environment and the region's seafood export market hangs in the balance.

We urge you to exercise your authority under Nova Scotia's *Environment Act* and associated *Environmental Assessment Regulations* to (a) reject this project due to the significant adverse effects and/or environmental effects that cannot be mitigated that this project will likely cause, or in the alternative, (b) require an environmental-assessment report given the incomplete nature of NPNS's Focus Report and Environmental Assessment Registration Documents. If you permit NPNS's project to proceed, you are putting the Atlantic Canada seafood products, and the fishing industry that provides these products, at risk, as well as the health of the Northumberland Strait marine environment.

Sincerely,

Jamie Simpson, on behalf of
Gulf Nova Scotia Fleet Planning Board
PEI Fishermen's Association
Maritime Fishermen's Union

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EXECUTIVE SUMMARY

We urge the Minister to review in detail the technical review provided by the fishing industry association and the expert reviews provided by Dr. Laura Braden, Dr. Arnault Le Bris, Dr. Andrea Battison, and NEXUS Coastal Resource Management Ltd. Each of these reports provide unique, detailed, and nuanced critiques of Northern Pulp Nova Scotia's proposed effluent treatment system, in terms of both the inadequate information provided to determine the full potential impact of the project on the Northumberland Strait, and the likely adverse effects and environmental effects that cannot be mitigated. Following is a summary of key findings of these reports.

1. **Bleached Kraft Pull Mill Effluent (BKPME) negatively impacts reproduction ability, immune system function, and liver function of marine life, and toxic elements of the effluent accumulate over time**

As detailed in Dr. Braden's expert report, BKPME is a complex mix of chemicals, many of which are known to be toxic to a variety of aquatic life, and some of which are known to persist and accumulate in the receiving environment for decades. NPNS has not addressed the substantial volume of scientific literature documenting the detrimental impacts of BKPME on fish health, and nor has NPNS conducted tests to determine the potential sub-lethal impacts of their effluent on fish health.

Furthermore, NPNS has based its assessment of potential negative impacts on the marine environment on a modelling study covering a mere one-month time period. Northern Pulp's one-month modeling exercise shows that parameters of its effluent are predicted to increase, but what are the impacts beyond one month? As such, Northern Pulp ignores the potential for long-term increase in concentration of toxic components of the effluent, and the resultant impact on marine life in the Strait.

NPNS must provide a long-term accumulation model for the various parameters of the effluent, before the Minister can reasonably conclude that there is no serious risk of harm to marine life in the Strait.

Furthermore, NPNS did not consider the impact of aluminum, barium, copper, iron, manganese, mercury, phosphorus, and zinc on the health of marine life in the impacted area. Metals, especially copper, are acute toxins to lobster and other marine crustaceans.

> *"The exclusion of many metals from the list of COPC [Chemicals of Public Concern] and minimal information on bioaccumulation is concerning as metals are known to be toxic to American Lobster."*
>
> Dr. Battison, Expert Report Submission

NPNS assumes that (a) there is no accumulative effect of their effluent over time on fish health, (b) there is no sublethal effect of diluted effluent on fish, (c) their modelling of effluent dilution is accurate, and (d) the characteristics of the actual effluent will be consistent with the predicted effluent. Given that NPNS has provided no assurance that these assumptions are valid, the Minister cannot reasonably rely on NPNS's assurances that their effluent will not adversely affect the marine environment in the Strait.

> *"The negative physiological effect of BKPME [Bleached Kraft Pulp Mill Effluent] has been well described on fishes, including depressed immunity, altered reproduction and decreased overall resilience…. [furthermore] there is no description or characterization of the potential for components of the predicted BKPME for bioaccumulation, despite the large body of evidence for*

bioaccumulation of several toxic components such as chlorinated organic compounds and wood extractives."

Dr. Braden, Expert Report Submission

"My major concern is that the one-month simulation period is not sufficient to evaluate the cumulative impacts of effluent waters released continuously for several years, possibly decades. … the focus report does not adequately address the risks of bioaccumulation of toxins in the marine environment."

Dr. Le Bris, Expert Report Submission

"Consensus within the scientific and technical community is that COPC [Chemicals of Public Concern] disposal, particularly those identified as endocrine disruptors and persistent … pollutants in marine environments is of mounting concern… and that conventional treatment options (including activated sludge processes as proposed in this ETF) are considered to be insufficient to address concerns regarding commercial fisheries. This is particularly in light of mounting concerns over the need for more stringent attention to cumulative effects and consideration of increasing stress indicators of ocean health. [refs. omitted]"

NEXUS Expert Report Submission

"In my professional opinion, given the information presented in the focus report and associated documents, it is impossible to conclude that the proposed work won't lead to harmful alteration, disruption, or destruction of fish habitat."

Dr. Le Bris, Expert Report Submission

2. NPNS has not provided empirical characterization of the effluent it intends to release into the Strait

As Dr. Braden states in her Expert Report, "There is limited-to-no information regarding the true chemical characteristics of the proposed effluent." The Minister cannot blindly approve the project without a full understanding of what NPNS intends to release into the Northumberland Strait.

3. NPNS's baseline study is inadequate to enable a full evaluation of the project's potential environmental effects and to enable an accurate environmental effects monitoring program

NPNS's marine water quality study was conducted over two days, which is too short a period to provide useful baseline information. Water quality in the impact area is dynamic; it has strong seasonal cycles in nitrogen, phosphorus, oxygen demand and phytoplankton bloom. Thus, a two-day sampling period is inadequate to gain an understanding of the receiving waters into which NPNS intends to release its effluent, and therefore it is impossible to know, based on the information provided by NPNS, how their project will impact marine waters in the area.

Furthermore, NPNS's fish and fish habitat survey was wholly in adequate to determine the diversity of fish that will be impacted by the effluent. NPNS considered impacts only on those species which it observed during a limited sampling exercise and an inadequate literature survey. NPNS ignores the potential impacts of their project on species at risk known to reside in the area to be impacted by their project, including American plaice, lumpfish, porbeagle and Atlantic sturgeon. It is unreasonable for the Minister to conclude that the project will have no adverse impacts when NPNS has not addressed the potential impacts of their project on species at risk in the impacted area.

Likewise, NPNS did not consider impacts on Atlantic halibut, perhaps because NPNS relied on outdated studies and did not account for recent changes in the population abundance and distribution of Atlantic halibut.

Without a proper baseline survey, it will be impossible to evaluate what impacts the effluent will have on the impacted area. In the words of Dr. Le Bris from his Expert Report submission, "the baseline surveys are insufficient to evaluate the impacts of the effluent on the marine environment in the future."

> *"The short duration [fish habitat] survey … was unable to capture seasonal variation in fish communities and fish habitat; therefore, it has limited value as a baseline survey."*
>
> Dr. Le Bris, Expert Report Submission

> *"[NPNS's Underwater Benthic Habitat Survey] was conducted using a towed camera and was designed to survey benthic substrate. This is not a proper methodology to survey highly mobile species such as fin-fish, because they can easily escape the camera field of view."*
>
> Dr. Le Bris, Expert Report Submission

> *"the focus report failed to recognize that the regional assessment area for this project is one of the regions with the historical highest diversity of fish species in the southern Gulf of St. Lawrence…"*
>
> Dr. Le Bris, Expert Report Submission

4. NPNS's Focus Report contains errors with respect to background concentrations of metals

NPNS's Focus Report contains inconsistencies with respect to background concentrations of metals in Caribou Harbour, in that it appears that actual concentrations are at least ten times lower than the concentrations listed by NPNS. The source of these inconsistencies could not be found due to missing raw data and associated quality assurance information.

The upshot of the background concentrations errors is that the distance from the diffuser by which ambient conditions are reached may have been significantly underestimated, and thereby the negative impacts of NPNS's effluent may be farther-reaching than reported by NPNS. The Minister must request NPNS to provide the missing data so that NPNS's assertions concerning the dilution zone can be independently verified.

5. NPNS has not adequately addressed the risk to the marine portion of the pipe due to ice scour

NPNS considered ice scouring from only a single year; there is no indication whether this was an average year for ice scouring, or what the range of extreme ice scouring might be. Without this information, the Minister cannot reasonably conclude that the proposed three-metre burial depth for the pipeline would be sufficient to avoid effluent spills due to ice damage.

The lack of leak detection technology in the marine portion of the proposed pipe is unacceptable.

6. NPNS has not adequately assessed the risk of sedimentation to fishing grounds within the impacted area

NPNS indicated that 90% of Total Suspending Solids (TSS) released with the effluent will be deposited somewhere between 1 and 21 kilometres from the diffuser. Given the wide range of this estimate, and given that much of the TSS are not easily biodegradable, we are concerned that the project poses an unacceptable risk of damage by sedimentation to fishing grounds in the region of the diffuser.

NPNS's only assurance that such risk is minimal comes from examples of other mills operating in other regions. This is cold comfort given that the nature of TSS settling is highly dependent on the nature of the specific receiving waters system.

> *"The potential effect of TSS is dependent on the type of raw material introduced to the natural environment and the nature of the receiving environment. Therefore, comparison of models using effluent from mills in other regions is irrelevant and can lead to inaccurate conclusions."*
>
> NEXUS Expert Report Submission

Honourable Minister Gordon Wilson
Nova Scotia Environment
PO Box 442
Halifax, NS B3J 2P8

Re: Northern Pulp Nova Scotia, Focus Report, Replacement Effluent Treatment Facility

Dear Hon. Minister Gordon Wilson,

The Gulf Nova Scotia Fleet Planning Board (GNSFPB), the Prince Edward Island Fishermen's Association (PEIFA) and the Maritime Fishermen's Union (MFU), including its subsidiary R&D company Homarus Inc., have reviewed the Focus Report submitted by Northern Pulp Nova Scotia (NPNS) on Oct 2, 2019. The report is visually appealing and gives some new information about the potential impacts of the project on many fronts. However, it lacks many details that would have been necessary to answer several of the concerns that we have with regards to the project. Due to limitations in time and resources, the comments below only cover the portions of the Focus Report relevant to the fisheries and marine environment. These three organizations along with Pictou Landing First Nation represents the interests of over 3000 commercial fishing licenses and 215 communal commercial licenses in New Brunswick, Prince Edward Island, Gulf Nova Scotia and Pictou Landing First Nation. Value of landed lobster in 2018 for LFA 26A on PEI alone was $59,977,775.00 (personal communication with the Province of PEI).

The GNSFPB, PEIFA and MFU have been engaged since the beginning of this process and have reviewed the previously submitted registration and Environmental Assessment documents. We still have significant concerns that the Focus Report has failed to adequately respond to the Terms of References outlined by the Minister. Northern Pulp Nova Scotia (NPNS) has failed to present relevant and adequate evidence to prove that the fishery, considering the biological and economic components, will not be seriously harmed as result of the proposed effluent treatment facility. The Focus Report inadequately addresses the impacts of the construction of the pipeline and discharge of effluent on key fisheries life stages, habitat and general population level health. The Focus Report does not provide the necessary contextual background that identifies the Southern Gulf of St. Lawrence as an ecologically significant area, which is currently undergoing climactic shifts in ambient water quality, considering temperature and oxygen levels. The ongoing changes in the Southern Gulf are altering the ecosystem resilience and baseline tolerance thresholds for environmental conditions. There are major gaps and assumptions made throughout this Focus Report which do not sufficiently meet the terms of reference assigned by the Minister of Environment.

Biology

7.0 Fish and Fish habitat TOR: *Conduct additional impact assessment for treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information, additional studies and/or an understanding of expected movement of contaminants. Assessment methodology must first be agreed upon by NSE in consultation with relevant federal departments.*

7.5 Fish and Fish Habitat TOR: *Clarify what contingency measures will be in place to mitigate potential impacts (e.g., thermal shock to fish) due to potential large and rapid fluctuations in water temperature in the winter at the diffuser location during low production or maintenance shut down periods.*

There are significant concerns regarding the potential for negative population level impacts on American lobster from the effluent discharge, specifically the presence of dioxins, furans and phenols. In addition to the presence of chemicals, there are concerns about the impacts of altering the pH, temperature, oxygen level and salinity in the receiving environment.

Considering water quality and effluent composition, we have several key concerns with the information presented by NPNS and the potential impacts on lobster health. First, NPNS predicts that effluent will have a temperature range of 25-37°C. DFO temperature probes throughout the Gulf of NS have shown annually that even during the warmest months, the average temperature does not go above 15-20°C. The effluent temperature is significantly higher than the ambient temperature in the receiving environment, and in the winter months, the thermal shock from heated effluent will be even greater. The Canadian Water Quality Guidelines for the Protection of Aquatic Life state that "Human activities should not cause changes in ambient temperature of marine and estuarine waters to exceed ±1°C at any time, location, or depth. The natural temperature cycle characteristic of the site should not be altered in amplitude or frequency by human activities. The maximum rate of any human-induced temperature change should not exceed 0.5°C per hour" (CCME 2003). NPNS only outlines the contingency methods to keep the effluent within the 25-37°C temperature range but does not describe how they will meet the guideline for rate of change, or elaborate on any biological impacts resulting from the expected temperature range.

In addition to this, the near and far-field modelling was completed for a 30-day tidal cycle to identify how and where the effluent will concentrate, given tidal condition and seasonal ice cover. The model only accounts for 30 days of effluent discharge during two seasonal conditions; and does not indicate what the entrainment and dilution rates would be over months or years of accumulation. Figure 4.2-4: Simulated Effluent Concentration by End of One-month Simulation Period in February shows that after 30 days there is accumulation in the North East corner of Caribou Island. The graph supplied is difficult to analyze, but it appears that there are concentrations at least at 2.00-2.25 mg/L after just 30 days. Dilution ratios are expected to

change over the winter months, with increased accumulation rates from annual ice cover from January to April. An accumulative model is necessary to predict the accumulation of parameters of concern; parameters such as resin acids, fatty acids, AOX, PAH, and TDF which are known to bioaccumulate in sediment, tissues of invertebrates, vertebrates (El-Shahawi 2010, Lander 1990).

Northern Pulp Nova Scotia's report states that monitoring would continue, which would supply data for required contingency plans. This concept of monitoring is useful in some projects, but in this case it is being proposed to monitor possible, unknown changes that **will be caused** by the effluent. This is a major gap in the data in the project. By the time a monitoring project picks up on changes it will be too late. The negative effects will have taken place and there is no timeline/predictions possible to show if it could be reversed or how long it would take.

It takes lobster 6-7 years to reach a size at maturity, meaning that effluent may flow for 6-7 years before we see any problems. If monitoring picks this up after 6-7 years and changes begin to be made, it's too late to reverse the 6-7 years of damage that is already done. Also, work done by Laufer et al, 2012 concludes **"that alkylphenols are endocrine disruptors to lobster larvae at metamorphosis because they possess juvenile hormone activity. They also delay molting, reduce growth, and are toxic at relatively low concentrations."** According to Appendix E of Appendix 7.2 (Underwater Benthic Habitat survey of Caribou Harbour Pipeline corridors), concentrations of all phenols measured in the effluent are greater than background concentrations at the proposed diffuser location. This is an unacceptable risk to take when dealing with the key fishery in the Southern Gulf of St. Lawrence.

Furthermore, the requirement here was to conduct additional impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information, additional studies and/or an understanding of expected movement of contaminants. A sentence stating that future studies "could include" specific testing shows this testing has not been completed and that it may not be in the future. This is not a path forward, it is a concept, but not a plan.

Within table 7.3-2 (labelled incorrectly as 7.3-1 in the body of the report) it states: *"Potential Effect - Water Quality – changes to water quality due the discharge of treated effluent to the Northumberland Strait at the diffuser outfall location Residual Effect - Meeting industry design standards for effluent treatment and design of the effluent diffuser to* ***maximize dilution*** *of effluent in the marine environment, effects will ensure that* ***any changes to water quality in the receiving environment are minimized to a small area*** *(within 5 m of the outfall) prior to water quality meeting background or CCME guidelines for the protection of aquatic life. Overall Significance -* ***Overall effects are considered to be generally minor, localized and generally reversible*** *- Not Significant"*

What are the expected minor, localized effects? If the proponent has done this work and knows there will be "expected minor, localized effects" they should be shared with in this

document. Decreased dissolved O_2, a change in temperature, salinity, etc. would effect species differently and should not be generalized. Increased temperature is more significant to scallops than lobster, but this is not portrayed in the table. In fact this data is not provided at all.

Sea Scallop - "Mortality will occur at temperatures of 23.5ºC or greater and mass mortality of scallops has occurred historically in portions of the southern Gulf" (DFO, 2011).

Lobster - "In lobsters, there is a complex relationship between temperature, growth and reproduction. Molting is inhibited below 5°C, and growth rate is proportional to temperature between approximately 8 and 25 °C" (Crossin, et al. 1998).

Both species would be affected by changes to their environment, but in different ways. NPNS has not laid out contingency plans to describe how damage to each species would be mitigated. There is also no definition of the phrase “generally reversible”. What does this mean and how is it going to be accomplished? Simply stopping the release of effluent will not reverse the damage done.

American Lobster Habitat Concerns

7.2 Fish Habitat Baseline Survey TOR: *Conduct fish habitat baseline surveys for the marine environment, to the satisfaction of Fisheries and Oceans Canada*

The proposed effluent treatment facility will cause extensive habitat displacement or destruction during the construction phase. NPNS conducted Underwater Benthic Habitat Surveys to understand the habitats and benthic communities that are present along the proposed pipeline corridor and diffuser area. The UBHS was conducted for a very limited period of only 5 days from May 3 to May 7, 2019. This limited sample window does not allow for a fulsome picture of the marine and benthic environment. The marine environment, including plant communities, benthic communities and planktonic composition fluctuate significantly on a seasonal cycle. Results from a study by Mutsamaki (2015) shows that “the patterns observed in one depth zone or season cannot be directly extrapolated to larger areas and that drawing meaningful conclusions on the small-scale distribution in the fish assemblage structure require sufficient replication of sampling in space and time”. This indicates the evidence presented in the UBHS should not be considered as a ‘meaningful’ representation of the full benthic and invertebrate communities.

The results of the limited UBHS show that there is valuable lobster habitat in all 3 areas studied (Pictou Harbour, Caribou Harbour and Diffuser Area). Lobster require different types of habitat throughout their life cycle; and DFO research indicates that availability of appropriate habitat types is a limiting factor for lobster population viability. Following the larval stage, stage IV lobsters will begin to settle on the ocean floor. Stage IV lobsters seek gravel, cobble and larger sediment to provide shelter. Younger stage IV lobsters may also use sand or silty environments

to bury themselves to provide protection. As lobsters grow and mature, they are able to use multiple habitat types to create shelter. NPNS does not present any adequate plan to mitigate habitat loss or effectively replace habitat.

The Focus Report states that there is a potential effect on marine fish habitat by "direct removal, disturbance of existing substrates utilized by multiple species and their life stages due to the staging, excavation, pipe placement and material backfilling" (Table 7.3-2 Summary of Marine Impacts, Mitigation Measures and Overall Significance). The Focus Report does not provide any description of mitigation measures, including how they will replace the existing habitat or how they will design a staged timing protocol to "incorporate fisheries timing windows to avoid sensitive life stages, periods of adverse weather or spring tides to reduce turbidity and sedimentation". NPNS repeatedly applies a vague blanket statement that they will time the in-water work to consider a multitude of factors (life stages, weather, tides, fisheries activity) while still meeting practical requirements. In order for NPNS to meet the TOR above, and for the Minister to make an informed decision on the effectiveness of proposed mitigation measures, NPNS must provide a detailed plan on these mitigation activities (ex: staged timing of work, Erosion and Sediment Control Plans). Mitigation measures must be assessed by their specific merits and ability to reduce or eliminate harm. It cannot be sufficient to state that a plan will be developed in the future.

Atlantic Herring Vulnerability

7.3 – Impact Assessment for Marine Fish TOR: *Conduct additional impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information, additional studies and/or an understanding of expected movement of contaminants. Assessment methodologies must first be agreed upon by NSE in consultation with relevant federal department.*

Beyond the 8 'important fisheries' identified for commercial, recreational and Aboriginal value, NPNS has recognized three "key indicator species" that warrant further investigation due to their importance in commercial and Indigenous harvests occurring within the LAA: American lobster, rock crab and Atlantic herring. Upon review of potential impacts on the herring fishery, NPNS has ignored a fundamental component related to the vulnerability of the herring population to impacts from the construction of the pipeline and discharge of effluent. The proponent only refers to the direct interaction with harvest activities, with no regard for the potential biological impacts.

There are two spawning stocks of herring in the Southern Gulf, Spring Spawning (SS) and Fall Spawning (FS). The SS stock has been in the critical zone since 2004, and the FS stock has been in the cautious zone since 1999 (Surette 2016). The Fall Spawning stock has 5 major spawning

grounds in the Gulf of St. Lawrence; one of these few remaining spawning grounds is located near the mouth of Pictou Harbour, directly adjacent to the proposed project area (Figure 1, Surette 2016). DFO is currently developing rebuilding plans for both Spring and Fall Spawning stocks. DFO states that "Elevated fishing mortality, during the mid-1990s to 2010, declines in weights-at-age, and low recruitment rates are contributing to declines in SSB, further impeding the rebuilding of the stock." (DFO 2018). Given DFOs mandate to support the protection of habitat and fish stocks using the Precautionary Approach, NPNS must provide further evidence that the pipeline construction and discharge of effluent will not further inhibit the rebuilding of this critically important fish stock; including sublethal effects on reproduction and recruitment rates in order to meet the TOR for fish health.

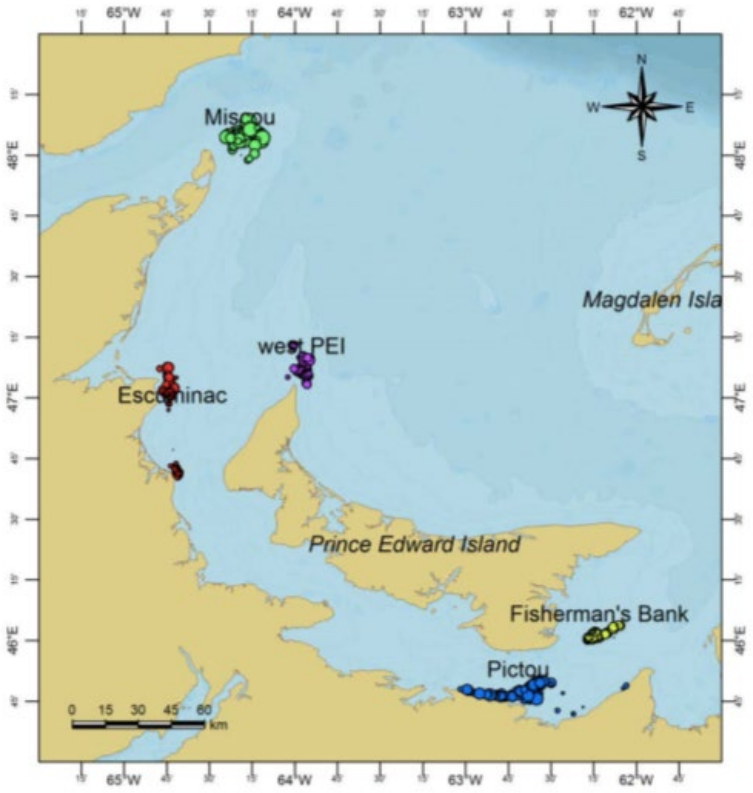


Figure 1: Herring Spawning grounds from 'Estimation of local spawning biomass of Atlantic Herring from acoustic data collected during fall commercial gillnet fishing activities in the southern Gulf of St. Lawrence' (NAFO Div. 4T). (Surette et al., 2016).

Unique and Vulnerable Habitat Concerns

7.3 – Impact Assessment for Marine Fish TOR: *Conduct additional impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information, additional studies and/or an understanding of expected movement of contaminants. Assessment methodologies must first be agreed upon by NSE in consultation with relevant federal department.*

In addition to the general habitat concerns above, NPNS also proposes the pipeline to be placed directly through a federally protected marine refuge, Scallop Buffer Zone 24. The Department of Fisheries and Oceans has established SFA 24 to conserve important juvenile American lobster habitat, as it is essential to the life cycle of the species. DFO states that "no human activities that are incompatible with the conservation of the ecological components of interest may occur or be foreseeable within the area" (DFO List of Marine Refuges, 2019). The construction and operation of a marine pipeline is directly incompatible with the conservation of the identified conservation objectives of SFA 24.

The presence of eelgrass is also identified by NPNS to be valuable in the life cycle of a variety of species, especially as a nursery shelter to provide protection in sandy and silty bottom types. In Table 7.3-2 Summary of Marine Impacts, Mitigation Measures, and overall significance, NPNS states that there is potential for "direct removal, disturbance of highly important habitat type for multiple species and their life stages due to the staging, excavation, pipe placement and material backfilling". The effects are expected to be "long-term, reversible", with the only mitigation method listed to "avoid direct removal of eel grass beds where feasible". NPNS fails to define the extent of 'reversible' impacts, and does not provide an estimate of the extent to which they can feasibly avoid eel grass beds throughout Caribou Harbour. Considering the Terms of Reference, NPNS has not assessed the impact of the loss of valuable and unique habitat to the overall health of the key marine species.

Ice Scour

2.2 Marine Geotechnical Survey TOR: *Conduct geotechnical surveys and provide the survey results to confirm viability of the marine portion of the pipeline route. The surveys must determine the potential impacts of ice scour on the pipeline.*

The risk of ice scouring is also present throughout the proposed area (Focus Report Section 2.2 Marine Geotechnical Survey). The marine geotechnical survey identified 146 ice scour features within the survey area. NPNS states that burying the pipeline 3 m under the seabed is appropriate to avoid scour impacts. This conclusion is based on limited information; NPNS relies on one sample from 2019 and does not consider any additional research or evidence.

Redistribution of Contaminants

7.3 – Impact Assessment for Marine Fish: *Conduct additional impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information, additional studies and/or an understanding of expected movement of contaminants. Assessment methodologies must first be agreed upon by NSE in consultation with relevant federal department.*

The working group has concerns around redistribution of metals during digging to install pipe along Pictou Causeway.

"A baseline marine environmental effects monitoring (EEM) program (including fish tissue analysis [using crab or lobster hepatopancreas tissue chemistry and mussel or oyster tissue chemistry], sediment and water quality, etc.) should be established in the Northumberland Strait marine receiving environment prior to remediation or disturbance of Boat Harbour sediments" (Romo et. al. 2019)

Considering levels of arsenic, cadmium, and other heavy metals along the causeway, there is concern that these heavy metals will be redistributed during the installation process. The report does not include mitigation measure being put in place to avoid the redistribution of dangerous metals. What is being done to mitigate this?

Contaminant Bioaccumulation and Potential Fisheries Closures

7.3 – Impact Assessment for Marine Fish: *Conduct additional impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information, additional studies and/or an understanding of expected movement of contaminants. Assessment methodologies must first be agreed upon by NSE in consultation with relevant federal department.*

4.1 – Marine Water and Marine Sediment: *Conduct baseline studies for the marine environment (such as marine water quality and marine sediment) in the vicinity of proposed marine outfall location.*

4.2 - Marine Water and Marine Sediment: *Update the receiving water study to model for all potential contaminants of concern in the receiving environment (based on the results of the effluent characterization and/or other relevant studies such as Human Health Risk Assessment). Baseline water quality data for Caribou harbour must be applied to this study. Refer also to Addendum 3.0.*

As mentioned in previous communications from fishing industry and others, the cumulative effects of the proposed receiving water contaminants on locally important commercial species such as lobster, herring and scallops, to cite but a few, are a major concern. The report provides details on the composition of the proposed receiving water (p.55 - Table 3.3.1) and models the dispersion of the effluent in the receiving water study (RWS). However, a bioaccumulation model

backed by scientific references and adapted to the special ecosystem parameters of the Northumberland Strait should have been produced.

Our concerns about bio-accumulation have still not been addressed by this latest report. For example, in British Columbia the bioaccumulation effect of contaminants discharged into the marine ecosystem (dioxins, furans, etc.) by local paper mills (ex: Port Mellon) have been the cause of important area fishing closures (Howe Sound area – bioaccumulation in Dungeness Crab hepatopancreas). Thus, the potential for fishery area closures in the Northumberland Strait remains.

Environmental Effects Monitoring

7.3 – Impact Assessment for Marine Fish: *Conduct additional impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information, additional studies and/or an understanding of expected movement of contaminants. Assessment methodologies must first be agreed upon by NSE in consultation with relevant federal department.*

7.4 Environmental Effects Monitoring *Submit an updated Environmental Effects Monitoring (EEM) program based on the results of various relevant baseline studies and an updated receiving water study. Refer also to Addendum item 4.0*

NPNS acknowledges that there is potential for the following impacts: changes to water quality, increase in sound and vibration, disturbance to benthic habitat, disturbance to highly important nursery habitat and spawning grounds, direct mortality (of marine shellfish, benthic invertebrate community) (Table 7.3-2). Despite these impacts, they predict that “no significant residual impacts to marine water quality are expected to arise on any fisheries or fish habitat as a result of this project” (7.0 Fish and Fish Habitat). In order to confirm this conclusion, that there will be no significant residual impacts, NPNS states that they will follow up with the federally-regulated Environmental Effects Monitoring program. Given the predicted conditions, the EEM would NOT require NPNS to conduct a fish community study component or a benthic invertebrate community study. NPNS would have zero mandated requirements to monitor impacts on the fish or benthic communities. Considering for a moment just the impacts on the lobster population, negative effects will not be fully observed until a full life cycle (6-7) has reached the commercial size. Without thoughtful, frequent and thorough monitoring, there could be catastrophic ecosystem level impacts where it is too late to intervene.

The federally-regulated EEM is insufficient in providing consistent baseline data according to Romo et al. 2019 in their review of the documents in consideration of the remediation of Boat Harbour. "**Selection of species, contaminants of concern and sampling locations were ad hoc**

and often inconsistent with environmental effects monitoring requirements under the Canadian federal Pulp and Paper Effluent Regulations"

The PEI Legislative assembly, standing committee on fisheries and agriculture invited representatives from Environment and Climate Change Canada, to discuss the proposed effluent treatment facility. Geoff Mercer, Regional Director General at ECCC stated in his opening remarks "Compliance rates with the regulations is high and based on the self-reported data, over 97% attest that mills across the country conduct are compliant with the regulations. **Despite this high level of compliance with the existing effluent standard, the environmental effect studies have shown that the effluents from 70% of the pulp and paper mills across the country are having an effect on fish and/or, depending, fish habitat."**

Both of these points show clearly how flawed the current system is and that this is not a reliable method to monitor changes. There is clearly data missing from the baseline study to consider it complete.

Fishing Activity, Human Health and Market Access

9.1 Baseline Study Marine Survey: *Complete baseline studies for fish and shellfish tissue (via chemical analysis) of representative key marine species important for commercial, recreational and Aboriginal fisheries in the vicinity of the proposed effluent pipeline and diffuser location.*

7.0 Fish and Fish habitat TOR: *Conduct additional impact assessment for treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information, additional studies and/or an understanding of expected movement of contaminants. Assessment methodology must first be agreed upon by NSE in consultation with relevant federal departments.*

The proponent is required to conduct impact assessments on the key marine fish species important for commercial, recreational and Aboriginal fisheries. In order to verify that there will be no negative impact on fisheries, NPNS must understand and take measures to mitigate interactions with physical fishing activities. NPNS uses a visual observation of lobster buoys in 2019 as a proxy for the exact location of lobster fishing activities (Figure 7.3-3: Northumberland Strait Lobster Buoy Locations). The graphic only shows buoy “clusters” observed on 3 different dates throughout the regular lobster fishing season. This attempt to pinpoint the location of fishing effort lacks relevant information in terms of the number of harvesters/vessels that fish within the area, how many buoy/lines are represented within each ‘cluster’. Generally, this shows that there was a lack of effort from NPNS to understand the most basic facts of the lobster fishing efforts in the area. The graphic fails to show that there are 20 vessels that fish lobster within 300 meters of the proposed marine outfall.

Under the TOR for the Human Health Risk Assessment portion of the Focus Report; NPNS is required to consider the impacts of human consumption of fish, other seafood and other exposure pathways. Of equal importance to the physical and biological impacts on the marine ecosystem, harvesters are concerned with the potential for challenges in marketability and the global reputation of pristine, healthy Canadian lobster. The Canadian lobster industry has an extensive export market, supplying international markets with much of our landed seafood. Canadian seafood harvesters, and the entire lobster sector, are fulfilling food security needs while providing a healthy, pristine renowned product.

NPNS states that there is a risk for tainting of seafood due to the chemical parameters identified in the effluent characterization (9.0 Human Health). NPNS compared the concentration of the parameters to the guidelines for taste and odour in water to identify the risk for tainting. There is potential for tainting under the following pathways: Total Iron, Catechol, 2-Cholrophenol, 2,3 Dichlorophenol, 2,6 Dichlorophenol, 3,4 Dichlorophenol, 2, 3, 4, 6 Tetrachlorophenol, 2,4,5 Trichlorophenol (9.0 Human Health). In addition to the physical risks of consuming tainted product, there will be detrimental impacts to the global reputation of Canadian lobster (and other seafood) products. Market perceptions of poor product quality (by tainting) can persist even if the results show safe exposure levels for consumption. This persistent perception will prolong and deepen the impacts for harvesters and other industry stakeholders. The magnitude of this impact should not be underestimated; this a ‘Canadian lobster’ issue, not just a Pictou or Caribou Harbour issue.

Throughout several areas of the Focus Report, NPNS uses proxy data and conditions from other Paper Excellence Mills, including Howe Sound and Crofton kraft mills in British Columbia. NPNS considers factors such as operating temperature and sedimentation rates to act as a surrogate for expected effluent quality at the proposed ETF. Upon investigation, there are challenges related to seafood tainting and contamination throughout the BC coastline. First, in fishing areas 28-1, 28-3; consumption of crab hepatopancreas should not exceed 55g/week due to dioxin contamination. Secondly, there is a permanent prohibition of all species of bivalve molluscs across the entire coastline and connected water sources of British Columbia. The closure is due to the widespread presence of biotoxins. While these closures are not solely attributable to the Pulp and Paper Mills; NPNS is unable to prove that there would not be similar closures as a result of the increase in dioxins or biotoxins from their proposed effluent.

Using proxy data is an assumption and does not meet the terms of reference which states: "Conduct additional impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information”

The socio-economics of a loss to the fishery for both commercial harvesters and First Nation harvesters is worth an assessment with updated information that it will be consistent with current discharge as the methodology behind treating the effluent is completely different. The

fact that the discharge will meet all provincial and federal discharge quality limits does not equate to the effluent being safe for the fish, benthic communities, and human health; as stated by Geoff Mercer, Regional Director General at ECCC during his appearance at the PEI Legislative assembly, standing committee on fisheries and agriculture on February 1, 2019: “Despite this high level of compliance with the existing effluent standard, the environmental effect studies have shown that the effluents from 70% of the pulp and paper mills across the country are having an effect on fish and/or, depending, fish habitat.”

Northern Pulp sent a team to visit mills in Sweden as well. These mills run systems similar to what is being proposed at the NPNS mill and is again used as a proxy. This makes it appear that meeting future regulations is the main concern and because it is being done successfully in Sweden it can be done successfully in Canada. The Harvesters and Pictou Landing First Nation are concerned with negative effects to the fish and benthic communities and not just if the mill is meeting regulation. There was a report completed by a group in Sweden regarding the Södra Mill; Biologisk recipientkontroll vid Södra Cell Värö Årsrapport för 2013 by Peter Ljungberg and Björn Fagerholm. This document shows that the fish community in the area of the Södra mill is completely different than in the Northumberland Strait. Trawl surveys were completed to look at species in the area and 66% of the catch is a species of flatfish. It’s all sandy/silt bottom with very few crustaceans. The assumption is that both areas can be compared but in actuality the ecosystems are different. The few Norway lobsters in the area of the Södra mill are declining in the area of effluent release over the last 10 years. This has not been directly attributed to the mill but the reason for the decline is also not stated. There are some species increasing in the area of the diffuser as well, but the report states; "The fact that an individual fish species is increasing need not only be positive for a society, it can also cause problems for other species in terms of competition or predation, factors that in turn lead to changes in the entire ecosystem"

Parameters measures and monitored by the regulatory authority in Sweden are TOC, nitrogen, phosphorus and suspended material. This is insufficient information based on what we have heard from Environment and Climate Change Canada regarding the requirement for changes to the Canadian Pulp and Paper Effluent Regulations.

On the human health risk question, there is only talk about doing an eventual study on the subject. This important question should have been discussed more broadly in the report and answered with best available science and modelling. Therefore, even if areas remain open there remains the potential for negative impacts on market access for products coming from areas adjacent to the mill and the Northumberland Strait due to perceived health risks by general consumers.

Sub-lethal effects and insufficient science references

In section 4, there should have been more discussions backed by scientific literature or studies. In particular, there is no discussion of potential sub-lethal effects of the proposed effluents on economically important species such as lobster, herring and scallops even though there exists scientific work and literature on the subject. Instead, the report provides water dispersion modeling accompanied by affirmations based on opinion alone.

Ecosystem Concerns

7.2 Fish Habitat Baseline Surveys: *Conduct fish habitat baseline surveys for the marine environment, to the satisfaction of Fisheries and Oceans Canada.*

The Department of Fisheries and Oceans is currently starting to incorporate an eco-system approach to their stock assessments. To better understand the fluctuations in populations of each species the department is incorporating aspects that effect the population such as: temperature, timing of prey availability, predator abundance, etc. NPNS's proposed effluent release has the potential to affect every species in the surrounding area including but not limited to mackerel, herring, scallops, and lobster directly and indirectly. There are numerous examples of population declines in the Gulf of St. Lawrence due to the change in timing of a species' prey. Changing ocean temperatures are causing phytoplankton and zooplankton to bloom earlier in the year resulting in lower food availability for those species relying on it. This has been shown for small mackerel which rely mainly on calanus copepods as a main prey source. According to NPNS's report, the dominant open water species found is calanoid copepods. Northern Pulp is proposing to release large amount of hot fresh water year-round. This will effect the timing of the copepods reproduction resulting in a mis-matched timing of food for the young mackerel in the area. Lack of food availability results in decreased condition of the mackerel and decreased recruitment to the fishery.

Mackerel are not the only species that rely on phytoplankton and zooplankton for growth and survival, herring, bivavles and even North Atlantic Right Whales all rely on these microscopic organisms for survival.

Understanding possible shifts in phytoplankton and zooplankton blooms is essential to baseline studies for a marine ecosystem. This portion of the baseline survey is incomplete; "Further studies in the area of the proposed diffuser location have begun in the summer of 2019, with **additional studies to be scheduled prior to any construction activities**. These studies aim to provide a baseline of phytoplankton and zooplankton presence, diversity and relative abundance."

Northern Pulp states that eelgrass and eel grass beds are present in Caribou Harbour. DFO has listed eelgrass as an ecologically significant species. It is important to understand what

the loss of eelgrass will mean for the area, but this has been listed as “not significant” by Northern Pulp (page 146).

According to DFO (2009): “Loss of eelgrass and other seagrass populations is a worldwide phenomenon largely associated with anthropogenic stresses. Eelgrass populations have been lost in virtually all areas of intense human settlement. Eelgrass plays an important role in the physical structuring of the nearshore marine environments by filtering the water column, stabilizing sediment, and buffering shorelines. Eelgrass meadows have extremely high levels of primary production, ranking among the most productive ecosystems on the planet. Eelgrass adds spatial complexity above and below the substrate creating a three- dimensional habitat that contributes to higher densities and different species compositions than in unstructured habitats, particularly mud/sand flats. Numerous species across several phyla (seaweed, invertebrates, fish) utilize the support structures of eelgrass and / or benefit from lower predation rates in vegetated habitat compared to unvegetated areas. There are no substitute structuring organisms with the same function as eelgrass that can grow on the sand/mud flats of intertidal and subtidal areas within the salinity ranges occupied by eelgrass. Eelgrass (*Zostera marina*) in eastern Canada has characteristics which meet the criteria of an Ecologically Significant Species. If the species were to be perturbed severely, the ecological consequences would be substantially greater than an equal perturbation of most other species associated with this community.”

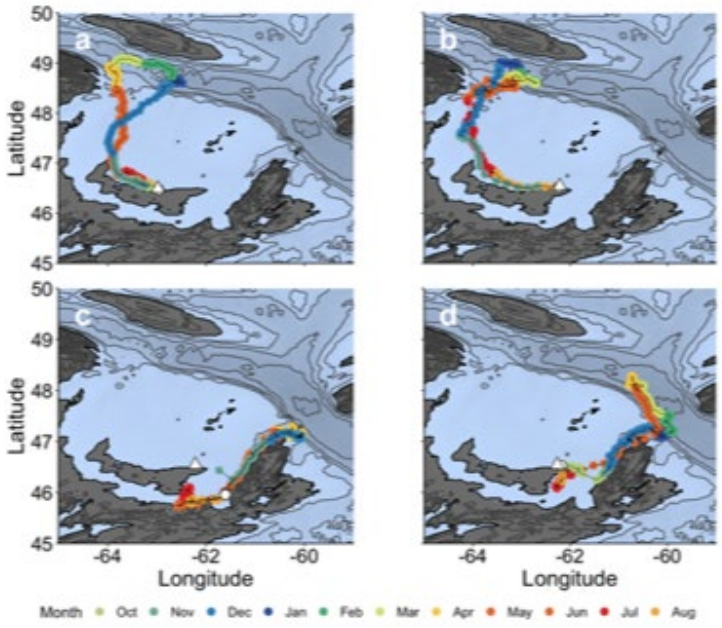
Loss of this species in any capacity should be considered significant and more data should be collected to assess the impacts to the entire eco-system. Loss of eel grass beds has the potential to disrupt and displace numerous species in the area. Sufficient data was not collected for the focus report to understand the fallouts of the loss of eel grass beds in the area.

Species Distribution

7.2 Fish Habitat Baseline Surveys: *Conduct fish habitat baseline surveys for the marine environment, to the satisfaction of Fisheries and Oceans Canada.*

Northern Pulp reported that they completed underwater video transects to determine benthic habitat from May 3-7, 2019. Although is seem obvious, the majority of marine life is capable of mobility. Looking at an area for 4 days in May is not representative of activity in an area for an entire year. Temperature changes and food availability shift which species inhabit which areas at different times of the year, but this is not accounted for while looking at only 4 days of video feed. According to Comeau and Fernand, 2002 in a review of movement studies of American lobster, *Homarus americanus* (American Lobster) move on average between 2 and 19 km depending on depths. The fact that no lobsters were seen during this survey is not representative of year-round benthic habitat but merely a snapshot of a few days in the year. This is insufficient data to be considered a baseline survey.

American lobster is not the only species present in the area but unaccounted for. The figure below shows Atlantic halibut that was satellite tagged in 2014 and the approximate path it took over the next several months. This publication has been submitted for peer review (James, et al 2019). Image C shows, an Atlantic Halibut in the area of the proposed diffuser site in June of 2015. This highlights a gap in baseline data because Northern Pulp was looking at only 4 days with a video transect which is insufficient to capture all species in the area at any given time throughout the year.



"The proposed project will interact with the Rock Crab resource along the proposed pipeline corridor (Figure 7.3-7) but not at depths greater than 10 m or near the diffuser location." This is a flaw in the report because the data is blatantly incorrect. Rock Crabs are in depths greater than 10 m: "Rock crab (Cancer irroratus) is distributed along the Atlantic coast, from South Carolina to Labrador, from the intertidal zone to a depth of 575 meters" (DFO 2008). This underestimates the effect the proposed pipeline will have on Rock Crab.

In closing, our three fishing organizations (GNSFPB, PEIFA and MFU) would like to reiterate that NPNS has failed to adequately address the Terms of Reference outlined in section 7.0 Fish and Fish Habitat, 9.0 Human Health and 2.0 Project Description. Due to limitations in time and capacity, this report only reviewed the information that was relevant to the fisheries. Northern Pulp relies on major assumptions and blanketed statements to suggest that there will be no harm to the marine environment, including fish and fish habitat. There are gaps in the evidence presented, including but not limited to: impact on lobster development and population

health, incomplete or non-existent commitment to follow up monitoring, lack of evidence to protect vulnerable populations or habitat such as fall spawning herring, other SARA (Cod, White Hake), Scallop Buffer Zone 24, eel grass beds, limited understanding of the seasonal impacts of ice cover and ice scouring. The importance of the global optics of the Canadian seafood brand can not be undervalued or excluded from this Environmental Assessment approach.

Our conclusion following the review of the report remains that some of the major concerns brought forth by commercial harvesters have still not been appropriately answered. Therefore, until these concerns have been met, Nova Scotia, Prince Edward Island and New Brunswick harvesters find unacceptable the pursued development of Northern Pulp's currently proposed effluent treatment facility.

All of the above is respectfully submitted to the Nova Scotia Minister of Environment, the Honourable Gordon Wilson, within the 30-day public comment period for consideration of the Northern Pulp Effluent Treatment Facility Focus Report.

The report is the collaborative effort of science staff from all three organizations. These are professionals with years of experience working and researching directly on the waters of the Northumberland Strait.

Authors:

Victoria Cullen holds a Bachelor of Arts Honours in Economics and Aquatic Resources from St. Francis Xavier University. Her studies were focused in fisheries bioeconomics. She is currently the Science and Communications Coordinator with the Gulf Nova Scotia Fleet Planning Board; where responsibilities include conducting 3-4 annual fisheries monitoring scientific projects on lobster along with projects on other species.

Melanie Giffin holds a Bachelor of Science, major Biology from St. Francis Xavier University and a Graduate Certificate of Science, major Marine Biology from James Cook University (Australia). She has been working as a marine biologist with the lobster industry since 2006 in various capacities from monitoring quality of lobster at the plants to researching lobster health at the University of Prince Edward Island's Atlantic Veterinary College: Lobster Science Centre. Her time with the PEIFA requires close collaboration with the Department of Fisheries and Oceans on numerous research projects including tuna otoliths, Atlantic halibut satellite tagging, lobster/crab predation, lobster larval collectors, tuna gonads, and mackerel length/frequency.

Dr. Dounia Daoud holds a Ph.D. in biology from the Université du Quebec à Rimouski, and has conducted post-doctoral research on the nutrition and physiology of crustaceans. She has been the science director of Homarus Inc. since 2010.

Melanie Giffin – Curriculum vitae

Current Work Position (2015 – current)

Marine Biologist and Program Planner
Prince Edward Island Fishermen's Association — Charlottetown, PE

- Maintenance of Marine Stewardship Council Certification (MSC) for the PEI MSC Stakeholder Group.
- Co-ordination and delivery of lobster quality and handling training courses.
- Oversight of license rationalization programs for various species.
- Professional services: proposal preparation, research, oversight and direction of successful projects, data analysis, data management, timely report writing and information distribution.
- Liaise with various levels of government and public agencies.
- Oversight, data collection and information distribution of numerous national files including: Marine Protected Areas, North Atlantic Right Whales, Marine Mammal Protection Act, Seafood Import Monitoring Program

Education

2005 - Graduate certificate Science, Marine Biology
James Cook University — Townsville, Queensland, Australia

2004 -Bachelor of Science, Biology
St. Francis Xavier University — Antigonish, Nova Scotia, Canada

Publications

James, T., Landsman, S., Ramsay, L., **Giffin, M**., Le Bris, A. & van den Heuvel, M. (2019): Migration Patterns of Atlantic Halibut Captured in the Southern Gulf of St. Lawrence as Assessed with Pop-up Satellite Archival and Floy Tags. Canadian Journal of Fisheries and Aquatic Sciences *(submitted for peer review).*

Presentation Chair

2011 - 9th International Conference and Workshop on Lobster Biology and Management
Bergen, Norway
Session Title: “Fisheries Development and Live Holding”

2011 - 7th Annual Lobster Science Workshop
Charlottetown, Prince Edward Island, Canada

Presentations

2009 - Fishermen and Scientists Research Society 16th Annual Conference. “Using Lobster Blood to Study Nutritional Status”. Truro, Nova Scotia

2009 - PEI Fishermen's Association Annual General Meeting. “Atlantic Lobster Moult and Quality Project”. Charlottetown, Prince Edward Island
2010 - Lobster Quality and Handling Workshop Series: “Lobster Health Research: An overview of the AVC Lobster Science Centre”; “Biology of the Lobster*, Homarus americanus*”; “The Quality of Fresh vs. Held Lobster”. Cornwallis, Nova Scotia Bridgewater, Nova Scotia
2010 - 6th Annual Lobster Science Workshop. “Lobster Quality: A Field Perspective”. Truro, Nova Scotia
2011 - Collaborative Lobster Science Workshop. “Lobster Biology”. Truro, Nova Scotia
2011 - 9th International Conference and Workshop on Lobster Biology and Management. “Physiological Assessment of American Lobsters (*Homarus americanus*) held in a specialized Live Seafood Transport System”. Bergen , Norway
2011 - 7th Annual Lobster Science Workshop. “Aqualife Transport System: a healthy alternative?”. Charlottetown, Prince Edward Island.
2012 - PEI Fishermen's Association Annual General Meeting. “How Handling Affects Lobster Quality”. Charlottetown, Prince Edward Island
2013 - The Mi'kmaw Conservation Group: The Confederacy of Mainland Mi'kmaq. “Levels of Environmental Contaminants in Lobster Tail Meat in Different Sites Across the Maritimes”. Annapolis Valley, Nova Scotia.
2014 - The Mi'kmaw Conservation Group: The Confederacy of Mainland Mi'kmaq. “Levels of Environmental Contaminants in Lobster Tail Meat in Different Sites Across the Maritimes”. Pictou Landing First Nation, Nova Scotia.
2016 - PEI Fishermen's Association Annual General Meeting. “Research Initiatives Update”. Charlottetown, Prince Edward Island
2017 - PEI Fishermen's Association Annual General Meeting. “MSC, Mackerel, MPAs, Electronic Logbooks: Where are we now and where are we going?”. Charlottetown, Prince Edward Island
2018 - PEI Fishermen's Association Annual General Meeting. “UPDATE! MPA's, Northern Pulp and Lobster Handling Sessions Charlottetown, Prince Edward Island

Industry Outreach

2010 - Aquatic Animal Medicine AVC Training Course for CFIA Veterinarians
Charlottetown, Prince Edward Island

- *Lab: Lobster Health Assessment, Handling and Bleeding*
- *Lab: Anatomy and necropsy of Lobster*

2010 – 2019 - Future Fishers Program
Prince Edward Island

- *Lobster Biology, Life Cycle and Diseases*
- *Lab: Lobster - Biology, Life Cycle and Diseases*
- *Lobster Quality and Handling*
- *Lab: “Lobster 101”*
- *Best Handling Practices*

2010 - VPM 482 Aquaculture Diagnostic Services Rotation
Charlottetown, Prince Edward Island

- *Lab: Lobster Anatomy and Diagnostic Tools*
- *Lab: Lobster Health Assessment Techniques in the Field*

2011 – 2019 - Mi'kmaq Confederacy of PEI Training Program
Abegweit First Nations Scotchfort, Prince Edward Island
Lennox Island Community Centre
Lennox Island, Prince Edward Island

- *Lobster Biology and Life Cycle*
- *Lobster Quality*

2011 – 2019 - Lobster Quality and Handling Workshop Series
Prince Edward Island

- *Lobster Quality and Handling: An in-depth look how handling practices affect your catch.*

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PRINCE EDWARD ISLAND FISHERMEN'S ASSOCIATION

Sincerely,

Ronald Heighton,

President
Gulf Nova Scotia Fleet Planning Board

Martin Mallet,

Executive Director
Maritime Fishermen's Union

Robert Jenkins,

President
Prince Edward Island Fishermen's Association

CC:

MP Sean Fraser
MP Mike Kelloway
MP Lenore Zann
Hon. Keith Colwell
MLA Karla MacFarlane
Mr. Serge Doucette

Finfish Health in Relation to the Proposed Northern Pulp Nova Scotia Effluent Treatment Facility

A Scientific Report

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Table of Contents

1.0 Definitions

BKPME – Bleached kraft pulp mill effluent
NPNS – Northern Pulp Nova Scotia
ETF – Effluent treatment facility
AOX – Adsorbed organohalides
TN – Total nitrogen
TP – Total phosphorous
DO – Dissolved oxygen
BOD – Biological oxygen demand
COD – Chemical oxygen demand
ASC – Antibody secreting cells
ROS – Reactive oxygen species
RWS – Receiving water system
MFO – Hepatic mixed-function oxygenase
EROD – Ethoxyresorufin-*o*-deethyase
VTG – Vitellogenin

2.0 Foreword – Statement of Qualifications

Laura Marie Braden, PhD, holds a doctorate in Molecular Immunology, with a focus on Aquatic Animal Health. With over a decade in experience in her field, Dr. Braden has over 10 publications in peer-reviewed journals, has presented her research at over 40 national and international conferences, 15 of which where she was an invited speaker. She sits on the editorial board as an external reviewer for many journals, including *Journal of Fish Diseases*, *Parasites & Vectors*, *Aquaculture*, *Fish & Shellfish Immunology*, and *Developmental & Comparative Immunology*. She currently leads the Molecular Genetics and Biotechnology Program at AquaBounty Canada and is an Adjunct Professor in the Department of Veterinary Medicine at the Atlantic Veterinary College. A *curriculum vitae* for Dr. Braden can be found in Appendix I.

3.0 Executive Summary

The following report includes a scientific review of the available information pertaining to the negative effects of bleached kraft pulp mill effluent (BKPME) on health of finfish. Specifically, this report attempts to summarize the scientific consensus on the physiological effects of BKPME on freshwater and marine finfish, and how those data pertain to the potential risks associated with the proposed effluent treatment facility (ETF) of Northern Pulp Nova Scotia ("the Proponent"; NPNS), which aims to discharge 85 million litres of BKFME per day into the Northumberland Strait.

Although improvements in treatment of BKPME have certainly decreased acute lethality to finfish, effluent from pulp and paper mills continues to release chemicals that affect physiological systems. Potential effects on fishes from exposure to BKPME can be generalized into two main categories; 1.) Direct effects, such as those impacting physiological processes including reproduction, immunity and hepatic function, and 2.) Indirect effects, including ecosystem alteration in habitat and food availability. The identity of the compounds associated with these effects remain to be elucidated; however, the scientific consensus is that these effects are mill-specific and must be considered in the context of environmental and ecological effects (1–5).

This report will first attempt to summarize the available scientific literature on the direct effects of BKPME exposure on finfish, and by doing so, will demonstrate significant deficiencies in the conclusions drawn by the Focus Report (FR), specifically related to the findings of no significant impact by the proposed effluent treatment facility on physiological parameters and fitness of fish populations in the receiving water system (RWS).

These deficiencies are summarized in the following document and include, a.) an assessment of the major findings and conclusions expressed by NPNS, b.) an assessment of the reliability of the underlying research relied upon to create these findings and conclusions, c.) identification of information gaps in the materials of the Focus Report, d.) impacts of these gaps on the reliability of the conclusions made in the Focus Report, and e.) a description of assumptions that are relied on in the Focus Report that drove the main conclusions filed by the Proponent.

Taken altogether, this assessment of the available data pertaining to the proposed ETF with respect to potential negative effects on finfish in the RWS concludes that there is insufficient evidence to support the overall claim by NPNS that there are no potential negative impacts on finfish health. For example, there is no empirical data characterizing the effluent that is predicted to enter the RWS, nor is there any empirical data demonstrating the physiological effects of this effluent on finfish that reside in the RWS, specifically, the Northumberland Strait.

Despite the lack of information or evidence presented by the Proponent in the EARD and the subsequent FR, where only predictions and modeling were used to assess impact to fish populations in the RWS, the Proponent reaches a firm conclusion that there is no expected impact to fish populations. This conclusion is not appropriate for the following reasons:

1.) *The Proponent does not provide adequate evidence to support a conclusion that there is no potential significant impact on finfish*
2.) *The Proponent does not supply critical information concerning effects of their predicted effluent on finfish reproduction, immunity, or liver function – three systems known to be affected by BKPME*
3.) *The Proponent claims that any damage will be "minimal" but not substantiated by data present in the report, nor is it substantiated by the pertinent scientific literature*
4.) *There is no evidence that the receiving water system (i.e., the Northumberland Strait) will be able to absorb and disperse the volume of effluent proposed by the ETF*

Given these described deficiencies, further studies (acute, sublethal, and generational) on the effects of the proposed BKPME on finfish residing in the RWS are required.

4.0 Scope of Review

This current critical review focuses on all areas of both the Environmental Assessment Registration Document (EARD) and subsequent Focus Report (FR) that pertains to the potential negative physiological consequences of exposure to the predicted effluent on finfish health (freshwater and marine).

Within the 245-pg FR, this review focuses specifically on Sections 3-4 and 7, with associated data found in Appendices 3, 4 and 7, and associated documents.

The FR attempts to address Terms of Reference delivered to NPNS after consultation with public stakeholder groups. The conclusions and recommendations are based primarily on the information provided in the FR and how it relates to published data on pulp and paper mills and BKPME, and how BKPME effects finfish, rather than a global review of the potential effects to marine species. Furthermore, this current report addresses the main points within the Terms of Reference pertaining to finfish health and whether these terms were addressed by the FR.

4.0 Background Review

4.1 Pulp and Paper Mills

The pulp and paper industry convert natural wood resources or recycled fibre into a wide variety of paper products. Canada is the world's largest exporter of pulp and newsprint, and the pulp and paper industry is a fundamental pillar of the economy and natural resource sector exporting over $13 billion CDN in 2013 (6). In order to manufacture paper products, wood chips or other plant fibres must be converted to pulp to create thick fiberboard that is later processed in a paper mill. The pulp and paper industry is the sixth largest polluting industry, discharging a variety of gaseous, liquid and solid wastes into the environment. The processes used to produce pulp are water intensive (50-60 m3 of water to produce a ton of paper; (1)) and generate large quantities of effluent which is comprised of > 240-250 different chemicals with varying degrees of toxicity to aquatic ecosystems (1,7). Due to the large-scale environmental degradation associated with this industry, it is imperative that a strict science-based approach be utilized to mitigate negative effects to both ecosystems and human health.

Resultant pulp only constitutes about 40% of the original weight of the wood, which results in a considerable proportion of organic matter as waste in effluents. These have potential for considerable damage to the receiving water system (RWS) if discharged as untreated due to high concentrations of biological oxygen demand (BOD), chemical oxygen demand (COD), adsorbed organohalides (AOX), suspended solids, fatty acids, tannins, resin acids, lignin and derivatives, sulfur and sulfur compounds (1). Both naturally occurring and xenobiotic compounds are present in effluent, with variable levels of persistence (8), and with acute and chronic toxic effects of varying

severity (9). Further to this complexity is the assertion that no two paper mills will discharge identical effluents due to operational differences. Thus, every pulp and paper mill is a large, complex, highly interactive operation with mill-specific effluent that should be characterized fully to understand the degree of toxicity (1).

4.1.2 Pulp Mills in Canada

As of 2019, there were 89 pulp mills across Canada, primarily located in British Columbia, Ontario, and Quebec (6,10), of which a majority operated on chemical pulping processes. Chemical pulp mills use two processes: either sulfate (kraft) or sulphite processes, both of which rely on high temperatures to break down lignin. Pulp produced from these processes are used for fine paper products. The kraft process involves treating wood chips with white liquor (sodium hydroxide and sodium sulfide) to break down and remove hemicelluloses and lignin, resulting in strong cellulose fibres. In contrast, the sulphite process results in weaker cellulose fibres, but creates pulp that is easier to bleach (i.e., bleached kraft pulp mill; BKPM). Alternative methods include thermomechanical and chemi-thermomechanical pulp mills, which apply steam to refine or pre-treat input wood chips with weak chemical solutions. All the above processes are known to produce considerable pollutant loadings to land, air, and water (11). For example, Canadian pulp, paper and paperboard mills released 302 tonnes of pollution onto land, 166,613 tonnes of air emissions, and 5,955 tonnes of wastewater in 2013 (6).

In 1992, regulations pertaining to the discharge of pulp and paper mill effluents (*Pulp and Paper Effluent Regulations*; *PPER*) were revised in Canada and included stricter control for discharge of BOD, TSS and acute lethality. Moreover, the revised regulations were paired with the establishment of the EEM program, which examines the effects of effluent on wild fishes. Data from the first several cycles of the EEM program showed that BKPME was causing general eutrophication in the receiving environments in addition to a national pattern of metabolic and physiological disruption in fish (4,12).

4.1.3 Northern Pulp Bleached Kraft Pulp Mill

The Northern Pulp Nova Scotia Corporation (NPNS) Bleached Softwood Kraft pulp mill is located at Abercrombie Point adjacent to Pictou Harbour in Pictou County, Nova Scotia. NPNS is a typical bleached kraft pulp and paper mill that has been operating in Pictou County, Nova Scotia, since 1967 and manufactures ca. 275,000 t of bleached kraft pulp annually (10). Effluent wastewater from NP has been treated by retention in settling and aerated ponds in a tidal lagoon known as Boat Harbour, in the Pictou Landing First Nation (PLFN), under a provincial agreement that expired in 2015. Since that time, the mill has been tasked with finding or developing an alternate facility to treat and dispose of wastewaters.

The Replacement Effluent Treatment Facility Project proposed by NPNS was registered February 7, 2019 for environmental assessment (EA). The EA Registration Document (EARD) was deemed insufficient by the Minister of Environment and a Focus Report was required to address a Terms of

Reference (TOR) document. The TOR included requests for more details on many deficiencies of the project, including:

1.) Public, Mi'kmaq and government engagement
2.) Project description
3.) Facility design, construction and operation and maintenance
4.) Marine water and marine sediment
5.) Fresh water resources
6.) Air quality
7.) Fish and fish habitat
8.) Flora and fauna
9.) Human health
10.) Archaeology
11.) Indigenous people's use of land and resources

With respect to the overall subject of this current review, there were many questions raised by reviewers of the EARD pertaining to potential impacts on fish and fish habitat. The TOR specifically requested documentation of these potential impacts. However, the Focus Report is extremely deficient in providing those details. In fact, there is no data showing effects of proposed effluent on fish, nor does the report acknowledge pre-existing data of the effects of BKPME on fish health. The following section attempts to summarize these effects.

4.2 Effects of Bleached Kraft Pulp Mill Effluent on Aquatic Animal Health

Bleached kraft pulp mill effluent (BKPME), like the effluent produced by NPNS, is a complex mixture of chemicals that possess environmentally active properties and are known to be toxic and mutagenic to a wide variety of aquatic organisms (2,9,13). The process of pulping and bleaching generates dissolved lignin, cellulose degradation products, and other wood extractives such as terpenoids, resin acids (RAs), phytosterols, and chlorophenolic compounds, some of which that are known to persist in the receiving environment for > 30 years (e.g., RAs; (8,14)). Wastewater discharge can include solids and dissolved organic matter which increases the biological oxygen demand (BOD) in receiving waters; ammonia, nitrates, phosphorus, and sulfur compounds, which cause nutrification of receiving waters; and heavy metals such as arsenic, cadmium, hexavalent chromium, lead, manganese, selenium and zinc; and finally, chelating agents, chlorates, and organochlorine compounds, known toxicants (6,9). The use of elemental chlorine for bleaching in kraft mills has historically results in elevated levels of organochlorine compounds such as polychlorinated dibenzo-*p*-dioxins (PCDD) and dibenzofurans (PCDF) in receiving environments. In Canada, *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations* issued under the *Canadian Environmental Protection Act* (CEPA), require mills using a chlorine bleaching process to

discharge effluent with dioxin and furans below measurable levels due to the closing of several fisheries.

However, despite the move away from elemental chlorine, organochlorines have not been eliminated from discharges (9), and detectable levels of toxicologically chlorinated dioxins and dibenzofurans have been detected in effluents from mills that use ECF technology, including that of NPNS (10). This is attributable to the co-generation of molecular chlorine from chlorine dioxide generators, as well as the liberation of chlorine from chemical reactions during pulp bleaching (1,15). Thus, there remains a certain level of AOX-associated toxicity in BKPME regardless of the elimination of elemental chlorine in bleaching processes. This has been demonstrated for both aquatic invertebrates (16), and vertebrates (17).

Despite several decades of research, pulp mill effluents are poorly described, and there is limited progress in identifying agents responsible for disrupting fish physiology due to complexity and variability of effluents (18). Notwithstanding, there are several parameters of BKPME that have consistently correlated with negative outcomes, including AOX, BOD, COD, RA, phytosterols and TSS loading. These toxic effects have been exhaustively explored over the last 20 years on both receiving aquatic ecosystems and organisms that reside within. With respect to wild fish populations residing in areas receiving pulp mill effluent, there are a variety of negative physiological impacts, including compromised immunity (19–22), altered endocrinology and reproductive parameters (4,5,15,17,23–30), organocellular damage (31,32), genotoxicity (13,33–35), altered hepatic retinoid storage (14), hepatic sex steroid ligand availability (36), and altered hepatic enzymatic activity (37,38). The following sections attempt to summarize some of the scientific data associated with these negative impacts on immunocompetence, reproduction and hepatic enzyme activity.

4.2.1 Effects on Immunocompetence

Negative impacts on fish immunity is strongly associated with exposure to BKPME, such as decreased numbers and activity of lymphocytes in fishes exposed to effluent including perch (39), roach (21), and mummichog (40). Changes in hematology may reflect a more profound effect on lymphocyte maturation and migration, which may indicate general immunosuppression. An immunosuppressive effect was reported for roach exposed to BKPME and this was correlated with lower numbers of circulating lymphocytes and circulating antibodies (20), and numbers of antibody secreting cells (ASCs) are reduced in laboratory exposure studies (21). Moreover, macrophage function was shown to be reduced in effluent-exposed mummichog (40). With respect to disease susceptibility, macrophages play a key role in detection and clearance of pathogens and are critical in orchestrating immune responses of fish (41). Thus, reduction in macrophage activity in BKPME-exposed fish suggests these animals are more susceptible to disease. Indeed, another study observed significantly higher burdens of a ciliate protozoan, *Ichthyophthirius multifiliis*, in fish residing in a BKPME-contaminated lake (20). In the freshwater fish, *Channa punctatus*, immunotoxicity due to BKPME exposure was elevated compared to controls and was exacerbated as a function of

temperature (19). Interestingly, there was a biphasic effect which was dependent on the time of exposure. For example, there was a stimulatory effect on ASCs after a short-term effluent exposure, while after long-term exposure there was an inhibitory effect. Santos *et al.* (42) observed significant oxidative damage due to activation of circulating phagocytes in European eel (*Anguilla anguilla*) gill, a tissue known to be susceptible to oxidative damage in response to BKPME exposure (43). Oxidative stress associated with activation of macrophages in fish exposed to BKPME has been reported, with incongruent results related to exposure times and distance from the discharge source (42). Thus, it is clear that chemicals present in BKPME significantly alters normal immune function, and furthermore, that these effects must not be considered in the absence of environmental (e.g., temperature, pathogen load) effects.

4.2.2 Effects on Reproduction

Decades of studies demonstrating a range of effects have shown that a major concern with respect to effects on fish physiology is the potential for BKPME to alter fish reproduction and fertility as observed by delayed sexual maturation, reduced circulating gonadotropins, smaller gonads and reduced secondary sexual characteristics (reviewed in (5,18,44–46)). These effects have been reported in North American, Scandinavian, New Zealand, and Chilean studies, where effluents from all types of mill processes, wood furnishes, and treatments are capable of impairing fish reproduction from the molecular to the individual or population level (17,18,47). Despite intense research efforts, the precise mechanisms underlying these adverse reproductive outcomes are not clear and the identification of bioactive substances have proven challenging. Research has concentrated on biologically active sex steroids in response to effluent exposures. Most of these studies have focused on estrogenic (48,49) and androgenic (29) pathways. While there is certainly strong evidence that these pathways are affected, they are not the only pathways that could be involved in the reproductive effects caused by pulp and paper mill effluents. In fact, many effluents have strong anti-reproductive activities but are neither strictly estrogenic nor androgenic in standard assays (18). Of the constituents of wood (''wood extractives''), the plant sterol β-sitosterol is one of the most common one present in effluents (50), and is known to cause several endocrine effects in fish, including vitellogenin (VTG) induction altered plasma sex hormone levels and gonadal steroidogenesis (51). Table 1 attempts to summarize the known reproductive effects on finfish due to BKPME exposure.

Table 1. Examples of reproductive effects due to BKPME exposure in teleost fishes (reviewed in (18)). As can be observed, deleterious reproductive effects are still observed despite the substitution for chlorine dioxide in ECF bleaching. NPNS has described its processes as "typical" in this category (10).

Test fish	Country	Treatment[1]	Toxic effect	References
White sucker (*Catostomus commersoni*)	Canada	ECF	Reduced gonad size, circulating sex hormones, and fecundity; delayed	(25)

Test fish	Country	Treatment[1]	Toxic effect	References
			sexual maturity; changes in secondary sex characteristics	
Goldfish (*Carassius auratus*)	Canada	ECF, TMP	Depressed sex steroids; Neuroendocrine pathways affected	(24,52)
Fathead minnow (*Pimephales promelas*) Zebrafish (*Danio rerio*)	Canada	ECF	Suppression of egg production; Induction of reproductive pathways	(53,54)
Mummichog (*Fundulus heteroclitus*)	Canada	ECF	Depression of testosterone production	(55)
Rainbow trout (*Oncorhynchus mykiss*)	Canada, Brazil, New Zealand, Chile	EC/ECF	Estrogenic effects; Increased gonad size and early maturation	(5,56,57)
Redbreast sunfish (*Lepomis auritus*)	USA	EC/ECF	Reduced estradiol, increased incidence of atretic vitellogenic oocytes	(58)
Largemouth bass (*Micropterus salmoides*)	USA	EC/ECF	Reduced gonad size lower plasma sex hormones, reduced vitellogenesis	(59)
Mosquitofish (*Gambusia holbrooki*)	USA	-	Masculinization of females	(28,60,61)
European perech (*Perca fluviatilis*) Roach (*Rutilus rutilus*)	Finland	ECF	Decreased size of gonad, reduction in plasma sex steroids	(39)
Eelpout (*Zoarces viviparous*)	Sweden	ECF	Significantly higher males in population	(59,62)
Shortfin eel (*Anguilla australis*)	New Zealand	ECF	Increased plasma estradiol and testosterone	(63)

[1]Treatment process refers to either elemental chlorine (EC), elemental chlorine free (ECF) bleaching, or thermomechanical pulping (TMP)

As previously stated, the exact chemical compounds involved in the effects on reproduction are ambiguous; however, they are known to occur in the absence of elemental chlorine bleaching such as the ECF processes utilizing chloride dioxide (15), similar to the processes performed at NPNS. Given the wide variety of reproductive effects observed, it is unlikely that there is a single chemical involved in anti-reproductive effects. The observation that neuroendocrine pathways are affected by BKPME exposure (24,64), in addition to the contribution of endocrine signalling in both androgenic and estrogenic pathways, implies that many different chemical compounds interact with neuroendocrine systems. However, many effluents have strong anti-reproductive activities but are

neither strictly estrogenic nor androgenic in standard assays (18). Thus, there is clearly a multitude of mechanisms contributing to these effects that are a product of the mill-specific processes.

4.2.4 Effects on hepatic enzymatic activity

BKPME is known to induce mixed-function oxygenase (MFO) in finfish. Induction of MFO enzymes in fish is a consistent indicator of the presence and bioavailability of polyaromatic compounds such as polynuclear aromatic hydrocarbons (38), some plant hormones (65), and chlorinated dioxins and furans (66). For BKPME, MFO induction can be used as a proxy for potency of the chemical constituents within, but the identity, concentration and ecological hazards of the individual compounds requires further analysis.

The elimination of elemental chlorine in the pulp bleaching process through new regulations led to a major reduction of toxic AOX-associated compounds in BKPME, and subsequently resulted in substantive decrease in the presence of these compounds in the receiving environment and associated organisms (11). However, negative impacts on fish are still observed despite improvements, including MFO induction (38) and increased liver size (67). It is thought that wood extractives are a major cause of this effect (66,68), and key molecules involved have been identified as chlorinated lignin-derivatives (37). Resin acids (RAs) and phytosterols are consistently found in pulp mill effluent and are capable of inducing liver damage via MFO enzymes. A well-established method for determined the activity of these enzymes is via the standard bioassay using rainbow trout where the activity of ethoxyresorufin-*o*-deethylase (EROD) is measured (66). Using this method, many researchers have demonstrated substantial induction of MFO in fishes exposed to BKPME, both in chlorine-based processes, and ECF-based processes similar to the one employed by NPNS (10,38,65).

5.0 Proposed Replacement Effluent Treatment Facility Project

The proposed project will consist of the development of a new effluent (wastewater) treatment facility (ETF) constructed on Northern Pulp property, and a transmission pipeline that will carry treated effluent overland and in the marine environment and discharge via an engineered diffuser (marine outfall) (10).

The proposed new ETF will employ the AnoxKaldnes BAS™ Biological Activated Sludge process purchased from Veolia Water Technologies, which combines Moving Bed Biofilm Reactor (MBBR) technology with conventional activated sludge. Once treated onsite at Northern Pulp's facility, effluent will be sent through an approximately 15 km long pipeline. The pipeline will enter the south side of Pictou Harbour and make landfall on the north side of the harbour roughly following Highway 106 right-of-way to Caribou, and then re-enters the marine environment adjacent to the Northumberland Ferries marine terminal and continues for approximately 4.0 km through Caribou Harbour to the Northumberland Strait, terminating at an engineered marine outfall.

As stated in the EARD, "*the effluent is anticipated to meet compliance with federal PPER*" (pg 84), and furthermore, that effluent "*will meet ambient water quality at the edge of a standard mixing zone*" (pg 84).

The quality of this effluent entering the RWS will be described in the following section.

5.1 Predicted Effluent Quality

Expected daily maximum water quality characteristics of the treated effluent were used to conduct modelling for simulated concentrations over a one-month period (10). Table 1 compares those data with the background water characteristics of the RWS. What can be observed is the significant increase in concentration of all metrics. However, this data does not consider any long-term accumulation of various parameters of the effluent. For example, AOX and RA are known to be recalcitrant to degradation and persist in the environment (3,8,69), and as such, an accumulative model is necessary to predict environmental concentrations over extended periods of time. Additionally, these values are predicted and do not represent the actual chemical characterization of the ETF BKPME, therefore, it is unclear what the actual increase or decrease of these metrics will be upon discharge of the effluent.

Table 2. Comparison of background quality with proposed ETF effluent water quality in receiving water system (Caribou Harbour). Parameters with empirical evidence for negative physiological effects on aquatic organisms are denoted with an asterisk (*).

		Average Value		
PARAMETER	**Unit**	**Background[1]**	**Average Velocity (2018)[2]**	**Fold change[3]**
AOX*	mg/L	n/a	7.8	7.8x
TN*	mg/L	0.17	6.0	35x
TP*	mg/L	0.5	1.5	3x
Colour	TCU	4.5	750	167x
COD*	mg/L	n/a	725	725x
BOD_5*	mg/L	ND	48	48x
TSS*	mg/L	2.5	48	19x
DO*	mg/L	9.7	>1.5	-6.5x
pH*	-	7.8	7.0-8.5	-1.1x – 1.1x
Temperature (summer)*	°C	16.8	37	2.2x
Temperature (winter)*	°C	1	25	25x
TDS	g/L	30	2	-15x
Cadmium	µg/L	0.084	1.03	12.2x
TDF*	pg/L	3.213	3.675	1.14x
PAH*	µg/L	0.01	0.044	4.4x
TRA*	mg/L	0.06	0.57	9.5x
TFA*	mg/L	0.07	0.335	4.8x
TPh*	µg/L	ND	6.13	6.13x

[1]Daily background water quality of the receiving water system (Caribou Harbour), obtained from Table 4.2-3 in the Focus Report (10)
[2]Daily effluent water quality during average velocity operations, obtained from Table 4.2-4 in the Focus Report (10)
[3]Calculated fold-change increase or decrease (-) of components taken as the ratio of effluent/background measurements

As can be observed in **Table 2**, all of the measured analytes will be altered in the RWS to varying degrees; however, the analytes that are of highest concern with respect to impact on fish health and fitness include concentrations of AOX, COD, BOD_5, TSS, pH, DO, TDF, PAH and TRA. Most studies evaluating negative physiological effects of BKPME exposure looks at the effluent as a complex mixture. Some of the available scientific evidence addressing components on an individual in reference to observable effects on fishes is summarized in **Table 3**.

Table 3. Summary of effects of the major harmful BKPME components on finfish health, including the predicted discharge from NPNS, effects that have been documented, the species and accompanying references.

Analyte	Expected daily discharge[1] (kg/day)	Effect(s)	Species	Reference(s)
Adsorbed organic halides (chlorinated compounds)	663	MFO induction; MFO induction, genotoxicity	Rainbow trout; Chinook salmon	(35,37)
Chemical Oxygen Demand	61,625	-	-	-
Biological Oxygen Demand	4,080	Reproductive anomalies, infertility	Fathead minnow	(4)
Suspended Solids	4,080	-	-	-
Dioxins and Furans	NP	Masculinization; Genotoxicity; Immunotoxicity; Anti-estrogenic	Mosquitofish; Smallmouth bass; Spotted snakehead	(19,28,34,70)
Resin Acids	NP	Altered vitellogenin, sex steroids in females; Depleted hepatic retinoic acid levels; Testosterone depression	Zebrafish; White sucker, Rainbow trout; Mummichog	(14,55,71)
Fatty Acids	NP	-	-	-
Phenols	NP	Testosterone depression	Mummichog	(55)
Polyaromatic hydrocarbons	NP	MFO induction; Altered testosterone; VTG induction	Rainbow trout; Mummichog; Rainbow trout	(23,37,51,65,68)

[1]Based on data provided in the FR

5.2 Findings of EARD/FR pertaining to Impacts of ETF and BKPME on Finfish (Freshwater and Marine)

In short, both the EARD and FR conclude that there are no potential significant impacts on either freshwater or marine fish or fish habitat.

These are described in detail below.

5.2.1 Freshwater

In the EARD, the Proponent summarizes the residual adverse effects and environmental effects (Section 8.6 and pg. 535). In this, during all three Construction, Operation and Maintenance Phases of the project, the conclusion was:

> *"No significant residual environmental effects identified with planned and standard mitigation implementation, authorization, and environmental protection measures".*

Similar to the EARD, the FR prepared by NPNS reported a summary of no significant impact due to operations (included effluent discharge):

> *"Once the project is operational, no impacts are anticipated to freshwater fish and fish habitat during the operation and maintenance phase"* (pg. 220)

5.2.2 Marine

In the EARD, the Proponent summarizes the residual adverse effects and environmental effects (Section 8.12 and pg 588). In this, during all three Construction, Operation and Maintenance Phases of the project, the conclusion was that there would be no significant impact:

> *"Overall, based on the results of this EA Registration, it is concluded that, with planned mitigation and the implementation of best practices to avoid or minimize adverse environmental effects, the residual environmental effects of the project, including the effects of accidents, malfunctions and unplanned events as well as cumulative environmental effects, during all phases are rated not significant"*

Similar to the EARD, the FR prepared by NPNS provided the following summary of the assessments conducted on marine fish and fish habitat (pg. v – Executive Summary):

> *"Potential impacts to these marine VECs were evaluated in light of minor adjustments to the marine pipeline route and the updated receiving water assessment and comparison to the current outfall. Based on the receiving water study results and with identified mitigation… no significant residual adverse environmental effects were identified… A diffused outfall near outside of Caribou Harbour in the Northumberland Strait is considered to have much less potential effluent impact on the receiving environment and represents an improvement."*

With respect to water quality of the RWS, the EARD and FR concludes that there is unlikely to be significant residual effects as a result of BKPME discharge. However, this conclusion was drawn after a **one-month modelling** of effluent discharge and **fails to take cumulative effects** of recalcitrant chemicals present in BKPME. Furthermore, the chemical characteristics of the BKPME are projected and do not represent the actual effluent. In the absence of empirical data, it seems unlikely that NPNS can make any conclusions about the potential negative impacts.

5.2.3 Assessment of Major Findings

The Proponent concludes that **there are no significant impacts anticipated** by either construction or the operational phases of the ETF, on either freshwater or marine fish or fish habitat. This assertion is based on the notion that the predicted BKPME will be at background levels within 2 m of the diffuser port and will therefore not pose a risk to finfish in the RWS. There are several key assumptions that play a critical role in the validity of these conclusions:

1.) The dilution of effluent is as predicted, and major harmful components of the effluent will be diluted to ambient by 2 m past the diffusers.
2.) The characteristics of the actual effluent is consistent with the predicted effluent
3.) The 85,000,000 L/day of effluent that will be discharged by the diffuser will act in a way that is accurate to models
4.) There is no accumulative effect of the effluent over time on health or habitat of finfish
5.) There is no sublethal effect of the diluted effluent on finfish in the RWS

Identified issues with Major Findings:

1.) As per **Table 1**, there is a substantive change in the concentration of many components of concern in the predicted BKPME. The buffering capacity of the RWS to reduce any negative effects of this volume of BKPME is a dangerous, and unsubstantiated, presumption. For example, COD in the immediate effluent is predicted to be 725x higher than ambient. That represents an extremely high gradient that is proposed to be reduced to 0 within 2 m (~ 7 ft) from the diffuser. This assertion does not seem credible and cannot be properly assessed using a modeling approach. Empirical evidence to support this predicted discharge and assumed dilution of discharge (over time) must be included.
2.) It is well documented in the literature that there are recalcitrant chemicals present in BKPME. These chemicals – namely, resin acids, fatty acids, AOX, PAH, and TDF – are extremely slow to degrade in the environment and **have a propensity to bioaccumulate in sediment** (72) or in tissues of invertebrates (73) and vertebrates (74). All the modeling data in the EARD and FR looks at the discharge and flow of effluent over a one-month period. Even with very small initial concentrations of these chemicals into the RWS, **it is inconceivable to assume there will be no accumulation over time or space**. Furthermore, this potential accumulation will be under influences of seasonal variation in tidal and current flow. It is unclear how the Proponent reaches the conclusion that there will be no effect when these parameters have not been addressed in the models.
3.) **Without sublethal testing of their proposed effluent**, it is unclear how the Proponent can conclude there will be no effects to finfish health. Due to the substantial variation both in terms of chemical characterization and effects on fish reproduction (reviewed in 7), it is necessary to test individual mills and their effluents for the potential to negatively affect aquatic organisms (46,75). As part of the effort to better understand these effects, several laboratory exposure and bioassay models have been developed. For example, a short-term

laboratory test assessing egg production by the fathead minnow (*Pimephales promelas*) is a consistent and sensitive indicator of overall reproductive status of how fish respond when exposed to mill effluent (25,76).

4.) Overall, both the EARD and the FR appear to have **omitted a science-based review on the available literature pertaining to the effects of BKPME on finfish health**. There is an exhaustive body of literature available, and only 1 reference (11) was mentioned in the references. To conclude the EA with a finding of no significant impact on fish health after all the primary data associated with the subject is not acknowledged lacks scientific credibility and is, frankly, unacceptable.

5.2.3 Addressing the Terms of Reference in the FR

The purpose of the FR was to address issues brought up during public consultation and review of the EARD by relative stakeholders. With respect to the focus of the current review, i.e., finfish health, the following sections of the TOR were assessed: 2.3, 2.4, 4.1, 4.2, 7.3, 7.4, and 7.5.

These terms of reference, including the data submitted in the FR and resultant conclusions drawn by the review herein are described below:

Project Description (2.3-2.4) – Regarding Effluent

The Proponent was asked to submit data regarding the complete physical and chemical characterization of the raw wastewater (pp 23-32 of FR; Appendix 2.3). The Proponent was also asked to submit a complete physical and chemical characterization of the expected effluent entering the RWS (pp 32-39; Appendix 2.4)

Assessment after review:

The Proponent refers to the 2018 Effluent Characterization (Table 2.3-3) to represent the predicted effluent. However, it is unclear how this conclusion is valid, as the 2018 Effluent is based off the old system, which differs on several different levels, including the "polishing" phase. In contrast, the predicted effluent will not undergo this "polishing" phase.

The Proponent consistently refers to the PPER as a guidance for justification of toxin levels in their effluent. At no point does the Proponent indicate they are moving towards a progressive and science-based approach. The PPER have been criticized for not setting higher standards for effluent treatment (4). For the Proponent to rely on these regulations only considering "*acute lethality to fish*" as an important indicator of toxicity is careless and demonstrates no consideration for the finfish communities residing in the RWS, many of whom are listed as threatened or endangered by COSEWIC (77–82).

Importantly, the data provided in 2.3-2.4 are based on predicting effluent characteristics and subsequent modelling. As stated on pp 33, "*Based on Veolia's **anticipated** performance of the proposed ETF, it is **expected** that the proposed replacement ETF will provide performance that is comparable to other mills*".

Considering the significant potential for negative impacts on several species of fish (see Section 6.0), a speculative and predictive approach is not justified. Empirical evidence is required to validate these claims.

Marine Water and Marine Sediment (4.1-4.2)

The Proponent was asked to perform baseline studies on marine water quality and sediment quality in the vicinity of the proposed marine outfall location (pp 82; Appendix 4.1). Furthermore, the Proponent was asked to update the receiving water study to model for all potential contaminants of concerns in the RWS (pp 82-96; Appendix 4.2).

Assessment after review:

The Proponent only demonstrates data for effluent modelling for a period of 30 days. As this project is projected to last for longer than 30 days and in months other than July and February, it is unclear why modelling results over a period of 365 days were not obtained. This data essentially ignores any potential for accumulation over time and space, which is extremely likely to occur given the volume and masses of effluent proposed to be discharged by the ETF. This fact is particularly concerning for refractory chemicals that are known to exist in BKPME (8).

This modeling data is extremely deficient and lacks reasonable credibility for the above reasons. Furthermore, there is a clear inconsideration for potential effects over time.

Fish and Fish Habitat (7.3-7.5)

The Proponent was asked to conduct additional impact assessment of treated effluent on representative key marine fish species important for commercial, recreational, and Aboriginal fisheries. This must be based on updated information, additional studies and/or an understanding of expected movement of contaminants (pp 122-; Appendix 7.3). The Proponent was also asked to submit an updated EEM program based on results of various relevant baseline studies and an updated receiving water study (pp). Finally, the Proponent was asked to clarify what contingency measures will be in place to mitigate potential impacts due to potential large and rapid fluctuations in water temperature in the winter at the diffuser location during low production or maintenance shut down periods.

Assessment after review:

The Proponent did not conduct any additional studies to help provide evidence that might support their initial claims of "no impact" in the EARD. What would have been expected would have included sublethal toxicity testing of the predicted effluent as is a common practice for understanding effects on fish health.

In contrast, the Proponent simply conducted review of their own studies (while ignoring the body of scientific data) and concluded "*no significant residual impact to marine water are expected to arise on any fisheries or fish habitat as a result of this project*". They go on to describe all of the studies that could be

performed after approval, *"Future studies could include toxicity testing, specifically on larval lobster and herring eggs to evaluate sublethal effects on these species".*

In contrast to the findings of the FR, the current review of the literature identified 6 species of finfish listed as "endangered", with 4 listed as "threatened" and 2 of "special concern". The Proponent fails to identify American plaice (endangered), lumpfish (threatened), porbeagle (endangered), and Atlantic sturgeon (threatened). They only consider a fish as potentially impacted by the project if they were observed during the sampling. This is extremely concerning, particularly with so many species in fragile population status. Atlantic sturgeon is known to inhabit the waters of Pictou and is particularly vulnerable to anthropogenic disturbances due to its longevity and age to reproduction (83). It is unacceptable for the Proponent to assume this species will not be affected by the project just because they did not observe it during their limited marine fish survey.

6.0 Impacts of Proposed ETF on Finfish considering Empirical Evidence

In contrast to the Proponent's conclusion that there are no significant impacts expected on freshwater or marine fish or fish habitat, **there is a substantial body of literature that documents the negative physiological effects of pulp and paper mill effluent at various concentrations on aquatic organisms, and in particular, finfish**. This body of literature is largely absent from the EARD and FR, so it is plausible that the Proponent was simply unaware of the scientific consensus. Notwithstanding, the data is quite clear and demonstrates that components of effluent, whether they be derived from chlorine- or chlorine-free treatment processes (such as NPNS), fundamentally alter fish reproductive and immune systems, and by doing so, significantly impact overall fitness of these organisms. It is worthwhile to mention that much of the research concedes that the chemical(s) ultimately involved in these effects are not well characterized (11). Differential treatment processes in pulp and paper mills across Canada, and from different locations around the world, discharge complex and variable effluent, and these effluents are in a dynamic state of flux with respect to their characterization (2,4,11,17). Thus, it is not a clear-cut mechanism of effect that can be generalized to any one mill. Because of this confounding factor, it becomes even more prudent to critically examine BKPME on an individual mill basis to fully understand potential impact, which would include using laboratory models such as the fathead minnow reproductive test or comparators (53).

With respect to the specific fish populations of the Northumberland Strait, there is an extreme paucity of data pertaining to the physiological impact of BKPME. Moreover, there is limited-to-no information regarding the true chemical characteristics of the proposed effluent. Thus, identification of true effects and potential impacts are limited to using a comparative approach (**Table 4**).

Table 4. Species of fishes known to inhabit the freshwater tributaries or marine waters of Northumberland Strait, their known habitat and COSEWIC status, the proposed impact by the EARD, and the potential impact of BKPME exposure as determined by scientific studies.

Species[1]	**Proposed Impact[2]**	**COSEWIC Status**	**Comparator Species[3]**	**Effect[4]**
Atlantic mackerel (*Scomber scombus*)	None	Secure	-	Unknown
American plaice (*Hippogloissoides platessoides*)	None	Threatened	Winter flounder (*Pleuronectes americanus*)	Skin lesions, increased parasite abundance, hepatic lesions, increased EROD (67)
Atlantic salmon (*Salmo salar*) Brook trout (*Salvelinus fontinalis*)	None	Special Concern – Endangered; Sensitive	Rainbow trout (*Oncorhynchus mykiss*) Chinook salmon (*Oncorhynchus tshawytscha*)	Altered retinoic acid receptors (14); Increased gonad size, early maturation (84); Intersex characteristics (57); Genotoxicity (35); Induction of EROD (38)
Rainbow smelt (*Osmerus mordax*)	None	Secure	-	Unknown
Blueback Herring (*Alosa aestivalis*)	None	Sensitive	-	Unknown
Gaspereau (*Alosa pseudblueoharengus*)	None	Sensitive	-	Unknown
Atlantic halibut (*Hippoglossus hippoglossus*)	None	Secure	Winter flounder (*Pleuronectes americanus*)	Skin lesions, increased parasite abundance, hepatic lesions, increased EROD (67)
Atlantic herring (*Clupea harengus*)	None	Special concern	-	Unknown
Atlantic sturgeon (*Acipenser oxyrinchus*)	None	Threatened	-	Unknown
Atlantic striped bass (*Morone saxatilis*)	None	Threatened	Largemouth bass (*Micropterus salmoides*)	Reduction in fry survival, endocrine disruption (27); Decreased lymphocytes, neutrophilia (85)
Atlantic bluefin tuna (*Thunnus thynnus*)	None	Endangered		

American eel (*Anguilla rostrata*)	None	Threatened	European eel (*Anguilla anguilla*)	Gill damage due to oxidative stress (42); Reduced immunity (42)
Atlantic cod (*Gadus morhua*)	None	Endangered	-	Unknown
Winter Skate (*Leucoraja ocellate*)	None	Endangered	Winter flounder (*Pleuronectes americanus*)	Skin lesions, increased parasite abundance, hepatic lesions, increased EROD (67)
Winter Flounder (*Pleuronectes americanus*)	None	Secure	Winter flounder (*Pleuronectes americanus*)	Skin lesions, increased parasite abundance, hepatic lesions, increased EROD (67)
Lumpfish (*Cyclopterus lumpus*)	None	Threatened	-	Unknown
Porbeagle (*Lamna nasus*)	None	Endangered	-	Unknown
Spiny dogfish (*Squalus acanthias*)	None	Special concern	-	Unknown
White hake (*Urophycis tenuis*)	None	Endangered	-	Unknown

[1]Species as listed by the EARD and FR
[2]Proposed impact by EARD and FR
[3]Comparator species; there has been no evidence pertaining to the effects of BKPME on the species of the RWS, thus, scientific studies that investigated these effects in closely related species are list. If there was no appropriate comparator, then (-) was recorded
[4]Physiological impacts as determined by the associated reference

Marine fish, and their habitat, are closely linked to the surrounding physical environment, including water and sediment quality – all of which could be impacted by the proposed ETF. The main commercial fisheries of importance include lobster, sea scallop, herring, mackerel and rock crab, however, the Northumberland Strait is an important migration corridor for many other species including Atlantic salmon, Atlantic bluefin tuna, American eel, winter skate, and Atlantic cod (86). Furthermore, nearshore habitats populated with eel grass are known nurseries for juvenile fishes (e.g., Atlantic salmon), or habitat for benthic species including that of the American eel (*Anguilla rostrata*). The American eel plays an important role in Canada's aquatic biodiversity. It has the greatest range of any fish species in North America and has supported major commercial, recreational, and Aboriginal fisheries (citation). Enlisted as threatened, it is thought that declines in abundance are due to habitat degradation, especially in light of pollution (77). Furthermore, introduction of an exotic parasite, *Anguillicoloides crassus*, that infects the swim bladder of American eels, is thought to be imposing an additional pressure on the species (87). Others have linked the collapse of the European eel to *A. crassus*, as heavy infections can lead to hemorrhagic lesions, swim

bladder fibrosis or collapse, skin ulceration, decreased appetite, and reduced swimming performance (88). It is well documented that exposure to BKPME reduces immune competence in fishes, and this has been associated with higher parasite burdens in some populations (20,22). Therefore, the additive effects of *A. crassus* infection with exposure to BKMPE may present a serious concern for populations of American eel and needs to be studied further. In addition to American eel, several other species of fish known to inhabit the RWS are listed as endangered by COSEWIC, including Winter Skate (89), Atlantic Salmon (82), Atlantic Sturgeon (83), Atlantic Cod (81), Atlantic Bluefin Tuna (79), Porbeagle (90), and White Hake (78).

The Northumberland Strait is home to 15 salmon-bearing rivers, and the populations of Atlantic salmon in that area are in decline. As ecological keystone species, the health of salmon populations can be viewed as an indicator of overall ecosystem health. The potential impacts of BKPME discharged by the proposed ETF are simply not understood, however, in other systems the negative impacts on reproduction and immunity are well documented in salmonids (e.g., (26)). The Proponent failed to produce any scientific evidence on the effects of their effluent on salmon.

The Proponent consistently states that their proposed ETF and associated effluent is treated to "*a level that is non-toxic and meeting regulated (PPER) effluent discharge parameters*" (example, page 66, (10)). However, there is no empirical evidence characterizing the true chemical properties of the effluent. It is unclear how the Proponent can make any informed or accurate predictions on the potential environmental impacts on the RWS or the organisms that reside there. Furthermore, it is important to note that these regulations are antiquated and are currently undergoing a major revision as recent EEM studies indicate that 70% of pulp and paper mills in Canada are impacting fish (91). Thus, although they may be true in stating they are within PPER *per se*, this will certainly not be the case in the future. Furthermore, the PPER are designed to prevent effluents that cause "*acute lethality*", and do not consider effects of long-term chronic exposure. Given the extremely high level of concern regarding the potential impacts on fish populations in the RWS, there should be an avoidance of harm, disruption or destruction, not simply "*acute lethality*". For example, there are known effects in fish that are not observed for years subsequent to initial BKPME exposure that would seriously impact the health of fish populations in the RWS (e.g., 53).

Irrespective of that fact, applying a science-based approach, as was claimed by the Proponent, would imply the most current available information would be used to inform decisions on effluent treatment and discharge. However, this is not the case. For example, a recent publication by Martel *et al.* (2017) discussed recommendations by experts in the field regarding the limits of BOD in BKPME that should be followed to prevent deleterious effects on fish populations (4). Therein, the authors prescribe a maximum BOD_5 of > 20 mg/L as having the greatest probability of no effect on finfish reproduction. The study was intended to provide insights for best management practices that could be incorporated into mill-specific strategies for achieving minimal or no impact on fish reproduction (4). These best practices recommendations should be included in the design or

development of any new pulp and paper mill. It is inappropriate for the Proponent to ignore recommendations made by scientific consensus.

The true impacts of the projected effluent should be evaluated using independent laboratory exposure studies for all major important species. Furthermore, upon close examination of the body of literature cited by both the EARD and FR, it is apparent that the Proponent did not consider the large and comprehensive available datasets produced across time and space, where a general consensus has been reached on the toxic effects of BKPME to finfish health.

7.0 Summary

The installation of secondary effluent treatment processes across Canada has substantially improved effluent quality through reductions of compounds producing acute toxicity, including organochlorine discharges and AOX compounds. However, BKPME released in aquatic receiving environments still contains bioactive compounds that affect fish metabolism, reproduction, and health. Investigations into the substances involved in these negative effects has indicated that wood constituents are partly to blame, but that many unidentified and uncharacterized substances in the effluent are involved. Thus, despite the improvement in effluents, pulp and paper mills continue to exact negative physiological effects on aquatic organisms, and furthermore, a more comprehensive understanding of the complete chemical profile of BKPME and associated bioactive properties needs to be completed.

With respect to the project in question, **there is simply not enough supporting documentation to support the conclusion that there will be no negative effects on aquatic animals and the associated ecosystem of Caribou Harbour and the Northumberland Strait**. The negative physiological effect of BKME has been well described on fishes, included depressed immunity, altered reproduction and decreased overall resilience. While effluent plume modelling may have some success in predicting the concentration of effluent in receiving waterways, they do not provide accurate accounts of the organisms in those waterways, as many are migratory. Furthermore, the relative importance of habitat is dynamic over time and space. For example, sensitive habitats of near-shore environments represent critical nursery areas for many larval fishes during certain times of the year (e.g., post-emergence of salmonid smolts), while for other organisms that are sedentary (e.g., mussels), avoidance of deleterious environmental stimulants is not possible. **Additionally, the predictive modeling fails to account for accumulation of BKPME components over a period longer than a month which severely limits any predictive power.** And finally, there **is no description or characterization of the potential for components of the predicted BKPME for bioaccumulation, despite the large body of evidence for bioaccumulation of several toxic components such as chlorinated organic compounds** (69)**, and wood extractives** (8)**.**

8.0 Conclusion

There are numerous issues and concerns that are raised in the above document pertaining to the effluent characterization and associated impacts to marine fish and fish habitat. For example, there is a lack of baseline environmental data, effluent composition data, or data on toxicity of proposed effluent to fishes that reside in the RWS. The Proponent appears to ignore the massive body of literature on the deleterious physiological impacts of BKPME on finfish, as well as the very real potential for bioaccumulation of toxic compounds in the RWS. Furthermore, the FR does not acknowledge the most up-to-date scientific recommendations on limits of effluent components (i.e.,

BOD limits), that are necessary to reduce potential harm to fishes. With respect to the fish species potentially at risk, there are 4 species residing within this RWS that are listed as “threatened”, and 6 species residing within this RWS that are listed as “endangered” by COSEWIC. Additive effects involving already stressed populations due to climactic variability and habitat loss, combined with the known impacts (e.g., compromised reproductive and immunological systems) of exposure to BKPMEs pose a real and significant concern for these species of fish.

In conclusion, it is of my professional opinion that this Focus Report is deficient in the necessary supporting documentation and empirical data regarding the potential impacts of the proposed ETF by NPNS on finfish in the Northumberland Strait.

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Appendix I – *Curriculum vitae,* Dr. Laura Braden

PEER-REVIEWED PUBLICATIONS

Braden, L.M., Whyte, S.K, Brown, A.B.J., Van Iderstine, C., Letendre, C., Groman, D., Lewis, J., Purcell, S.L., Hori, T.S., Fast, M.D. (2019). Vaccine-induced protection against infection with *Aeromonas salmonicida* spp. salmonicida in Arctic charr *Salvelinus alpinus* involves pre-emptive priming of humoral immunity. *Frontiers in Immunology*, DOI: 10.3389/fimmu.2019.00120

Braden, L.M., Rasmussen, K.J., Purcell, S.L., Ellis, L., Mahony, A., Cho, S., Whyte, S.K., Jones, S.R.M., Fast, M.D. (2018). Acquired protective immunity in Atlantic salmon *Salmo salar* against the myxozoan *Kudoa thyrsites* involves induction of MHIIβ^{+} CD83^{+} antigen-presenting cells. *Infection & Immunity*, 86:e00556-17.

Poley, J.D., **Braden, L.M.,** Messmer, A.M., Igboeli, O.O., Whyte, S.K., Macdonald, A., Rodriguez, J., Gameiro, M., Rufenerd, L., Bouvierd, J., Wadowska, D.W., Koop, B.F., Hosking, B.C, Fast, M.D. (2018) High level efficacy of lufenuron against sea lice (*Lepeophtheirus salmonis*) linked to rapid impact on moulting processes. *IJP: Drugs and Drug Resistance*, 8, 174-178.

Braden, L.M., Sutherland, B.J.G., Koop, B.F., Jones, S.R.M. (2017). Enhanced transcriptomic responses in the Pacific salmon louse *Lepeophtheirus salmonis oncorhynchi* to the non-native Atlantic salmon *Salmo salar,* implies increased parasite fitness. *BMC Genomics,*18:110.

Poley, J.D., **Braden, L.M.,** Messmer, A.M., Whyte, S.K., Koop, B.F., Fast, M.D. (2016). Cypermethrin exposure induces metabolic and stress-related gene expression in copepodid salmon lice (*Lepeophtheirus salmonis*). *Comp. Biochem. Phys. D*., 20, 74-84.

Braden, L.M., Koop, B.F., Barker, D.E., Jones, S.R.M. (2015). Differential modulation of resistance biomarkers in skin of juvenile and mature pink salmon, *Oncorhynchus gorbuscha* by the salmon louse, *Lepeophtheirus salmonis*. *Fish Shellfish Immunol*., 47, 7-14.

Braden, L.M., Koop, B.F., Jones, S.R.M. (2015). Signatures of resistance to *Lepeophtheirus salmonis* include a T_H2-type response at the louse-salmon interface. *Dev. Comp. Immunol*. 48, 178-191.

Braden, L.M., Barker, D.E., Koop, B.F., Jones, S.R.M. (2012). Comparative defense-associated responses in salmon skin elicited by the ectoparasite *Lepeophtheirus salmonis*. *Comp. Biochem. & Physiol. D*. 7, 100-109.

Braden, L.M., Prosperi-Porta, G., Kim, E., Jones, S.R.M. (2010). *Tetracapsuloides bryosalmonae* in spawning pink salmon, *Oncorhynchus gorbuscha* (Walbaum), in the Quinsam River, British Columbia, Canada. *Journal of Fish Diseases*, 33, 617-621.

Barker, D.E., **Braden, L.M.,** Coombs, M., Boyce, B. (2009). Preliminary studies on the isolation of bacteria from sea lice, *Lepeophtheirus salmonis*, infecting farmed salmon in British Columbia, Canada. *Parasitology Research*, 105(4):1173-7.

INVITED & CONTRIBUTED PRESENTATIONS

Invited presentations

2019 – **L.M. Braden,** D.M. Michaud, J.P Poley, W. Cai, M.D. Fast "The salmon-louse interactome". Oral Presentation, International Conference of Integrative Salmonid Biology, Edinburgh, Scotland.

2019 – **L.M. Braden**, W. Cai, D. Michaud, J.D. Poley, M.D. Fast, "Characterizing pathways of virulence in the salmon-louse interactome" Oral presentation, International Society of Animal Genetics, Lleida, Spain.

2019 – **L.M. Braden,** W. Cai, D. Michaud, J.D. Poley, A. Overgaard, M.D. Fast, "Virulence in *Lepeophtheirus salmonis* – characterizing the salmon-louse interactome". Oral presentation, Aquaculture Association of Canada, Victoria, BC.

2019 – **L.M. Braden** "Leveraging biotech to improve sustainability in aquaculture: A global perspective". Oral presentation, Eastern Aquaculture Veterinary Association Meeting, Moncton, NB

2018 – **L.M. Braden,** C. Smith, M.D. Fast. "Should I Stay or Should I Go? Dismantling the molecular decision to smolt in an anadromous salmonid". Oral presentation, PHARMAQademy Conference, Inverness, Scotland.

2018 – **L.M. Braden,** M.D. Fast. "Subverting molecular subterfuge – Coho find the Achilles heel of salmon lice". Oral presentation, PHARMAQademy Conference, Inverness, Scotland.

2018 – **L.M. Braden** "Leveraging OMICs to reveal novel biomarkers and pharmaceutical targets for sea lice control: A holistic approach". Oral presentation, Institute of Aquaculture, University of Stirling, Scotland.

2018 – **L.M. Braden**, J.D. Poley, D. Michaud, A. Øvergård, H. Kongshaug, S. Dalvin, F. Nilsen, M. D. Fast. "Decoding important regulators of sea lice physiology using gene silencing techniques". Oral presentation, Atlantic Canada Fish Farmers Association Research Forum, St. Andrews, NB.

2016 – **L.M. Braden**, Hori, T., Poley, J.D., Byrne, P., Fast, M.D. "Characterizing the rapid rejection of salmon lice, *Lepeophtheirus salmonis*, by juvenile coho salmon, *Oncorhynchus kisutch*". Oral presentation, Atlantic Canada Fish Farmers Association Research Forum, St. Andrews, NB.

2015 – **L.M. Braden,** B.J.G. Sutherland, S.R.M. Jones. "Susceptibility to infection by the salmon louse is related to both host and parasite responses". Oral presentation, Host-Microbe Interaction Workshop, Plant & Animal Genome XXII, San Diego, CA.

2014 – **L.M. Braden.** "Investigating the molecular basis of the variable host response of salmonids to *Lepeophtheirus salmonis.*" Guest lecture, Ecological Parasitology, Vancouver Island University, Nanaimo, BC.

2013 – **L.M. Braden.** "Investigating the molecular basis of the variable host response of salmonids to *Lepeophtheirus salmonis.*" Novartis Parasitology Research & Development, Bioforum, St. Aubin, Switzerland.

2013 – **L.M. Braden**. "The sea lice saga: past, present and future of the pesky little parasite." Vancouver Island University Science & Technology Seminar Series, Nanaimo, B.C.

2012 – **L.M. Braden.** "Investigating the molecular basis of the variable host response of salmonids to *Lepeophtheirus salmonis*". Marine Scotland Lunch & Learn, Aberdeen, Scotland.

2011 – **L.M. Braden.** "Living off a fish – a co-evolutionary success story." Guest lecture, Fish Health, Vancouver Island University, Nanaimo, BC.

Contributed presentations & posters

2018 – **L.M. Braden**, O.O. Igboeli, M. Dundrop, L. Hamre, F. Nilsen, S. Dalvin, M.D. Fast. "Critical links between GFAT, the chitin synthesis pathway, and infection in *Lepeophtheirus salmonis*." Oral presentation at the 12th International Sea Lice Conference, Punta Arena, Chile.

2018 – **L.M. Braden,** "Virulence factors in the salmon louse." Oral presentation at the 12th International Sea Lice Conference, Punta Arenas, Chile.

2018 – **L.M. Braden,** S.L. Purcell, K.J. Rasmussen, M. Zadworny, C.T. Smith, M.D. Fast. "Should I Stay, or Should I Go? Divergent immunity in an anadromous salmonid." Oral presentation at the International Symposium on Aquatic Animal Health, Charlottetown, PE.

2018 – **L.M. Braden,** S.K. Whyte, A.B.J. Brown, C. VanIderstine, C. Letendre, D. Groman, J. Lewis, S.L. Purcell, T.S. Hori, M.D. Fast. "Vaccine-induced protection against infection with *Aeromonas salmonicida* spp. salmonicida in Arctic charr *Salvelinus alpinus* involves pre-emptive priming of humoral immunity." Oral presentation at the International Symposium on Aquatic Animal Health, Charlottetown, PE.

2016 – **L.M. Braden**, Hori, T., Poley, J.D., Byrne, P., Fast, M.D. "Characterizing the rapid rejection of salmon lice, *Lepeophtheirus salmonis*, by juvenile coho salmon, *Oncorhynchus kisutch*." Oral presentation at the 11th International Sea Lice Conference, Westport, Ireland.

2016 – **L.M. Braden**, Poley, J.D., Hori, T., Byrne, P., Fast, M.D. "Characterizing the rapid rejection of salmon lice, *Lepeophtheirus salmonis*, by juvenile coho salmon, *Oncorhynchus kisutch*." Oral presentation at Aquaculture Europe, Edinburgh, Scotland.

2016 – **L.M. Braden*,** S.D. Cho, M.D. Fast, S.R.M. Jones. "Defining the cellular response of Atlantic salmon *Salmo salar* to *Kudoa thyrsites*." Oral presentation at the International Society of Fish and Shellfish Immunology conference, Portland, Maine.

2015 – **L.M. Braden*,** M.D. Fast, S.R.M. Jones. "*Kudoa thyrsites* in salmon aquaculture." Oral presentation at Atlantic Canada Fish Farmers Association Research Forum, St. Andrews, NB.

2015 – **L.M. Braden*,** S.D. Cho, M.D. Fast, S.R.M. Jones. "Resolution of *Kudoa thyrsites* infection is associated with infiltration of MHIIβ+ cells in Atlantic salmon." Oral presentation at the 17th European Association of Fish Pathologists, Las Palmas, Gran Canaria, Spain.

2015 – **L.M. Braden*,** B.J.G. Sutherland, B.F. Koop, S.R.M. Jones. "Host susceptibility to infection by the salmon louse, *Lepeophtheirus salmonis*, involves responses by salmon and parasite." Oral presentation at the 17th European Association of Fish Pathologists, Las Palmas, Gran Canaria, Spain.

2015 – S.R.M. Jones, **L.M. Braden**, B.F. Koop. "Age-dependent immunity to the salmon lice, *Lepeophtheirus salmonis*, in pink salmon, *Oncorhynchus gorbuscha*." Oral presentation at the 17th European Association of Fish Pathologists, Las Palmas, Gran Canaria, Spain.

2014 – **L.M. Braden*,** B.J.G. Sutherland, B.F. Koop, S.R.M. Jones. "Host-specific virulence by the sea louse, *Lepeophtheirus salmonis*." Poster presentation at Genome Canada: The Power and Promise, Ottawa, Canada.

2014 – **L.M. Braden*,** B.J.G. Sutherland, B.F. Koop, S.R.M. Jones. "Evidence for host-specific feeding responses by the sea louse, Lepeophtheirus salmonis." Oral Presentation at the 10th International Sea Lice Conference, Portland, Maine, USA.

2014 – **L.M. Braden***, B.F. Koop, S.R.M. Jones. "Cellular factors in the skin of salmon during sea lice attachment." Poster presentation at the 2nd International Conference on Integrative Salmonid Biology, Vancouver, BC, Canada.

2014 – S.R.M. Jones*, B.J.G. Sutherland, **L.M. Braden,** B.F. Koop. "Salmon – Louse interactions: genomics and the evolution of the inflammation paradigm." Oral Presentation at the 2nd International Conference on Integrative Salmonid Biology, Vancouver, BC, Canada.

2013 – S.R.M. Jones*, B.J.G. Sutherland, **L.M. Braden,** B.F. Koop. Parasitological, physiological and molecular metrics of resistance to *Lepeophtheirus salmonis* among salmon. Oral presentation at the 16th International Conference on Diseases of Finfish and Shellfish. Tampere, Finland.

2013 – **L.M. Braden***, B.F. Koop, D.E. Barker, S.R.M. Jones. "Insight into the molecular basis for resistance of Pacific salmonids to the ectoparasite, *Lepeophtheirus salmonis*." Oral presentation at World Aquaculture 2013, Nashville, TN, USA.

2012 – **L.M. Braden***, B.F. Koop, D.E. Barker, S.R.M. Jones. "Development of a skin injection model for studying local and systemic responses to *Lepeophtheirus salmonis* in salmon." Oral presentation at the 9th International Sea Lice Conference, Bergen, Norway.

2012 – **L.M. Braden***, B.F. Koop, D.E. Barker, S.R.M. Jones. "Development of a skin injection model for studying local and systemic responses to *Lepeophtheirus salmonis* in salmon." Oral presentation at the 2012 Aquaculture Association of Canada Meeting, Charlottetown, PEI, Canada.

2011 – **L.M. Braden***, B.F. Koop, D.E. Barker, S.R.M. Jones. "Site-specific transcriptomic responses in salmon skin elicited by the ectoparasite *Lepeophtheirus salmonis*." Oral presentation at the 2011 Aquaculture Association of Canada Meeting, Quebec City, QC.

2011 – **L.M. Braden***, B.F. Koop, D.E. Barker, S.R.M. Jones. "Defense-associated responses in salmon skin elicited by the ectoparasite *Lepeophtheirus salmonis*." Oral presentation at the 8th International Symposium on Fish Parasites, Vina del Mar, Chile.

2011 – **L.M. Braden***, B.F. Koop, D.E. Barker, S.R.M. Jones. "Site-specific transcriptomic responses in salmon skin elicited by the ectoparasite *Lepeophtheirus salmonis*." Oral presentation at the Western Fish Disease Workshop, Nanaimo, BC, Canada.

2010 – **L.M. Braden***, B.F. Koop, D.E. Barker, S.R.M. Jones. "Immune gene expression in Atlantic (*Salmo salar*), pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon due to *Lepeophtheirus salmonis* infection." Oral presentation at the Western Fish Disease Workshop, Corvallis, OR, USA.

2010 – **L.M. Braden***, B.F. Koop, D.E. Barker, S.R.M. Jones. "Immune gene expression in Atlantic (*Salmo salar*), pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon due to *Lepeophtheirus salmonis* infection." Oral presentation at the 2010 Aquaculture Association of Canada Meeting, St. John's, NFLD.

2010 – **L.M. Braden***, B.F. Koop, D.E. Barker, S.R.M. Jones. "Immune gene expression in Atlantic (*Salmo salar*), pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon due to *Lepeophtheirus salmonis* infection." Oral presentation at the 8th International Sea Lice Conference, Victoria, BC, Canada.

PROFESSIONAL MEMBERSHIPS

World Aquaculture Society
Aquaculture Association of Canada
International Society of Fish and Shellfish Immunology
European Association of Fish Pathologists
American Society of Microbiology

ACTING REFEREE

Developmental & Comparative Immunology
Fish & Shellfish Immunology
Journal of Fish Diseases
Aquaculture
Parasites & Vectors
Journal of Aquatic Animal Health
Histology & Histopathology
Journal of Immunology
Journal of Parasitology

Expert witness report on the Focus Report for the Northern Pulp Nova Scotia Replacement Effluent Treatment Facility

November 7, 2019

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Statement of expertise

I am a research scientist in Coastal and Fisheries Ecology at the Fisheries and Marine Institute of Memorial University of Newfoundland. My position involves conducting research on Northwest Atlantic marine ecosystems and fisheries and training graduate students in Fisheries Science.

My research focuses on understanding and quantifying the impacts of human activities on marine and coastal ecosystems. I have been conducting research on Northwest Atlantic and more particularly on the Gulf of St. Lawrence for 11 years. My current research projects are diverse and include lobster population productivity, restoration ecology of eelgrass habitat, migration of Atlantic halibut and Atlantic cod, and life-history of northern shrimp. I have numerous primary publications demonstrating wide understanding of the Northwest Atlantic marine ecosystems. Furthermore, a large portion of my research involves mathematical and statistical modelling and often require to work with outputs from complex oceanographic models. I have thus developed quantitative and modelling skills over the years.

I obtained a Bachelor Degree in Biology and Ecology from Université de Rennes I (France), during which I learn the important ecological patterns and processes that control vulnerability of natural environment to natural and human-induced disturbances. I then obtained a joint Master of Science degree of Oceanography from the Université de Marseille (France) and Université du Québec a Rimouski. During this degree I took many courses on the four main disciplines that composed the field of Oceanography: Geological, Physical, Chemical, and Biological Oceanography. This was key to understand how the various components of marine and coastal environments are interconnected. Finally, I obtained a PhD degree in Marine Biology from Memorial University of Newfoundland during which I became familiar with Canadian ecosystems. The PhD degree was a critical step in the development of my independent and critical thinking.

My reputation in Fisheries Ecology is growing and my expertise is increasingly requested to peer-review journal manuscripts and grant proposals, and to act as an external reviewer for fish stock assessment meetings. I have recently testified as an expert witness at the House of Commons for a study on Fisheries and Oceans Canada. This attests my ability to provide an objective and unbiased opinion on specific matters.

Introduction

Context of this report.

On October 2, 2019, Northern Pulp Nova Scotia Corporation (NPNS) submitted a focus report for the replacement effluent treatment facility project for environmental assessment. This focus report was requested by Nova Scotia Environment as additional information to support a final decision regarding the approval of the environmental assessment for the construction and subsequent operation of a new effluent treatment facility including a pipeline to transport treated effluent for discharge into the Northumberland Strait.

Public comments on the focus report can be made until November 8, 2019. In this context, the Gulf Nova Scotia Fleet Planning Board, Prince Edward Island Fishermen's Association, and Maritime Fishermen's Union solicited my expert opinion via Barrister and Solicitor, Jamie Simpson of Juniper Law. This report presents my objective, unbiased opinion on the potential impact of the new effluent treatment Facility project proposed by NPNS.

Content of this report.

The report provides first a short summary of my analysis of the focus report. Given my expertise in biological Oceanography and Fish Ecology, I conducted an in depth reviewed of parts 4. Marine Water and Marine Sediment and 7. Fish and Fish Habitat of the focus report. This second part of my report documents the series of issues that I identified with parts 4 and 7 of the focus report and relevant appendices (Appendices 4.1, 4.2, 4.3, 7.2, 7.3, and 7.4).

Finally, a general discussion addressing two main questions is provided:

- Does NPNS's submitted materials adequately address the potential risks of bioaccumulation of toxins in the marine environment, and if not, what these risks may be?
- Is NPNS's assertion that the effluent released into the Strait through the proposed treatment system will be less harmful than the effluent currently entering the Strait via the current Boat Harbour treatment system (particularly with respect to the release of metals) valid?

The response to these questions rely on my analysis of the entire focus report, with particular attention to parts 2.3 and 2.4 (because of their relevance to the second question listed above) and with an in-depth review of parts 4 and 7.

Summary

The results of the focus report in terms of impact of the replacement effluent treatment facility to the marine environment are highly dependent on the results from the receiving water study. The receiving water study is based on two modelling exercises. The credibility of the results from any modelling exercises depends mainly on 1) the robustness of the models, 2) the implementation of the models. Reviewing the robustness of these two models is outside my expertise; therefore, I did not review the structure of these two models. However, given my modelling skills and general knowledge of physical oceanography, I was able to review the implementation of these two models. I found a potentially significant issue with the implementation of the far-field model: **it assumes that the one-month simulation period is enough to represent dilution processes that will occur over the several decades of effluent discharge from the proposed outfall location**. This is an issue, because effluent concentrations are likely to increase over time, which will affect future dilution. More details on this issue and other potential issues with the receiving water study are provided in the part 4 of this report.

The terms of reference for the focus report included baseline surveys of the marine fish and fish habitat as well as an impact assessment of treated effluent for key marine species important for commercial, recreational and Aboriginal fisheries. These surveys and impact assessments are especially important given the great concern expressed by the public and the government for the potential impact of the proposed work on the value environmental component (VEC) "Marine Fish and Fish Habitat". Indeed, according to the concordance tables showed in the focus report (pages 2 and 3, Dillon 2019), 195 public comments (2nd highest number) and 34 government comments (4th highest number) were related to the VEC "Marine Fish and Fish Habitat".

On June 21, 2019, Bill C-68, an act to amend the Fisheries Act and other Acts in consequence has received Royal Assent and is now law. This enactment amends the fisheries act to "provide measures for the protection of fish and fish habitat with respect to works, undertakings or activities that may result in the death of fish or the harmful alteration, disruption or destruction of fish habitat". An important question related to item 7.2. of the terms of reference is thus: Can the proposed work lead to the harmful alteration, disruption, or destruction of marine fish habitat?

In my professional opinion, given the information presented in the focus report and associated documents, **it is impossible to conclude that the proposed work won't lead to harmful alteration, disruption, or destruction of fish habitat.** Indeed, I found that baseline fish and fish habitat surveys for the marine environment were incomplete and had numerous gaps. No surveys of the intertidal zone and of the extent and structure of eelgrass meadows were conducted. Furthermore, as described in the focus report and appendix 7.2, the methodology used for marine fish habitat surveys is not reproducible, which will prevent future comparison if environmental monitoring programs are conducted.

Review of part 4. Marine Water and Marine Sediment

4.1 Baseline Marine Studies

Conduct baseline studies for the marine environment (such as marine water quality and marine sediment) in the vicinity of proposed marine outfall location.

Marine water quality

A baseline water quality study was completed to enable future monitoring of the impact of the effluents on water quality and also to be used in the water quality receiving study. Water samples were taken on May 24 and 25, 2019 at varying depth and tide cycles. The analysis of the water samples that were collected are robust and the concentrations are reliable. However, despite proper chemical analysis of collected water samples, the current baseline study of water quality is of limited use for future comparison because of its short temporal extent.

Issue 4.1.1. The marine water quality study was conducted over a period of time too short to provide a useful baseline.

The biochemical properties of marine waters in the southern Gulf of St. Lawrence, including the area of study, are highly dynamic in time and show strong seasonal cycles (Strain et al. 1998, Blais et al. 2018). For instance, concentrations in nitrogen and phosphorus, and oxygen demand show strong variation in response to seasonal plankton blooms (Blais et al. 2018). These seasonal cycles vary in their timing from year to year and any comparison of chemical properties of marine water through time needs to capture these seasonal cycles. The marine water quality baseline study conducted as part of the focus report does not provide sufficient temporal information to enable future monitoring of change in water quality.

Suggestion. Conduct a new study of the chemical properties of marine water in the proposed work area with sample collection extended throughout the year

Sediment quality

A baseline study of the sediment chemical composition was conducted to characterize the materials that may be excavated and potentially permanently sidecast or disposed of during the construction phase. Sediment samples were collected along the length of the proposed pipeline corridor and in the vicinity of the preferred outfall location.

Issue 4.1.2. The sediment in Pictou Harbour showed concerning levels of harmful chemical concentrations.

Results indicated that many chemical concentrations exceed levels of Canadian Environmental Protection Act Disposal at Sea for Pictou Harbour. This included Total PAH, 2-Methylnaphthalene, acenaphthene, fluorine, naphthalene, arsenic, and cooper. This raises concerns for the future excavation of the sediment in Pictou Harbour.

Because of the lack of baseline data (Romo et al. 2019), it is difficult to affirm that these elevated concentrations **of Total PAH, 2-Methylnaphthalene, acenaphthene, fluorine, naphthalene, arsenic, cooper and lead are related to the past and ongoing effluents discharged from Boat Harbour.** However, given the results from the far field modelling study, which indicates that effluent from the existing dam discharge at Boat Harbour can accumulate in Pictou Harbour (Figure 4.2-6 of Focus Report, Dillon 2019), there is a high likelihood that these elevated concentrations of harmful chemicals are related to current effluent discharge in Boat Harbour. This is a significant concern for any future effluent discharge in the Northumberland Strait, and supports the adoption of the precautionary approach.

4.2 Receiving Water Study

Update the receiving water study to model for all potential contaminants of concern in the receiving environment (based on the results of the effluent characterization and/or other relevant studies such as Human Health Risk Assessment). Baseline water quality data for Caribou Harbour must be applied to this study. Refer also to Addendum 3.0.

The receiving water study is a key component of the focus report and the results from this study are used in section 7.3. to evaluate the potential impacts of the proposed work on marine fish and fish habitat. If the results are inaccurate then conclusion in section 7.3 of the focus report needs to be revised.

The receiving water study was conducted using a far-field hydrodynamic model (Mike 21) and a near-field hydrodynamics model (Cormix). Results from the far-field hydrodynamic model were then used into the near-field model. Evaluating the robustness of these models is outside my area of expertise and would require a professional physical oceanographer familiar with these two models. Even if a model is robust, the accuracy of the results depends heavily on the proper implementation of the models. Given with my expertise in biological modelling and my general knowledge of physical oceanography, I was able to review the implementation of the far-field model and of its results.

I identified three issues that require clarifications. Issue 4.2.1 and potentially 4.2.2 could have serious implications for the credibility of the results of the receiving water study.

Issue 4.2.1. Concern that a one-month simulation is not sufficient to capture cumulative impacts of effluent waters over many years.

One specific objective of the receiving water study was to model the dispersion of effluent characteristics in order to evaluate potential for cumulative effects. This was done using a far-field hydrodynamic modelling using the MIKE 21 model. Model simulations were conducted for a period of one month (simulation time) and the reported results show effluent concentrations at the end of this one-month simulation period (Figures 4.2-3 and 4.2-4 of focus report). **My major concern is that the one-month simulation period is not sufficient to evaluate the cumulative impacts of effluent waters released continuously for several years, possibly decades.** On figure 41 of Appendix 4.2 of the focus report, we can notice positive trends in simulated effluent concentrations at the 8 locations located at 100 m from the outfall (Figure 1 of this report). These trends suggest an accumulation. As stated by the focus report, the concentration remains low at the end of the simulation period. However, one can ask given trends observed in Figure 41, what would the final concentrations after a simulation period of several months or several years? **This question needs to be addressed given its implication for future monitoring of potential impacts on marine life.**

Figure 1. Simulated effluent concentrations at three locations at a 100 m radius of the Outfall Discharge in July. Figure 41 from Stantec (2019). The time series of simulated concentrations show positive trends through time, which indicates accumulation. Only 3 of the 8 model locations are shown here, but increasing trends in concentration are visible at the 8 locations in Figure 41 in Stantec (2019).

Issue 4.2.2. It is not clear how the discharge is incorporated into the model.

The flow parameter is clearly specific (85,000 m^3 / day), but it is unclear how the discharge is released. One would expect that a discharge of ~3,542 m^3 is released at every time step (60 minutes) of the model. However, this is not mentioned in the description of the model implementation. This issue aligns with a previous comment from the reviewer from ECCC that the "explanatory details provided on far-field simulations are very brief and do not permit a full appreciation of the model's robustness or the credibility of its results" (page 4 of Addendum 3.0). The figures provided in the report and in appendix 4.2 do not capture the continuous nature of the discharge of effluent water. This casts some doubts on the model implantation and credibility of results. This is especially concerning in the light of comment on page 8 of focus report on which it is written that the model assumes that "no background concentrations are present". Does that mean that background concentration from a previous time step or resulting from accumulation over months or years is not considered?

Issue 4.2.3. Conditions during the months of February and July are unlikely to reflect year-round conditions.

The focus report included a simulation for the month of February in response to comments from Environment and Climate Change Canada (ECCC) and Nova Scotia Environment (NSE) – Addendum 3.0. The concern was that the presence of ice in the winter modifies stratification of water column and thus could affect dispersion rates. The appendix 4.2 of focus report now states on page 2.28 that the two scenarios (July and February) "will be able to envelope the year-round physical oceanographic and hydrodynamic environments for modeling effluent dispersion". However, given that wind is a main driver of ocean circulation and that winds vary drastically in both their direction and amplitude across seasons in the study area, we can expect that simulations for the months of July and February are unlikely to reflect spring and fall conditions. This is especially true for the fall season, during which winds are generally stronger.

4.3 Sediment transport modeling

Provide results of sediment transport modelling work to understand the impacts of potential accumulation of sediment within near-field and far-field model areas. This should include chemical and physical characterization of the solids proposed to be discharged by NPNS as well as a discussion of how these solids will interact with the marine sediments and what the potential impact will be on the marine environment as a result.

The focus report was tasked with discussing how the solids discharged by NPNS can impact the marine environment. Based on the modeling results and observed currents in the area, the focus report concluded that "effluent sedimentation is not likely to occur in the proposed diffuser

area". Therefore, effluent sediment will not have a significant impact on the marine benthic environment" (page 102, Dillon 2019). The focus report only looked at the risks of sedimentation of total suspended solids (TSS) and potential subsequent impacts on the benthic environment. They omitted to evaluate other impacts that TSS can have such as light attenuation in the water column.

Issue 4.3.1. The report does not discuss potential impacts that release of total suspended solids may have on light attenuation and subsequently on the growth of eelgrass and seaweed in the local and regional assessment area.

Light and temperature are the two main parameters controlling the growth of marine flora such as eelgrass and seaweed. Eelgrass beds have been shown to be very sensitive to change in light intensity as a result of human disturbance (Larkum et al. 2006). Given that the dredging of marine sediments will result in an increase in the TSS in the water column, this will reduce light intensity, which has the potential to impact eelgrass meadows adjacent to the proposed work area. However, the NPNS environmental impact assessment and focus report did not consider the potential impacts that added TSS in the water column can have on eelgrass and seaweed beds.

Review of part 7. Fish and Fish Habitat

7.1 Conduct fish and fish habitat baseline surveys for the freshwater environment, to the satisfaction of Fisheries and Oceans Canada.

Conduct fish and fish habitat baseline surveys for the freshwater environment, to the satisfaction of Fisheries and Oceans Canada.

I reviewed the freshwater Fish and Fish habitat surveys and did not find any significant issue.

7.2 Fish Habitat Baseline Survey

Conduct fish habitat baseline surveys for the marine environment, to the satisfaction of Fisheries and Oceans Canada.

Environmental impacts of a development project are best evaluated using before-after-control-impact (BACI) design studies. Baseline surveys conducted before project construction are thus necessary to enable future evaluation of the environmental impacts by the company or by any other groups who wish to do so. To be useful, data from baseline surveys need to be collected in a thorough and reproducible manner.

An underwater benthic habitat survey (UBHS) was conducted from May 3 to 7, 2019 in Caribou Harbour and Pictou Harbour. The objectives of the survey were: i) to identify what habitat types are present; ii) to identify what benthic (bottom) communities are present; iii) to determine if eelgrass is present; and iv) to describe what vegetation species are present (Dillon 2019). As well as this, a side-scan survey was conducted to characterize substrate in the proposed project area. ***I found numerous issues with the Fish Habitat Baseline Survey.*** These issues are described below.

Issue 7.2.1. The baseline survey is too short to capture seasonality in species distribution, growth and life-history.

The fish habitat baseline survey was conducted over a very short period of four days from May 3 to 7. In regions with strong seasonal fluctuations in climate such as the proposed work area, seasonality is a prominent feature governing many aspects of marine species life, including distribution, growth, survival, and recruitment. For instance, lobster larvae are released in the water column during the summer and settled to the bottom late summer / fall (Annis 2005). Similarly, juvenile Atlantic cod and other groundfish adopt a bottom life style in September – October and thus density of juvenile cod and other groundfish is higher in nearshore water in the fall (Methven and Bajdik 1994). Growth of eelgrass is maximal during warmer summer months and thus the extent of eelgrass meadows is maximal in early fall before winter die-offs (Larkum et al. 2006). Some migratory benthic fish species such as halibut migrate from winter deep spawning areas to summer shallow feeding areas (Le Bris et al. 2019). Those are a few examples of how seasonality governs life-history of fish and fish habitat Atlantic Canada. To be useful, baseline surveys need to capture this seasonality. **Because of its very short duration, the fish and fish habitat baseline survey conducted as part of the focus report did not capture the seasonal variation in fish communities and fish habitat; therefore, it has limited value as a baseline survey.**

Suggestion. Conduct a fish habitat baseline survey at multiple times of the year to capture seasonal variations.

Issue 7.2.2. The extent (surface area) of eelgrass meadows in the vicinity of proposed work was not measured. As well as this, the methodology used in the marine baseline habitat surveys does not provide the necessary information to enable future comparison as part of an environmental monitoring program.

The underwater benthic habitat survey indicated that eelgrass was present in Caribou Harbour in the vicinity of the proposed work (Dillon 2019). Eelgrass (*Zostera marina*) is the only seagrass

species (*i.e.* marine flowering plants) found in Canada. Seagrass meadows are among the most productive ecosystems on the planet (Cullen-Unsworth and Unsworth 2018). For instance, seagrass meadows sustain global fisheries production (Unsworth et al. 2019) and are responsible for more than 10% of global carbon sequestration annually (Fourqurean et al. 2012). Consequently, the global decline in seagrass extent has been a great concern for ocean health (Cullen-Unsworth and Unsworth 2018, Orth et al. 2006, Waycott et al. 2009). In Canada, eelgrass is considered an ecologically significant species because a disturbance to eelgrass meadows has substantially greater ecological consequences than a disturbance of equal magnitude on most other species in the community (DFO 2009). Eelgrass has been shown to be particularly important for juvenile fish, including juvenile Atlantic cod, because it offers shelter from predators, thus reducing predation risks (Gorman et al. 2009). A complete survey of eelgrass meadows adjacent to any coastal development or new human activities should be included in marine fish habitat baseline surveys.

It has long been demonstrated that excessive nutrient inputs can reduce growth, density, and biomass of eelgrass meadows (Short et al. 1995). Furthermore, eelgrass has minimum light requirements to grow and it is thus highly sensitive to change in turbidity (Larkum et al. 2006). Therefore, in order to evaluate in the future if the effluent is impacting eelgrass meadows in the area, it is necessary to properly measure:

- The extent of the eelgrass meadows (i.e. surface area).
- The percentage cover of the meadows in a given area.
- The density of the eelgrass meadows (density of shoot).
- The canopy height (average leaf length).

Measuring the above characteristics can be relatively easily done through snorkelling / SCUBA Diving survey and analyses of satellite imagery (Wilson et al. 2019) or of aerial photography taken by planes or by drones (Duffy et al. 2018). The work conducted as part of the fish habitat baseline surveys for the marine environment only recorded the presence / absence of eelgrass along video transect lines. This is insufficient to enable future monitoring of the potential impacts on eelgrass meadows of the proposed project.

Suggestion. A complete survey of eelgrass meadows adjacent to the proposed work area should be completed. This should include eelgrass meadows that can be impacted by either the transport of effluent materials or by the physical work that will be conducted to install the pipeline and which could result in re-suspension of sediment and thus reduction in light intensity. Eelgrass meadows potentially located along Caribou Island, Munroes Island and along the coast outside Pictou Harbour should be surveyed. Such survey should follow the methodology developed by the Global Seagrass Monitoring Network (www.seagrass.net) in addition to measuring the full extent (surface areas) of each meadow encountered.

Issue 7.2.3. The methodology used to analyze images from the underwater benthic habitat video survey is not well detailed and sometimes subjective, which will impede comparison of results with potential future monitoring studies.

The detailed video analysis presented in Appendix 7.2. quantified the percent cover of each substrate categories at each transect. The methodology used to estimate percent cover is not explained. An approach that can be used to limit observer bias when quantifying percent cover from images or videos is to divide the image frame in numerous grid cells using and count the presence / absence in each grid cell. Because of the lack of mythological explanation in focus report and Appendix 7.2, it is unclear if the percent cover analysis was done using a grid on the images or not. As well as this, to quantify percent cover from videos require to stop the video at specific time interval (e.g. every minute). Unfortunately, no details are provided on how video images were analyzed. Finally, distribution of macro faunal species was estimated using a semi-quantitative approach (page 6 of Appendix 7.2.). A quantitative approach could have been easily employed by, again, dividing the images in numerous grid cells and counting the presence / absence in each grid cell. Such approach would have provided more reproducible results.

Suggestion. More details on the video analysis methodology should be provided to enable an evaluation of the performance of the marine fish habitat survey and, most importantly, to evaluate if the survey is reproducible in the future. A more quantitative approach should be used for the estimation of substrate percent cover and for distribution of macro faunal species.

Issue 7.2.4. Only a survey of the benthic habitat was conducted. No survey of the pelagic (in the water column) and intertidal zones (zone between low and high tide mark) was conducted.

Fish habitat is defined in subsection 2(1) of the Fisheries Act to include “all waters frequented by fish and any other areas upon which fish depend directly or indirectly to carry out their life processes”. Based on this definition, not only the bottom but the entire water column should have been surveyed, including the intertidal zone. Water quality analyses were conducted in section 4 of the focus report but no survey of the biological communities (phytoplankton, zooplankton and ichtyoplankton) was provided. These are important species communities at the base of the food web that drives future recruitment of marine fish species important for commercial, recreational and Aboriginal fisheries. As well as this, no survey of the intertidal zone was conducted. The intertidal zone is home to communities of species specifically adapted to this environment and that constitute important food source for many coastal fish species. Without proper surveys of the intertidal and pelagic zones, the future impact of the proposed work will be impossible to monitor because of the lack of baseline information.

Other minor issues:

- The justification for the choice of the classification scheme for substrate type was not provided (Appendix 7.2, page 6). There is also one size class missing between "Boulder (>25 cm)" and "Cobble (3-13 cm)".
- The term "high-level video analysis" is used on numerous occasions in the report on the marine fish habitat baseline survey (Appendix 7.2) without being defined. The superlative "high" is subjective.

7.3 Impact Assessment for Marine Fish

Conduct additional impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information, additional studies and/or an understanding of expected movement of contaminants. Assessment methodology must first be agreed upon by NSE in consultation with relevant federal departments.

The focus report conducted an additional impact assessment of treated effluents on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. Despite the presence of numerous fish species in the area, including species important for commercial, recreational and Aboriginal fisheries, the focus report concluded that "*no significant residual impacts to marine water quality are expected to arise on any fisheries or fish habitat as a result of this project*" (page 123, Dillon 2019). **This conclusion is driven uniquely by the results of the receiving water modelling study, which indicated that beyond a zone < 5 m from the diffuser, water parameters will match marine baseline data in the Northumberland Strait.** If the predictions from the receiving water study are inaccurate, then the conclusion of the focus report regarding potential impacts on marine life is not valid. As noted above, there is some doubt regarding the credibility of the results of the modelling studies. Regardless of the type of model, any results from modelling studies should be taken with caution given that modelling exercises always require assumptions – and the precautionary approach principle must be applied.

On top of the potential issues with the receiving water study, **I noticed several issues in the study of distribution of marine fish species in the proposed work area**. These issues are presented below.

Issue 7.3.1 The "Distribution of Marine Fish and Fish Habitat in Study area" part of the section 7.3. is insufficient.

The focus report only uses the results from the Underwater Benthic Habitat Survey (UBHS) to describe the distribution of marine finfish in the study area and stated that "marine invertebrates and marine fin-fish species sightings were rare and were not found in any abundance" (page 127, Dillon 2019). This survey was conducted using a towed camera and was design to survey benthic substrate. This is not a proper methodology to survey highly mobile species such as fin-fish, because they can easily escape the camera field of view.

As well as this, the focus report failed to recognize that the regional assessment area for this project is one of the regions with the historical highest diversity of fish species in the southern Gulf of St. Lawrence and that the region is considered as an Ecologically and Biologically Significant Area (Rondeau et al. 2016).

Issue 7.3.2. The mitigation measures proposed in table 7.3-2 are often vague and not specific to each indicator and / or potential effect.

For instance, one mitigation measure for the physical disturbance of plankton diversity and abundance is to stage the work according to fisheries timing windows. This does not make sense because there is no fishery for planktonic species. Similarly, the same mitigation measure is proposed to reduce impact on lobster and avoid sensitive stages. Sensitive stages are not defined. They could include larvae stages, young of the year, or egg-bearing females. Clarification on how mitigation measures will address each species indicator and potential effects are required.

Issue 7.3.3. Atlantic halibut (*Hippoglossus hippoglossus*) is not evaluated in the potential impacts to important fisheries of commercial, recreational, and Aboriginal value within the project area and the likelihood of occurrence of Atlantic halibut in the LAA should be revised from low to medium-high.

Atlantic halibut is a species of growing commercial value in Atlantic Canada. Its value has increased from 6.6 million dollars in 1995 to 59.8 million dollars in 2017 and it is now the third most valuable fin-fish fishery in the country (https://www.dfo-mpo.gc.ca/stats/commercial/sea-maritimes-eng.htm). Accompanying the growth in population abundance, the population has expanded its distribution (Boudreau…) and halibut is now commonly present in the eastern part of the Northumberland Strait. Indeed, figures from the most recent halibut stock assessment report (DFO 2019) show that halibut is commonly caught in scientific surveys (Figure 2) and in commercial catches (Figure 3) in the eastern Northumberland Strait in the vicinity of the Marine Regional Local Assessment Areas. Finally, recent tracking of halibut using pop-up satellite archival tags has revealed that a halibut tagged in on the northeast side of Prince Edward Island (46.543°N; 62.218°W) on November 11, 2014, for which the tagged popped-up near Port Hood Nova Scotia (46.956°N; 62.608°W) on August 20, 2015 spent several days from June 18, 2015 to June 30, 2015 inside the regional assessment area and the local assessment area (Figure 4). This indicates that the area of interest is a summer feeding area for Atlantic halibut. Tracking of other Atlantic halibut using pop-up satellite archival tags in the

same region revealed that other tagged Atlantic halibut used the eastern part of the Northumberland strait as a summer feeding area (James et al. In Review).

The focus report did not consider the Atlantic halibut fisheries in its review because the likelihood of occurrence of Atlantic halibut in the LAA was evaluated as low. The likelihood of occurrence of Atlantic halibut in the LAA was evaluated as low because it was based on information from one study with data up to 2013. **Thus the evaluation did not consider the recent changes in Atlantic population abundance and distribution.** Based on information provided here, the likelihood of occurrence in the LAA in the Appendix 7.3 should be revised from low to medium. Atlantic halibut should be included in the list of species likely to Inhabit the study area (table 3-11 of Appendix 7.3) and in the Commercial, Recreational and Indigenous Fisheries Resources and Use in the Study Area part of the focus report.

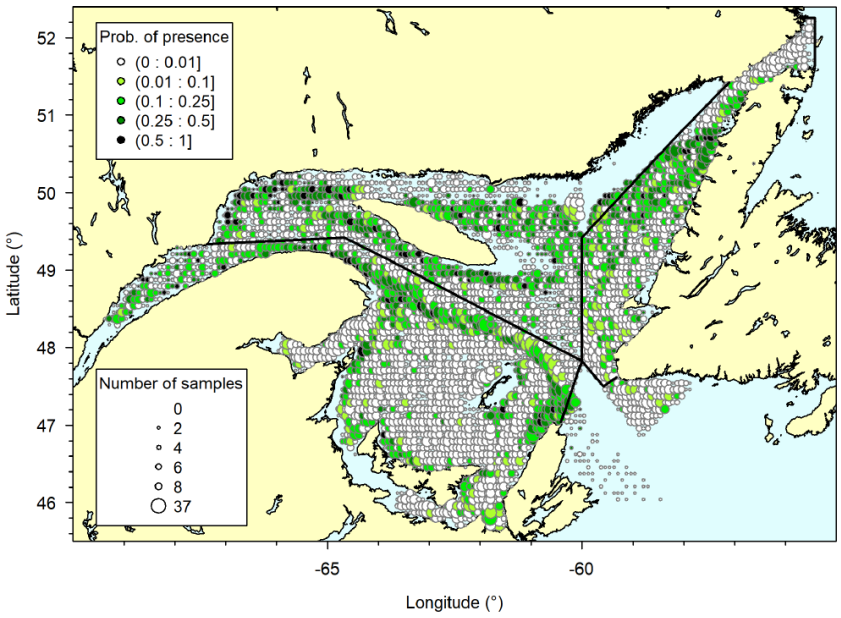

Figure 2. Probability of occurrence of Atlantic halibut in catches made during mobile gear research surveys, per 5-minute square. Figure from DFO (2019).

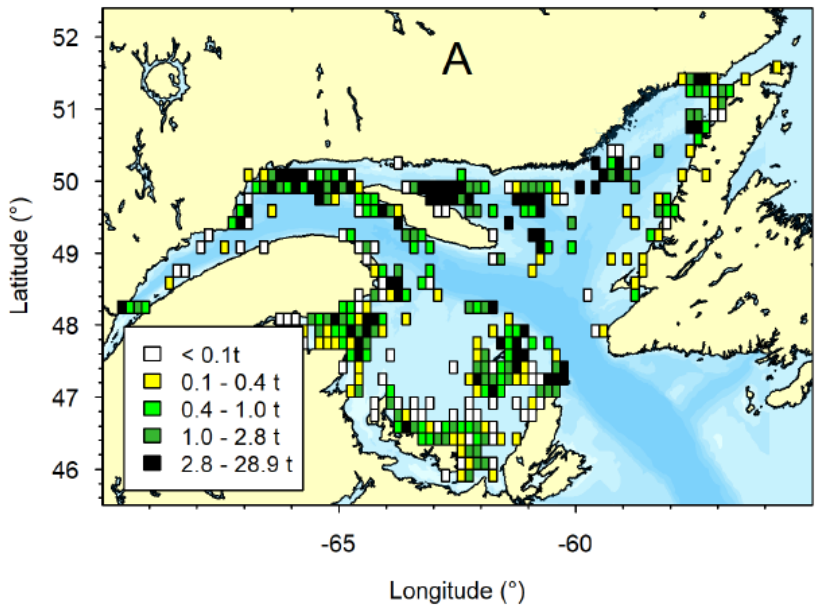

Figure 3. Distribution of Atlantic halibut catches per 10-minute square for the 2017-2018 and 2018-2019 fishing seasons combined. Figure from DFO (2019).

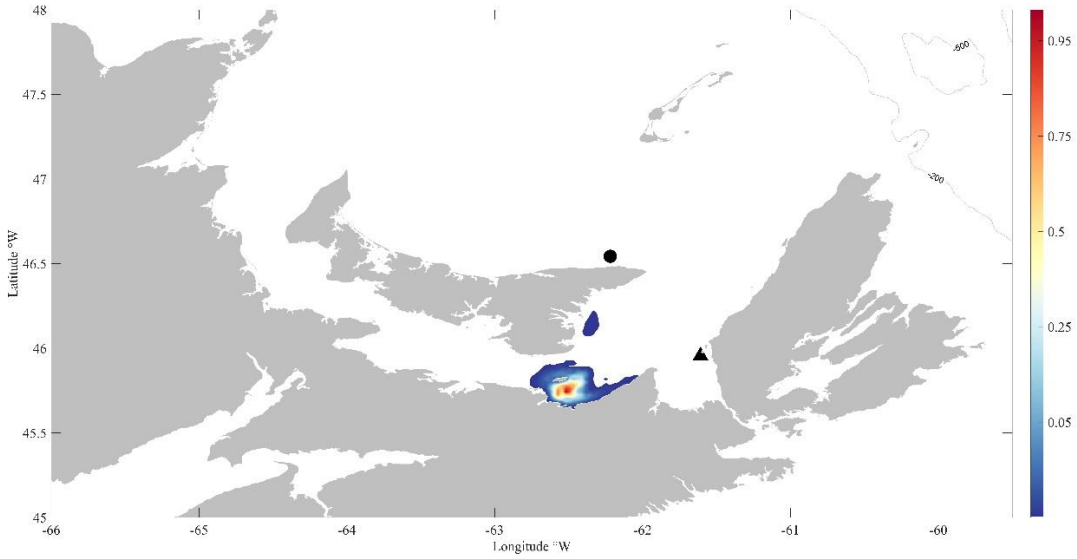

Figure 4. Probability distribution of Atlantic halibut equipped with pop-up satellite archival tag #14P0060 between June 18 and June 30, 2015. Black circle and triangle indicates tagging and tag pop-up locations, on November 11, 2014 and August 20, 2015, respectively. Data from James et al. (In review).

Other minor issues.

- In the summary of section 7.3., the additional work listed on page 122 is incorrect. No survey of benthic, planktonic and fish species was done in section 4.1. or 7.1. as indicated.
- Plaice (*Hippoglossoides platessoides*) is often referred to as Atlantic Plaice (pages 132, 133 and 142 of focus report and 3.29, 3.37, 4.22, and Appendix D of Appendix 7.3.). The proper common name is American plaice.

7.5 Clarify what contingency measures will be in place to mitigate potential impacts (e.g., thermal shock to fish) due to potential large and rapid fluctuations in water temperature in the winter at the diffuser location during low production or maintenance shut down periods.

This question is more related to the engineering part of the project and is outside the scope of my expertise.

Discussion and Conclusions

The first question that I address here is: **Is the Northern Pulp's assertion that the effluent released into the Strait through the proposed treatment system will be less harmful than the effluent currently entering the Strait via the current Boat Harbour treatment system (particularly with respect to the release of metals) is valid?**

The comparison of the treated and untreated effluents from current Boat Harbour treatment system and predicted effluents from new proposed treatment system suggested that they will have similar characteristics regarding Total Suspended Solid, Total Nitrogen and Total Phosphorus. However, no information is provided on the concertation of metals (i.e. arsenic, lead, manganese, cadmium, etc.) that will be released in the new treatment facility in comparison to the current Boat Harbour treatment system. The new treatment facility will increase the dilution of the effluent in the Strait because it is located in a zone with more intense currents; however, **it cannot be concluded that it will be less harmful to the environment because we do not have information on the concentrations of metals that will be released with the new treatment facility**.

The second question that I address here is: **Does the materials submitted by Northern Pulp adequately address the potential risks of bioaccumulation of toxins in the marine environment?** In my opinion, the focus report from NPNS does not adequately address the potential risks of bioaccumulation of toxins in the environment.

The evaluation of the risks of bioaccumulation of toxins in the marine environment in the focus report relies mostly on the results from the receiving water study. A major assumption of the receiving water study is that the one-month simulation conducted in the far-field modelling is representative of the entire time period (possibly several decades) during which effluent will be discharged. The model assumes that no background effluent concentrations are present at the start of the one-month simulation period. By the end of the one-month simulation period, effluent concentrations are still low; however, we can notice an increase in these concentrations through time (see details above in part 4.2). Thus an important question is: **what would be the values of effluent concentrations and dilution factors if the simulation period was extended to several years**? This is a very important point that aligns with the focus report addendum point 3.0, which requires clarification on potentially overestimated dilution ratios and distances.

A second assumption is that climatic and oceanographic conditions in July and February are representative of the full year, and that conditions observed in 2019 are representative of future climatic and oceanographic conditions. This assumption is unlikely to be met given the seasonality in climatic and oceanographic conditions in the region with predominant storms in the late summer and fall, and given the risks for an increase in the frequency and intensity of storms with climate change. No uncertainty around predictions are provided with the results of the receiving water study, and little sensitivity analyses of the input parameters such as temperature, salinity, wind forcing were conducted. Modelling exercises always have limitations and characterizing uncertainty and conducting sensitivity analyses are required to gain trust of the results of any modelling study. Without in depth uncertainty characterization and thorough sensitivity analyses, the precautionary principle should apply.

To conclude,

i) the focus report does not demonstrate that the new effluent treatment facility will be less harmful to the environment that the current Boat Harbour treatment system (**medium confidence**)
ii) the focus report does not adequately address the risks of bioaccumulation of toxins in the marine environment (**medium confidence**)
iii) the baseline surveys are insufficient to evaluate the impacts of the effluent on the marine environment in the future (**high confidence**).

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Appendix Attached. Curriculum Vitae

ARNAULT LE BRIS - Curriculum Vitae

Contact Information

Centre for Fisheries Ecosystems Research
Marine and Fisheries Institute
Memorial University of Newfoundland
St. Johns, NL, A1C 5R3, CANADA

Phone: (709) 778-0482
E-mail: arnault.lebris@mi.mun.ca
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Current Positions

Research Scientist **September 2016 - Present**

Centre for Fisheries Ecosystems Research
Fisheries and Marine Institute of Memorial University of Newfoundland

Research Interests

Fisheries ecology, Climate change and marine ecosystems, Movement modeling, Population dynamics, Habitat restoration, Life-history theory, Telemetry

Education

Ph.D. Biology. Memorial University of Newfoundland, St. John's, NL **2009 - 2014**

- Dissertation title: Mechanisms and consequences of variation in the migratory behaviour of Atlantic cod (*Gadus morhua* L.) in the northern Gulf of St. Lawrence
- Co-advisors: Joe Wroblewski and Alain Fréchet

M.Sc., Oceanography. Université de la Méditerranée, Aix-Marseille 2 **2006 - 2008**
One year exchange program CREPUQ - Université du Quebec à Rimouski (2007 - 2008).

- Dissertation title: Estimation of fish stock exploitation rate based on tagging data
- Co-advisors: Jean-Claude Brêthes and Alain Fréchet

B.Sc., Biology, Université de Rennes 1, France **2003 - 2006**

Professional Experience

Postdoctoral Research Associate **2014 - 2016**

Gulf of Maine Research Institute and University of Maine. Integrated modeling of the impacts of climate change and fishing on New-England lobster fisheries. Supervisor: Dr. Andrew Pershing.

Fish Stock Assessment **2008 - 2017**

Department of Fisheries and Oceans Canada. Involved in the assessment of several fish stocks (Atlantic cod, redfish, Atlantic halibut) from the Gulf of St. Lawrence. Role: estimation of the stock exploitation rate from mark-recapture data.

Research Assistant **May-June 2013**

Memorial University of Newfoundland. Statistical analyses of fish diversity, abundance, and presence-absence data in relation to habitat characteristics. Supervisor: Dr. Joseph Wroblewski.

Research Internship **Jan-June 2008**

Institut des sciences de la mer de Rimouski - Department of Fisheries and Oceans Canada. Development of a model to estimate the exploitation rate of the northern Gulf of St.Lawrence Atlantic cod stock from tagging data. Supervisors: Dr. Jean-Claude Brêthes, Alain Fréchet.

Peer-reviewed

2019. Liu C., Cowles G.W., Zemeckis D.R., Fay G., **Le Bris A.**, and Cadrin S.X. A hardware-accelerated particle filter for the geolocation of demersal fishes. *Fisheries Research*, 213: 160-171.

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2018. **Le Bris A.**, Wroblewski J.S. 2018. Species composition and habitat preferences of the nearshore fish fauna of Bonne Bay, Newfoundland. *Marine Biodiversity Records*, 11:12.

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2017. Murphy H.M., Fisher J.A.D., **Le Bris A.**, Desgagnés M., Castonguay M., Loher T., and Robert D. Pop-up satellite archival tags provide the first characterizations of depth distributions, temperature associations, and seasonal migrations of Atlantic halibut in the Gulf of St. Lawrence. *Marine and Coastal Fisheries*, doi.org/10.1080/19425120.2017.1327905

2016. **Le Bris A.**, Pershing A.J, Gaudette J., Pugh T.L., and Reardon K.M. Multi-scale quantification of the effects of temperature on size at maturity in the American lobster (*Homarus americanus). Fisheries Research*, 186: 397-406.

2016. Pershing A.J., Alexander M.A., Hernandez C.M., Kerr L.A., **Le Bris A.**, Mills K.E., Nye J.A., Record N.R., Scannell H.A., Scott, J.D., Sherwood G.D., and Thomas A.C. Response to Comments on "Slow adaptation in the face of rapid warming leads to the collapse of an iconic fishery". *Science*, 352 (6284): 423.

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2015. **Le Bris A.**, Pershing A.J., Hernandez C.M., Mills K.E., and Sherwood G.D. Modelling the effects of variation in reproductive traits on fish population resilience. *ICES Journal of Marine Science*, 72: 2590-2599.

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James T., Landsman S., Ramsay L., Griffin M., **Le Bris A.**, and van den Heuvel M. Migration Patterns of Atlantic Halibut Captured in the Southern Gulf of St. Lawrence as Assessed with Pop-up Satellite Archival and Floy Tags. *Canadian Journal of Fisheries and Aquatic Sciences.*

Research documents

Brassard C., Gauthier J., Schwab P., **Le Bris A.**, Way M., and Collier, F. The status of cod in the Northern Gulf of St. Lawrence (3Pn, 4RS) in 2014. DFO Can. Sci. Advis. Sec. Res. Doc. 2016-010

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Fréchet A., Gauthier J., Schwab P., Lambert Y., **Le Bris A.**, Tournois C., Way M., and Collier, F. The status of cod in the Northern Gulf of St. Lawrence (3Pn, 4RS) in 2008. DFO Can. Sci. Advis. Sec. Res. Doc. 2009-090

Grants Scholarships Awards

2019 NSERC Discovery Grant and Supplement. PI. *Modelling groundfish spatial dynamics in the Northwest Atlantic.* $177,500

2019 MEOPAR Early Career Faculty Grant. PI. *Monitoring juvenile American Lobster (Homarus americanus) to forecast productivity in the growing Newfoundland lobster fishery.* $100,000

2019 NSERC Engage Grant. PI. *Development of a new acoustic data storage tags to track aquatic species.* $22,700

2017 Ocean Protection Plan - Coastal Restoration Fund. PI. *Restoring Placentia Bay Coastal Ecosystem.* $4,779,255

2017 NSERC Strategic Partnership Grants. Role: co-PI. *Quantifying spatial dynamics and stock structure of Atlantic halibut within the Gulf of St. Lawrence to improve sustainable exploitation and management.* $566,472. Attributed to me: $153.172

2017 Ocean Frontier Institute - Canada First Research Excellence Fund. co-investigator. *Sustainable capture fisheries and their ecosystems.* $3,509,628. Attributed to me: $353,125.

2015 Subaward on a Saltonstall-Kennedy Grant - NOAA Fisheries. Collaborator (PIs: Drs. Geoffrey Cowles and Steven Cadrin. SMAST - University of Massachusetts Dartmouth). $131,491. Attributed to me: $9,493.

2014 Fellow of the School of Graduate Studies. Memorial University of Newfoundland

2012 Best PhD talk awarded at the 5th Biology Graduate Student Symposium. Memorial University of Newfoundland

2009-13 Graduate Fellowship. Memorial University of Newfoundland. $30,000

2009-12 DFO Academic Research Contribution Program. $30,000

2008 Mobility scholarship. French Ministry of Research and Education. 4500€

Teaching experience

Supervision

Supervisor of postdoctoral research associate Dr. Paul Gatti	**2018-**
Thesis supervisor of Ph.D. student Tanya Prystay	**2018-**
Thesis supervisor of M.Sc. student Caley Ryan	**2018-**
Thesis supervisor of M.Sc. student Rachel Marshall	**2018-**

Thesis supervisor of M.Sc. student Andrés Beita **2017-**

Academic Services

Thesis committee member of M.Sc. student Aaron Sneep **2018-**
Geography Department - Memorial University of Newfoundland

Thesis committee member of Ph.D. student Chang Liu **2015-2019**
School for Marine Science and Technology (SMAST) - University of Massachusetts Dartmouth

Comprehensive examination committee member of Ph.D. student Devin Flawd **2017**
Biology department - Memorial University of Newfoundland

Thesis examination committee. M.Sc. student Tomas Araya-Schmidt **2017**
Environmental Science Program - Memorial University of Newfoundland

Teaching **2017-2018-2019**
Instructor of a population dynamic module in graduate courses FISH6001: Ecology, Management, and Practice of North Atlantic Fisheries.

Workshop facilitator **2012**
Estimating fish stock exploitation rate from conventional tagging data. Maurice Lamontagne Institute, QC. Attended by biologists from the Department of Fisheries and Oceans Canada.

Teaching assistant: Biology 4750. Fisheries Ecology. **2010-2012**
Memorial University of Newfoundland. Instructor: Dr. Joseph Wroblewski. Duties: laboratories coordination and marking, plus 4 hours of lectures.

Teaching assistant: Biology 3714. Estuarine Fish Ecology. **2010-2012**
Summer field course at the Bonne Bay Marine Station. Instructors: Drs. Craig Purchase, David Methven and Joseph Wroblewski. Duties: logistic coordination and data recordkeeping.

Teaching Certificates
Graduate Program in Teaching Certificate (School of Graduate Studies, MUN) **2010**
International Teaching Assistant Training Program Certificate (MUN) **2010**

Professional Service

Committee Service
NSERC Ship Time allocation Committee **2019-2022**

Member. Academic Advisory Committee, Fisheries Science Graduate Program **2017-**
School of Fisheries, Marine Institute of Memorial University of Newfoundland

Guest Editor
Bulletin of Marine Science

Reviewer - Journal Manuscript
Canadian Journal of Fisheries and Aquatic Sciences, Conservation Physiology, Fisheries Oceanography, Global Change Biology, ICES Journal of Marine Science, Journal of Animal Ecology, Marine Biodiversity Records, Marine Ecology Progress Series, PlosOne

Reviewer - Funding proposal
NOAA Saltonstall Kennedy. Competitions 2018 and 2019
Ocean Frontier Institute Seed Fund. Competitions 2018 and 2019

External Reviewer - Fish Stock Assessment

Assessment of American Lobster in Newfoundland. Fisheries and Oceans Canada. St. John's, NL. October 16-17, 2019.

Stock Framework for American Lobster in Lobster Fishing Areas (LFAs) 27-33. Fisheries and Oceans Canada. Halifax, Ns. October 16-17, 2019.

WITNESS ACTIVITY House of Commons Canada. Report of the Standing Committee on Fisheries and Oceans. Study on Climate Change and Lobster and Snow Crab Fishery. June 2019.

SPECIFIC TRAINING RECEIVED **Summer School**

IMBER ClimEco5: Towards more resilient oceans: Predicting and projecting future changes in the ocean and their impacts on human societies. Natal, Brazil. August 10-17, 2016. *Travel support provided by Ocean Carbon Biogeochemistry.*

Course Mixed Modelling using R-INLA. Highland Statistics. St John's, NL. August 12-16, 2019. Instructors: Drs. Alain Zuur and Elena Ieno.

LAST UPDATE: November 7, 2019

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Review of the Northern Pulp Nova Scotia's Focus Report Replacement Effluent Treatment Facility from an Animal Health Perspective with a Focus on Crustaceans

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November 7, 2019

DISCLAIMER

This document entitled 'Northern Pulp Nova Scotia's Focus Report Replacement Effluent Treatment Facility from an Animal Health Perspective' with a Focus on Crustaceans was prepared by CrustiPath for Juniper Law (the Client) on behalf of the Gulf Nova Scotia Fleet Planning Board, PEI Fishermen's Association, and Maritime Fishermen's Union. Any reliance on this document by any third party is strictly prohibited. The material in it reflects CrustiPath's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between CrustiPath and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, CrustiPath did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that CrustiPath shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Table of Contents

EXECUTIVE SUMMARY

CrustiPath was engaged by Juniper Law on behalf of the Gulf Nova Scotia Fleet Planning Board, PEI Fishermen's Association, and Maritime Fishermen's Union to review the October 2019 Focus Report provided by Northern Pulp Nova Scotia (NPNS) on its proposed replacement effluent treatment facility and provide opinions, within the limits of their expertise, on the potential environmental impacts of the proposed project on fisheries and the marine environment within the Northumberland Strait.

Inconsistencies were noted in NPNS's Focus Report regarding the reporting of the Reportable Detection Limits (RDLs) and summary statistics for metals in the Caribou Harbour background water samples and associated summary statistics in Appendices B-1 (*n* =14) and B-2 (*n* = 5) of Appendix 7.3 and Appendix 2.3 (*n* = 6). These inconsistencies could not be investigated completely as portions of the raw data and associated quality assurance information could not be found within the Focus Report documents or the EARD. Review of available data and quality assurance information from other water sampling sites (Raw Water, Point 'A', Point 'C') suggests that the background concentration of many metals in Caribou Harbour are 'not detectable', as reported in Appendix 2.3, and so are at least 10—fold lower than the concentrations indicated in Appendix 7.3, Table 4-3 and Table 7.3-1 '*Marine Water Quality COPCs and Estimated Dilution*'. If these much lower background values are confirmed, then the values for '*Distance (m) from Diffuser Ambient Condition is Reached based on Dilution Ratios*' in Table 7.3-1 will need to be reviewed and possibly revised. This could be significant if some of the revised values are greater than the Local Assessment Area (LAA) which is defined in the Focus Report, in part, as a 200 m radius around the effluent discharge point.

From a crustacean health perspective, it is concerning that of the nine metals (aluminum, barium, cadmium copper, iron, manganese, mercury, phosphorus, zinc) which had higher concentrations in the effluent than background water, all but cadmium were dropped from the screening process for Chemicals of Potential Concern (COPC) with respect to water quality due to a lack of Canadian Water Quality Guidelines. If many background water metal levels are confirmed to be 'not detectable', the list of metals in effluent higher than background water will likely expand. Metals, especially copper, are recognised as acute (short term) toxins to American lobster and other marine crustaceans. There is insufficient information in the literature, the Focus Report or the EARD on the effects of sub-acute (medium term) or chronic (long-term) exposure to low levels of metals, directly or through bioaccumulation, on the American lobster. The Focus Report indicates custom toxicity tests have been developed for lobster larvae. It would be preferable to see an unequivocal commitment to use them in any future effluent toxicity testing. Inclusion of chronic exposure of adults, eggs and generational testing is also encouraged.

Anthropogenic noise (seismic testing, mechanical) is increasingly recognised as potentially harmful to marine life, including warm water lobster species, with even short exposures having long term negative effects on behaviour or increasing mortality levels. Exposure to high intensity sound is listed as a recognised interaction during the construction (three months) and operation and maintenance (several decades) phases of the project. These interactions were not considered significant as the exposures were short. Assessment of the potential for negative effects on larval, juvenile and adult American lobsters and eggs exposed to high intensity sounds is warranted.

No reference to the potential impact, if any, of the high temperature effluent in the 4 km of pipeline might have on the temperature of the overlying sediment or water column was found. This may be relevant as larval lobster drifting in the water column are susceptible to high temperatures. The movements of juvenile and adult lobsters on the ocean floor could be modified as they would likely move to avoid temperatures above their tolerance limits.

Overall, there were reporting errors noted that need to be evaluated for any effect on 'distance from diffuser that ambient conditions are reached' and screening for COPCs. The exclusion of many metals from the list of COPC and minimal information on bioaccumulation is concerning as metals are known to be toxic to American lobster. A stronger commitment to the inclusion of developed custom lobster larval effluent toxicity assays in EEM and long-term adult and generational studies is encouraged. Further evaluations on the potential effects of exposure to high intensity sounds and thermal effects, if any, from the 4 km of pipeline, during the life of the project are recommended.

EXPERTISE

Andrea Battison DVM, MVSc, DACVP, PhD is a veterinary clinical pathologist, certified by the American College of Veterinary Pathologists and a member of the American Society of Veterinary Clinical Pathology. As a veterinary clinical pathologist, Dr. Battison has extensive experience in the study of animal disease and interpretation of laboratory results and associated quality assurance data. Dr. Battison's PhD is in the field of lobster health assessment and she has participated in multiple industry projects involving American lobster. With respect to the current project, Dr. Battison's main areas of expertise relate to evaluation of laboratory test data and lobster health.

SCOPE OF REVIEW

A general review of the pertinent sections of the Focus Report and associated Appendices (1.2, 2.3, 2.4, 4.1, 4.2, 7.3, 7.4, 9.1, and 9.2) and EARD was completed with a specific interest on potential effect of the treated effluent on crustaceans. Provided references in the Focus Report and Appendices, as available, were reviewed. This led to a focus on metal concentrations in the current treated effluent as these are meant to be surrogates for metal concentrations in the proposed treated effluent and background water quality. Inconsistencies in reporting were noted in the raw data summary tables for metals in Caribou Harbour (background). These were followed up in detail including how inconsistencies might affect other tables and calculations and implications as carried through the associated Appendices and the Focus Report. This represents the bulk of the material presented in this report given time constraints. Information on the known toxic effects of metals on American lobsters and other crustaceans and, short- and long-term effects of seismic testing on plankton and adult warm water lobsters, respectively is also provided.

GLOSSARY

CMC	Criterion Maximum Concentration
CCC	Criterion Continuous Concentration
CCME	Canadian Council of Ministers of the Environment
CWQG	Canadian Water Quality Guidelines
COPC	Chemicals of Potential Concern
DACVP	Diplomate American College of Veterinary Pathology
Dataset	the numbers, or values, used for evaluation
DVM	Doctor of Veterinary Medicine
EARD	Environmental Assessment Registration Document
EEM	Environmental Effects Monitoring
Maximum	the largest value in a dataset
Mean	the average value in a dataset (sum of all values / number of values)
Median	the middle value of set of values arranged in ascending order
Minimum	the smallest value in a dataset
MVSc	Master of Veterinary Science
n	The number of values in a dataset
ND	*"A non-detect value is a laboratory assigned concentration that indicates the concentration of that parameter in the sample is below the level that could be detected or reliably quantified by the laboratory using a particular analytical method*."
NG	not given
NPNS	Northern Pulp Nova Scotia
PPER	Pulp and Paper Effluent Regulations
Range	the difference between the largest and smallest values in a dataset
RDL	reportable detection limit; the lowest value that an assay/test can detect in a sample
Standard Deviation	a measure of the amount of variation in a dataset

INCONSISTENCIES NOTED IN THE PROVIDED DATA BY SECTION

Throughout the Focus Report, tables often reported means without standard deviations and/or reported medians without a range or did not indicate if a mean or median value was being presented. Attempts were made to examine the raw data to better understand which values were being reported in the tables; however, some of the data could not be found in the Appendices. As metals e.g., copper, cobalt, cadmium and zinc, are recognised toxins for American lobsters and other crustaceans (Johnson & Gentile, 1979; Maharajan, Rajalakshmi, Vijayakumaran, & Kumarasamy, 2012; Maharajan et al., 2011; McLeese, 1974; Mercaldo-Allen & Kuropat, 1994) the raw data for tables with information on metal concentrations in water were examined in the most detail.

1. **Focus Report Section 2. 'Project Description'**
   In Section 2.3 of the Focus Report 'Characterization of the Effluent' and its associated Appendix 2.3, neither the raw data for the indicated May 29, 2018 Point C (treated effluent) nor the data collected during annual testing by NPNS since 2015 could be located. Appendix E-2 of Appendix 7.3 suggests sampling dates of Feb 25, 2015, Oct 2, 2016 and Feb 23, 2017. Consequently, verification or determination of range (max and min) or standard deviations was not possible. Providing standard deviations and range in addition to the average, or mean, values would have provided a better indication of the variation in the data.

Table A. Summary of water quality and effluent samples that were indicated as collected for use in the focus report and those for which raw data could be found.

Freshwater 'Raw'		Point 'A'		Point 'C'		Caribou Harbour	
Sampled	**Data Available**	**Sampled**	**Data Available**	**Sampled**	**Data Available**	**Sampled**	**Data Available**
Apr 24/18	Yes	May 29/18	Yes	May 29/18	**Not found**	May 24/19 13:00 (CH-BOF 1-2 outfall, flooding, bottom 20m)	Yes
May 14/19	Yes	May 14/19	Yes	May 14/19	Yes	May 24/19 13:30 (CH-BOF 1-1 outfall, flooding, surface 0.5 m)	Yes
				July 17/19	Yes	May 25/19 17:00 Caribou Seawater 1 (Caribou Harbour, ebbing, surface 0.5m)	Yes
				Annual testing data collected since 2015 (dates in Appendix E-2, of Appendix 7.3 suggest *n* = 3)	**Not found**	May 25/19 17:00 Caribou Seawater 2 (Caribou Harbour, ebbing, bottom 3m)	**Not found**
						May 25/19 18:15 (CH-B 2-1 outfall, ebbing, surface 0.5m)	Yes
						May 25/19 18:15 (CH-B 2-2 outfall, ebbing, bottom 21m)	Yes
						May 25/19 18:15 (2-W1) Not defined in Table 4.1-1	phenol results only
						October 2018 for chemical characterization at diffuser site?	**Not found**
						June 2019 for chemical characterization at diffuser site?	**Not found**

Water quality data for 'May 25/19 17:00 Caribou Seawater 2', October 2018, and June 2019 could not be located. Only phenol data were available for site labelled '2-W-1, Caribou Harbour, May 25, 2019'. These findings are summarised in Table A of this report.

Table 1-3 'Analytical Results, Metals', in Section 1.3.2 'Metals' of Appendix 2.3 (*n* = 6) reports some metal concentrations in Caribou Harbour as ND, defined in Table 2.3-2 of the Focus Report as "*ND = Non-Detect. A non-detect value is a laboratory assigned concentration that indicates the concentration of that parameter in the sample is below the level that could be detected or reliably quantified by the laboratory using a particular analytical method*." This is consistent with results from the five May 2019 samples which are available for review. This contrasts markedly with results presented in Table 4-3 'Marine Water Quality COPCs and Estimated Dilution' of Appendix 7.3 (which also appears as Table 7.3-1 in the Focus Report) where the 'Median Background Quality' values for 2019 are reported. Here, median background levels for metals are 10-fold greater than their reportable detection limits (RDLs) (see item 2, following).

Table 1-3: 'Analytical Results, Metals' also has a footnote for the Caribou Harbour cadmium results *"Cadmium of 0.12 µg/l was detected in one Caribou Harbour sample, all others were below the 0.1 µg/l detection limit*." The actual detection limit for cadmium appears to be 0.01 µg/l (see item 2, following).

2. **Appendix 7.3, Section 3. 'Existing Environment'**

Section 3.1.1 'Background Water Quality' indicates that water samples were collected for chemical characterisation in October 2018, May 2019, and June 2019 (eight within Caribou Harbour along the pipeline and 14 within the effluent mixing zone). The summary and individual values are supposed to be found in Appendix B. No individual data or quality assurance data were found other than that for the five May 24 and May 25, 2019 samples at the end of Appendix 2.3 'Raw and Treated Effluent Characterisation' under 'Caribou Harbour' (see Table A, this report). Summary data for **'Background Water Quality at Diffuser Location (2018-2019)** are provided in **Appendix B-1** (with 1 - 14 samples evaluated depending on parameter = 'count'; all metals indicate *n* = 14). Summary data for '**Background Water Quality at Pipeline Corridor (2018 – 2019)**' (from 1 - 5 samples evaluated, depending on the parameter; *n* = 5 for all metals) are presented in **Appendix B-2**.

All (14/14 and 5/5) values for copper in Appendices B-1 and B-2, respectively, were recorded as below their RDL in the column 'Count (<RDL)'. According to the quality assurance data in Appendix 2.3, water quality results for other sites, and suggested by a value of <0.5 µg/l appearing in the minimum value column in Appendix B-1, the RDL for copper is assumed to be 0.5 µg/l. Yet, Appendix 7.3, Section 3.1.6 'Metals', states that "*Two metals (copper and nickel) were reported in one or more surface water samples, taken along the pipeline route or diffuser location, above the EPA chronic screening level criteria (3.73 µg/L and 8.28 µg/L, respectively*)." A value of 3.73 µg/l is above the apparent reprotable detection limit (RDL) and so the result for column 'Count (< RDL)' should be either 13/14 for Appendix B-1 or 4/5 for Appendix B-2 depending on where the sample was collected. It is also unclear why the median and maximum values would be reported as < 5 µg/l when the RDL appears to be 0.5 µg/l (see item 3, following).

3. **Appendix 7.3, Appendices B-1 and B-2**

Some of the raw data and quality assurance data for Appendices B-1 and B-2 could not be found (see item 1 above, Table A). The May 2019 water samples had RDLs provided in their quality assurance data (found in Appendix 2.3). These RDLs, rather than the value presented in the result tables, will be assumed to be correct.

Inconsistencies in the reporting for metals are noted when low, non-detectable (ND) values are encountered, particularly evident in Appendix B-1. While it is not incorrect that e.g., a value that is less than 0.5 µg/l is also less than 5.0 µg/l, it is not as accurate as it could be. The convention would be to report a non-detectable value as less than the reportable detection limit (RDL) for the parameter (as done in the results for 'Raw Water', Point A, and Point C, Table 3-1 in Appendix 2.3, and the minimum value column in Appendix B-1, Appendix 7.3). This is particularly important for the median values as these are carried forward to Table 4-3 of Appendix 7.3 (Table 7.3-1 in the Focus Report) for comparison to the modelled values for COPCs to determine the distance from the diffuser where dilution reaches ambient conditions.

As an example, values for ***copper*** are reported as < 0.5 µg/l (minimum) but < 5 µg/l (median and maximum) in Appendix B-1. The RDL is reported as 0.5 µg/l in the accompanying Quality Assurance information in all but one water quality assessment report for Raw water, all Point A and Point C sites. As all values for copper are reported as being less than the RDL (column 'count < RDL'), which is similar to 'not detected' or ND, in Appendices B-1 and B-2, all values (minimum, median, and maximum) should be reported as < 0.5 µg/l or ND (as in the tables in Appendix 2.3). As a result, a median value of < 5.0 µg/l rather than < 0.5 µg/l (a minimum 10-fold increase) for copper in background water at Caribou Harbour is carried through to Appendix E-1 '*Step 1 in Screening Process: Comparisons of Concentrations in Treated Effluent (represented by current treated effluent concentrations) to Background Concentrations (represented by concentrations at the location of the proposed diffuser)*'and Table 4-3 in the Appendix 7.3 and the Focus Report Table 7.3-1. Note that even with a value for copper of 3.73 µg/l (see item 2 above) in Appendix B-1 or B-2, this would not affect the median (or middle) value for copper as the rest were < RDL.

This occurs with all metals (***aluminum***, ***barium***, ***iron***, ***manganese***, ***zinc***) where values are below the RDL e.g., median cadmium concentrations reported as < 0.1 µg/l *vs* < 0.01 µg/l. These changes are summarised in Table B of this report.

A cursory screen of the minimum and median values for the '***Dioxin and Furans'*** category also reveals variability in the reporting of what appears to be the RDL. No obvious patterns were recognised. This was not investigated further in the current report.

The values reported for ***mercury***: minimum (<0.002 µg/l), median (<0.00225 µg/l), and maximum (<0.013 µg/l) in Appendix B-1; and, minimum (<0.002 µg/l), 5th percentile (<0.00202) 50th percentile, (0.0034 µg/l), 95th percentile (<0.013 µg/l) and maximum (<0.013 µg/l) are not

consistent with the available raw data, values in the 'count < RDL column', nor the RDL of 0.013 µg/l as shown in the quality assurance data. When the RDL of an assay is 0.013 µg/l, values less than that cannot be reported. Such values should have been listed as < 0.013 µg/l or ND. Two of 14 results in Appendix B-1 and two of five results in Appendix B-2 are indicated as being above the RDL. As a result, values of 0.013 µg/l or greater should have been reported as the maximum value in each table but both are shown as < 0.013 µg/l. A result of 0.013 µg/l is reported in the May 25, 2019 18:15, CHB 2-1 raw data for Caribou Harbour. With 3/5 and 12/14 values below the RDL in Appendix B-1 and B-2 respectively, the minimum and median values would have to be reported as ND or < 0.013 µg/l. Of note, the averaged or mean (not median) value for mercury in the effluent (Point C) presented in Table 1-3 of Appendix 2.3 'Raw and Treated Effluent Characterization' is 0.022 µg/l while the result for Caribou Harbour is ND.

For ***manganese***, Appendix B-2 indicates only 4/5 values were below the RDL but the maximum value is reported as less 20 µg/l. (note that the RDL is reported as 2.0 µg/l for other sites and suggested as 2.0 µg/l in Appendix B-1, minimum value for manganese)

4. **Appendix 7.3, Appendix E-1 'Step 1 in Screening Process: Comparison of Concentrations in Treated Effluent (represented by current treated effluent concentrations) to Background Concentrations (represented by concentrations at the location of the proposed diffuser)**

The column 'Median Background Concentrations (Proposed Diffuser Location)' contains values generated in Appendix B-1 of Appendix 7.3. The 'less than' symbol '<' has been dropped from all values with the consequence that a median value that was e.g., <10 µg/l (includes values from 0 - 10 µg/l) becomes 10 µg/l. This error is compounded by the fact that median values for most metals in Appendices B-1 and B-2 suggest RDL values which are at least 10-fold higher than shown in the quality assurance data. For example, copper was reported as ND in all available background water sample data and in Appendix 2.3. Using the RDL from the quality assurance data for the copper assay, all values including the median value, were less than 0.5 µg/l (includes 0.0 – 0.49 µg/l) or ND rather than 5.0 µg/l as shown in Appendix E-1. This represents at least a 10-fold increase. The median background levels for cadmium are reported as 0.1 µg/l and should be reported as either less than 0.01 µg/l (includes 0.00 – 0.009 µg/l) or ND. Similar minimum 10-fold increases are noted for aluminum, iron, manganese, and zinc. The median background level for mercury should be less than 0.013 µg/l (includes 0.00 – 0.012 µg/l) or ND, rather than 0.00225 µg/l.

5. **Appendix 7.3, Table 4.3 'Marine Water Quality COPC and Estimated Dilution'**

Assuming that the numbers used to populate the column 'Median Background Quality' are drawn from Appendix B-1 (*n*=14) only and that the available quality assurance data is the best indicator of the RDLs, and results in Appendix 2.3 are correct, the median levels for ***copper***, ***iron***, ***manganese*** and ***zinc*** are more correctly reported as either ND or as less than their RDLs which are 0.5 µg/l, 50 µg/l, 2.0 µg/l, and 5 µg/l, respectively as all values for all four metals were reported as less than their RDLs (<RDLs) in Appendix B-1. For ***aluminum***, the median value should be

reported as ND or less than 5 µg/l, not 50 µg/l, as 13 of 14 values were less than the RDL of 5 µg/l. The median value for mercury should be ND, as 12 of 14 values were ND, or less than 0.013 µg/l.

Multiple inconsistencies are noted for background water quality for ***cadmium*** where 13 of 14 values were reported as ND in Appendix B-1 subsequently, the median value should also be ND or less than 0.01 µg/l. Appendix 7.3, Table 4-3 currently shows a value of 0.084 µg/l for both the median background concentration and for the concentration at 100 m based on dilution ratios. Table 4.1-2, Focus Report '***Background Water Quality at Caribou Harbour used in RWS'*** also shows a value of 0.084 (median or average not specified) for cadmium, with the accompanying text indicating that the value was derived from the May 2019 water samples. All but one (0.12 µg/l) of these results (raw data on five of six samples are available in Appendix 2.3) were ND or, less than the RDL of 0.01 µg/l. The median value would be ND or less than 0.01 µg/l. An averaged value of 0.084 µg/l is shown in Table 14 'Background Water Quality' of Appendix 4.2 'Receiving Water Study' and described in the text as "*water quality data for Northumberland Strait around the CH-B location collected in May and June 2019*". Water quality data for June 2019 could not be found in the Focus Report documents to verify this result. It is noted that values for many metals and other compounds at 100 m are identical to the currently reported 2019 median background levels in Table 4.3, Appendix 7.3.

The maximum value for **cadmium** in effluent at Point C should be 1.4 µg/l (see raw data for cadmium in Appendix E-2 of 0.66, 0.73, 0.898, 1.11, and 1.4 µg/l). The value shown is 1.03 µg/l which is also the value shown in Appendix 2.3, Table 1-3 'Analytical Results, Metals' and is described as the average value using data from the current study and "*test data collected during annual testing done since 2015*".

The values for ***mercury*** at Point C, and 5 m and 100 m from the diffuser are all 0.028 µg/l suggesting no dilution is occurring with increasing distance from the diffuser. This is likely an entry error. The values for aluminum, barium, copper, zinc are also the same for 5 m and 100 m from the diffuser suggesting either no dilution is occurring with increased distance or, a table entry or calculation error.

The final column in Table 4-3 shows the 'Distance (m) from Diffuser Ambient Condition is Reached Based on Dilution Ratios'. The dilution ratios used to determine the distances are taken from Table 4-4 'Dilution Ratios at Distance'. As the median background, or 'ambient', levels, shown in Appendix 2.3, Table 1-3 as ND, have decreased by a factor of at least 10-fold for most metals if the RDLs from the available quality assurance data are used or, need to be adjusted for reasons mentioned above, the 'Distance from Diffuser Ambient Condition is Reached based on Dilution Ratios' should be recalculated to determine if the values currently listed (most at less than 2 m) remain valid. As all background medians for metals are less than their RDLs, any distance values calculated using the RDLs would be minimum distances. The table currently shows values of 0.028 µg/l for mercury at both 2 m and 100 m from the diffuser, neither of which are below the current reported median background value of '0' µg/l or the RDL of 0.013 µg/l. The value of <2 m as the distance from diffuser ambient condition is reached is therefore incorrect. Using the values currently presented in Table 4-3 it should be >100 m.

It is unclear why the 'Distance from Diffuser Ambient Condition is Reached based on Dilution Ratios' is often reported as <2 m while column heading indicates 'Concentration at 5 m from Diffuser based on Dilution Ratios'.

Values for total Dioxans and Furans, Phenanthrene (PAH), Total Resin Acids, Total Fatty Acids, Total P&P Phenols and other water quality parameters presented in Table 4-3 were not evaluated for the purposes of this report.
Table B summarises the points raised in items 1 – 5 above.

6. Appendix 7.3. Figure 3-7: Benthic Invertebrate Relative Abundance in Representative Substrate Types

These values represent EEM cycles 3, 4, 5, and 7 spanning a 14-year period from 2002 through 2016. The data is presented as pie charts. The accompany text does not indicate whether these are averaged values or medians. Results from the most recent cycle in 2016 would be more representative of the current situation. Of interest, would be a presentation of changes, if any, that have occurred from 2002 to 2016.

Table B. Partial replication information presented in Table 4-3 of Appendix 7.3 (presented in the Focus Report as Table 7.3-1) and Appendix 2.3, Table 1-3, showing the effects of reporting median background levels of metals as less than the Reportable Detection Limit (RDL) derived from the available quality assurance information for the parameter. Shaded and outlined boxes contain values of particular interest discussed in the accompanying text.

Parameter	unit	RDL[1] from Quality Assurance Data	CWQG[2] (marine)	Median Background (Caribou Harbour) Quality		Appendix 2.3 Average Caribou Harbour Results	Maximum Effluent Quality Point C – original values	Maximum Effluent Quality Point C – corrected values	Fold Increase Point C over Revised Median Background Quality	Concentration at 5 m from Diffuser based on Dilution Ratios	Concentration at 100 m from Diffuser based on Dilution Ratios	Distance (m) from Diffuse Ambient Condition is Reached based on Dilution Ratios - Original	Distance (m) from Diffuse Ambient Condition is Reached based on Dilution Ratios – Revised[7]
				2019 Original Value (*n* =14)	2019 Revised Value (*n* = 14)	(*n* = 6)	(*n* = 6?[3])	(*n* = 6)					
Aluminum	µg/l	5.0	NG[4]	50	<5.0 (ND)[5]	ND	2330	nc[6]	≥466	50	50	<2 m	?
Barium	µg/l	1.0	NG	10	<1.0 (ND)	13	450	nc	≥450	10	10	<2 m	?
Cadmium	µg/l	0.01	0.12	0.084	<0.01 (ND)	ND	1.03	1.4	≥140	0.1	0.084	<2 m	?
Copper	µg/l	0.5	NG	5	<0.5 (ND)	ND	7.5	nc	≥15	5	5	<2 m	?
Iron	µg/l	50	NG	500	<50 (ND)	ND	718	nc	≥14.36	≤500	≤500	<2 m	?
Manganese	µg/l	2.0	NG	20	<2.0 (ND)	ND	2800	nc	≥1400	54	19	≈50 m	?
Mercury	µg/l	0.013	0.016	0	<0.013 (ND)	ND	0.028	nc	≥2.15	0.028	0.028	<2 m	?
Zinc	µg/l	5	NG	50	<5.0 (ND)	ND	160	nc	≥32	50	50	<2 m	?

[1] RDL = Reportable Detection Limit
[2] CWQG = Canadian Water Quality Guidelines
[3] dates in Appendix E-2, of Appendix 7.3 suggest *n* = 6 total (cadmium), includes the 'annual testing data since 2015' (Feb 25, 2015; Oct 2, 2016; Feb 23, 2017)
[4] NG = not given
[5] ND = not detectable
[6] nc = no change

POTENTIAL ENVIRONMENTAL IMPACTS OF NORTHERN PULP NOVA SCOTIA'S PROPOSED PROJECT ON FISHERIES AND THE MARINE ENVIRONMENT WITHIN THE NORTHUMBERLAND STRAIT

METAL CONCENTRATIONS IN CARIBOU HARBOUR

Appendix 2.3 states "*Other metals, such as cobalt, titanium, copper, zinc and aluminum are also likely coming from the pulping process as non-process elements in the wood itself. As described earlier, these non-process elements are regularly purged from the system, either via the effluent or solid waste, in order to protect the integrity of the equipment and the process. Except for aluminum, which is used as alum (aluminum sulphate) in the treatment of raw water from Middle River, none of these metals are components of additives used in the pulping process."*

While 'naturally' occurring from the wood itself these metals are still toxic to crustaceans. A 1994 report summarises acute and subacute effects on American lobsters of a wide range of contaminants including metals (Mercaldo-Allen & Kuropat, 1994).

Lack of a CCME, Canadian Water Quality Guideline for the Protection of Aquatic Life resulted in all of metals that were found in higher levels in the effluent than in the background water, but cadmium, being dropped from the review process for COPC in Appendix 7.3 Section 4.1.3.2 'Potential Effects Arising from Project-Related Emissions' , Figure 4-1 'Overview of Process for Identifying COPCs in Treated Effluent.

The maximum values for copper at Point C (7.5 µg/l) and modelled values at 100 m (5 µg/l) (Table 7.3.1 and Appendix E-1) are below reported acute toxicity levels 48 µg/l (larvae) and 56 – 100 µg/l (adults) (Johnson & Gentile, 1979; McLeese, 1974) but are above the US Environmental Protection Agency list of National Recommended Water Quality Criteria levels of 4.8 µg/l , acute CMC (criterion maximum concentration) and 3.1 µg/l, chronic CCC (criterion continuous concentration) (US EPA, 1994.). This was also mentioned in Appendix 7.3, Section 3.1.6. Susceptibility to copper increases with increasing water temperature (McLeese, 1974) which may prove relevant in a world of increasing water temperatures and climate change. Subacute copper toxicity levels for *H. americanus* were not found. Levels of 9.55 µg/l and 19.1 µg/l over 28 days, caused damage to muscle, hepatopancreas, gills and heart tissue and chromosomes in the spiny lobster *Panulirus homraus* (Maharajan et al., 2012, 2011).

Cadmium has been associated with moult inhibition in the crab, *Chasmagnathus granulatus* and *Daphnia magna,* and inhibition of ovarian growth in fiddler crabs (*U. pugalotor*) exposed for two weeks (Rodríguez et al., 2007). Changes (transient increases (hyperglycemia) in acute exposures, decreases in chronic exposures) in hemolymph (blood) glucose levels in response to metal exposure have been documented in crayfish and in the shrimp *Palaemon elegans* exposed to mercury, cadmium, and copper (Rodríguez, Medesani, & Fingerman, 2007). Heavy metal exposure can also inhibit food intake by small crustaceans (Rodríguez et al., 2007).

Acute, lethal concentrations (LC-50 at 96 hours) of cadmium, copper, and mercury for stage I *Homarus americanus* larvae were determined to be 78 µg/L, 48 µg/L, and 20 µg/L, respectively (Johnson & Gentile, 1979) and 56 to 100 µg/L for copper in adult American lobsters, depending on temperature (McLeese, 1974). Although the current maximal effluent and modelled levels at 100 m of these metals are below the few toxic levels known for American lobsters, and PPER Guidelines do not require it, it would be advisable to regularly monitor the level of all metals in the sediment, water, plant and animal life during the anticipated life of the mill project as part of an EEM program were the project to go ahead. The information available on the longer term, or subacute, toxic levels of these metals in American lobsters is limited and more studies would be advisable. The potential for bioaccumulation was not addressed in the Focus Report but is of concern given the anticipated lifetime of 'several decades' for the mill and the potential for change in the system.

NEED FOR ENVIRONMENTAL EFFECTS MONITORING

If 'Distance (m) from Diffuser Ambient Condition is Reached based on Dilution Ratios' values are changed, an EEM program could be required. In Appendix 7.3, Section 5.1 'Environmental Effects Monitoring Program' states:

> *"Within the regulations there are provisions for the removal of the requirements for specific components of the EEM program based on the dilution of effluent to <1%. If the mill demonstrates that the effluent concentration is <1% at a distance of 250 m then the EEM does not require a fish community study component. Likewise, if the mill demonstrates that the effluent concentration is <1% at 100 m from the discharge then a benthic invertebrate community study is not required. The most recent 3D modeling of effluent dispersion in the local study area as part of the updated receiving water study (RWS) indicates that dilution to less <1% effluent will occur at approximately 20 m from the discharge (Stantec ,2019).*"

The importance of lobster is recognised, and it is indicated that "*custom tests have been developed that can be completed using larval lobster and herring embryos. The tests will include Stage I-IV larval lobster and include a live-dead (acute) assessment of the various stages, as well as the assessment of sublethal effects on moulting time and growth.*" This is very encouraging. Of concern is the preceding statement of "*NPNS will continue to investigate the feasibility of performing toxicity testing to determine both potential acute and sublethal effects on immature stages of lobster and herring*". Given the major economic value of lobster to the region, it would be preferable to see that NPNS has committed to run these tests unequivocally. As the tests have been developed, it is regrettable that they were not performed over the summer of 2019 when larvae were present. It is possible that the tests were being developed during this time, however. Inclusion of chronic exposure of adults and generation testing would also be encouraged.

Section 4.2, 'Receiving Water Study' presents information on one month simulated spatial distribution studies in July and February showing only a few traces of highly diluted effluent in the region (Figures 4.2-3 and 4.2-4). It would be preferable to see simulated distributions of effluent at 12-, 24-, 36-months or 'decades' of operation of the mill. This might provide information on the risk of bioaccumulation.

HIGH INTENSITY SOUNDS

Seismic testing is used to examine the sea floor when doing oil and gas exploration. A 2017 paper describes the dramatic, deadly and widespread effect on plankton within 1.2 km a test site (McCauley et al., 2017). A two- to three-fold increase in number of dead larval (included decapod larvae) and adult plankton was detected. Larval lobster, decapods, are part of the plankton community. In a separate study, noise from seismic testing was shown to have prolonged (>365 days and a moult) damaging effect to the sensory hairs of the statocyst (a structure involved in coordinating body position and movement) and a delay in righting reflex in adult rock lobsters, *Jasus edwardsii*, (Day, McCauley, Fitzgibbon, Hartmann, & Semmens, 2019). The study also discusses how other anthropogenic noises can negatively impact behaviour in other crustaceans. The plain language summary section of Appendix 7.3 mentions exposure to high intensity sounds as seismic testing for three months during construction and as part of Operations and Maintenance for several decades commencing 2021. Section 4.1.6 'Consideration of Significant Residual Effects', Table 6 does not include noise in Potential Physical Effects. Further study to identify what effects, if any, the expected high intensity sounds might have on life stages of American lobster is warranted.

SEDIMENT AND WATER TEMPERATURE CHANGES ASSOCIATED WITH THE BURIED PIPELINE

Modelling of water temperature of effluent (35 ^{o}C) at the diffuser outflow site anticipates that the temperature of the receiving water will reach background summer levels of 17.2 ^{o}C and 16.8 ^{o}C at 5 m and 100 m from the diffuser, respectively. These temperatures are below the reported 31.1 ^{o}C – 29.1 ^{o}C range of lethal temperatures, for exposures of one to 24 hours, for larval lobsters and the sublethal temperatures of 20 ^{o}C - 26 ^{o}C, for short and long term exposures, as summarised by Quinn (Quinn, 2017).

The project proposal indicates 4 km of buried pipeline carrying water of around 35^{o}C. Information on what, if anything, this might do to the temperature of the 4 km of overlying sediment and surrounding water column was not found in the Focus Report. Adult lobster can easily move away and avoid or go around an area if the temperature proves inhospitable while larval stages cannot. Information on expected temperature effects on associated sediment and water column, including any anticipated effects on baseline water temperatures due to climate change over the expected lifetime of the project (several decades), could be relevant.

CONCLUSIONS & RECOMMENDATIONS

- The missing raw and associated quality assurance results for Appendices B-1 and B-2 in Appendix 7.3, should be provided so that the values listed can be verified.

- Minimum, median, maximal, and percentile values should be reported as less than the RDL values where appropriate (will also provide consistency with summary tables for other sample sites) and Appendices B-1 and B-2 updated.

- Values in Table 4-3 of Appendix 7.3 and Table 7.3-1 in the Focus Report should be updated as required and the values for 'Distance (m) from Diffuse Ambient Condition is Reached based on Dilution Ratio' revised as needed.

- There is inadequate information available on the acute, chronic and generational toxic effects of metals on crustaceans, particularly American lobster. Further studies are warranted given all life stages may be exposed to diluted effluent over several decades should the project be approved.

- It would be preferable to see simulated distributions of treated effluent at 12-, 24-, 36-months or 'decades' of operation of the mill. This might provide information on the risk of bioaccumulation.

- There is inadequate information available on the acute, chronic and generational effects of marine noise on crustaceans, particularly American lobster. Further studies are warranted given all life stages may be exposed to seismic and mechanical noise for months and over several decades, respectively, should the project be approved

- There is inadequate information on the temperature effects, if any, the hot effluent travelling in the 4 km of buried pipeline might have on the overlying sediment and water column. Further studies are warranted as warmer temperatures could potentially present a mobility barrier to adult lobster or heat stress to larvae.

- The language for inclusion of lobster larval assays for determining effluent toxicity in any future EEM program is not as strong as it could be. Given the economic importance of lobster to the region, lack of CWQG values for most metals in marine waters and known toxic effects of metals to larval and adult crustaceans, close monitoring of these populations would be advisable. Inclusion of chronic exposure of adults and generation testing would also be encouraged.

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APPENDIX

Resume for Dr. Andrea Battison

Academic Qualifications

2003	PhD, Lobster Health "Haemolymph evalution for health assessment of the American lobster"	University of Prince Edward Island
1997	Diplomate ACVP, Clinical Pathology	American College of Veterinary Pathologists
1996	Senior Diagnostic Fellow, Clinical Pathology	University of Saskatchewan
1994	Master of Veterinary Science, Clinical Pathology	University of Saskatchewan
1990	Doctor of Veterinary Medicine	University of Saskatchewan

Professional Development

Co-Chair, Steering Committee. 2015. The American lobster in a changing ecosystem II: US-Canada Lobster Science Symposium. Charlottetown, PE, Canada. www.peifa.org/lobster_symposium/

Co-Chair, Steering Committee. 2012. The American lobster in a changing ecosystem: US-Canada Lobster Science Symposium. Portland, ME. http://www.seagrant.umaine.edu/lobster-symposium

Organising Committee, Member. 2009. 8th Annual Meeting of Canadian Animal Health Laboratorians Network (CAHLN/RCTLSA). Charlottetown, PE.

Chair. 2007-2012. Atlantic Veterinary College Lobster Science Centre (AVCLSC) Science Committee.

Shrimp Pathology Short Course. 2005. Department of Veterinary Science and Microbiology, University of Arizona. Tucson, AZ.

Professional Memberships

2003 - present	Member	Prince Edward Island Veterinary Medical Association
1997 - present	Member	American College of Veterinary Pathologists
1995 - present	Member	American Society for Veterinary Clinical Pathology
1990 - present	Member	Canadian Veterinary Medical Association
1990 - 2003	Member	Saskatchewan Veterinary Medical Association
1990 – 1991; 2017-present	Member	Royal College of Veterinary Surgeons

Editorial Activity

2015 – 2016 Managing Guest Editor, Special Section Fisheries Research, Volume 186 Part 1 February 2017
2009 - 2014 Member. Editorial Board, Veterinary Clinical Pathology

Employment

CrustiPath
P.O. Box 682
Charlottetown, PE
Canada C1A 4L3
Tel: (902) 367 - 6878
www.crustipath.com

October 2012- present

Owner/Principal consultant. This veterinary clinical pathology consultation company specialises in work with crustacean samples; however, can provide services for all veterinary species.

Torrance Diamond Diagnostic Service (TDDS)
The Innovation Centre
University of Exeter
Rennes Drive
Exeter
EX4 4RN

Tel: (+44) 01392 247914
Fax: (+44) 01392 262354

April 9 – April 27, 2018;
May 22 – June 13, 2018;
March 11 – March 9, 2019
July 22 – Aug 9, 2019

Locum position as a diagnostic clinical pathologist at TDDS.

Langford Vets, University of Bristol
Langford House
Langford
Bristol
United Kingdom BS40 5DU

Tel: (+44) 0177 394 0510

January 2 – February 13, 2018

Six week locum position as a clinical pathologist for the Diagnostic Laboratory.

Clinical Pathology Laboratory
Cornell University
Ithaca, New York U.S.A.
Tel: (607) 253 - 3266

February 2017 – March 2017

Visiting Professor for the Clinical Pathology laboratory in the Department of Population Medicine and Diagnostic Sciences and the Animal Health Diagnostic Center. Responsibilities included serving as the clinical pathologist in the diagnostic laboratory.

Diagnostic Services, Department of Pathology and Microbiology
Atlantic Veterinary College
University of Prince Edward Island
Charlottetown, PE
Canada C1A 4P3
Tel: (902) 566 - 0541

January 2017 – May 2017
Employed as a diagnostic clinical pathologist for Diagnostic Services at the Atlantic Veterinary College.
(locum, 6 weeks).

Diagnostic Services, Department of Pathology and Microbiology
Atlantic Veterinary College
University of Prince Edward Island
Charlottetown, PE
Canada C1A 4P3
Tel: (902) 566 - 0541

August 2016 – October 2016; January 2017 – May 2017
Employed as a diagnostic clinical pathologist.
(locum, 4 weeks).

Atlantic Veterinary College Lobster Science Centre
University of Prince Edward Island
Charlottetown, PE
Canada C1A 4P3

December 2002 - March 2012

As a research scientist, responsibilities included coordination of multiple projects on crustacean health, preparation of quarterly and annual reports, and writing funding proposals. Co-supervision of one MSc student (defense Aug 2011) and one PhD student and served on the supervisory committee of two MSc students.

Diagnostic Services, Department of Pathology and Microbiology
Atlantic Veterinary College
University of Prince Edward Island
Charlottetown, PE
Canada C1A 4P3
Tel: (902) 566 - 0541

July – August, 2018

Employed as a clinical pathologist in Diagnostic Services for three weeks over the period.

January – May, 2017

Employed as a clinical pathologist in Diagnostic Services for six weeks over the period.

August – October, 2016

Employed as a clinical pathologist in Diagnostic Services for four weeks over the period.

November 2006 - May 2010

Employed as a clinical pathologist (25% FTE) in Diagnostic Services and assisted in the second year hematology laboratories and resident training.

January - June 2005

On secondment to the Department of Pathology and Microbiology, worked as a clinical pathologist (25% FTE) in Diagnostic Services and assisted in the second year student hematology laboratories.

January - April 2004

On secondment to the Department of Pathology and Microbiology, participated in teaching of the senior student clinical pathology rotations, completed clinical pathology, duties in Diagnostic Services, and assisted in the second year hematology laboratories.

May and August 2002

This represents two contract positions for teaching clinical pathology rotations to senior veterinary students.

Diagnostic Services
The Royal Veterinary College
Hatfield, Herts. England
Tel: (01707) 666323

November - December 1998

Three week contract position serving as the clinical pathologist in the diagnostic laboratory. The position also included teaching responsibilities.

Clinical Pathology Laboratory
Cornell University
Ithaca, New York U.S.A.
Tel: (607) 253 - 3266

October 1996 - October 1998

Clinical Instructor in the Department of Pathology. Responsibilities included serving as the clinical pathologist in the diagnostic laboratory, teaching senior veterinary students, and resident supervision.

Department of Pathology and Microbiology
Atlantic Veterinary College
University of Prince Edward Island
Charlottetown, PE Canada
(902) 566 - 0541

January - February 1996

Five week contract position including serving as the duty pathologist in the diagnostic laboratory and teaching senior student clinical pathology rotations.

Manitoba Agriculture
Veterinary Services Branch
Winnipeg, MB Canada
Tel: (204) 945 - 7652

April - June 1995

Three month contract position as the clinical pathologist for the diagnostic laboratory.

Cape Breton Veterinary Services
Sydney River, NS Canada
Tel: (902) 564 - 4080

August 1991 - June 1992

Clinical associate in companion animal medicine and surgery.

Ambivet Veterinary Group
Heanor, Derbyshire England
Tel: 01144 (1773) 717780

July 1990 - June 1991

Clinical associate in companion animal medicine and surgery.

Teaching

Graduate and Search Committees

Date	Program/Role	Institution	Title
2009-2012	Master of Science Committee Member	Atlantic Veterinary College, UPEI	Microarray analysis of reproductive status of female American lobsters (*Homarus americanus*).
2009-2012	Master of Science Committee Member	Atlantic Veterinary College, UPEI	In vitro cultivation of *Hematodinium* sp. isolated from Atlantic Canadian snow crab: developmental cycle, optimization of culture conditions
2009-2012	PhD Co-Supervisor	Atlantic Veterinary College, UPEI	Pathology of Bitter Crab Disease
2009-2011	Master of Science Co-supervisor	Atlantic Veterinary College, UPEI	Nutritional assessment of the American Lobster (*Homarus americanus*) throughout the moult cycle
2010	PhD Examination Committee Member	Atlantic Veterinary College, UPEI	*In vitro* model of interaction of *Vibrio splendidus* and hemocytes of *Mya arenaria*
2008	PhD Comprehensive Exam Committee Member	Atlantic Veterinary College, UPEI	Host-pathogen interaction between bivalves and marine bacteria
2007	Canada Research Chair in Aquatic Health Sciences Search Committee, Member	Atlantic Veterinary College, UPEI	
2007	MVSc Examination Committee Chair	Atlantic Veterinary College, UPEI	The PFA-100 Platelet Function Analyzer: Enhancement of a canine closure time reference interval, evaluation of in vitro hemodilution effects and assessment in ill dogs.
2006	Bachelor of Science Committee Member	St. Francis Xavier University	Impact of mechanical vibration on the viscera and health of the male American lobster, *Homarus americanus*.

Coursework

Date	Course	Institution	Format
2007-2008	Aquaculture and Fish Health	Atlantic Veterinary College, UPEI	Lab and lecture, 2nd year veterinary students
2005	Diseases of Cultured Fish	Atlantic Veterinary College, UPEI	Lectured section on shrimp and lobster diseases, graduate course
2004	Diagnostic Services – Clinical Pathology	Atlantic Veterinary College, UPEI	Small group teaching of senior veterinary students
2004	Core course - Clinical pathology	Atlantic Veterinary College, UPEI	Lab component, 2nd year veterinary students
2002	Diagnostic Services - Clinical Pathology	Atlantic Veterinary College, UPEI	Small group teaching of senior veterinary students
1997-1998	Clinical Pathology – senior rotation	Cornell School of Veterinary Medicine	Small group teaching of senior veterinary students
1996	Diagnostic Services - Clinical Pathology	Atlantic Veterinary College, UPEI	Small group teaching of senior veterinary students

Publications & Presentations

Papers in Refereed Journals

Battison A. 2018. Use of a Brix-based classification system to describe haemolymph biochemistry parameters in *Homarus americanus*, H. Milne Edwards 1837 (Decapoda: Malacostraca: Nephropidae). Journal of Crustacean Biology. https://academic.oup.com/jcb/advance-article/doi/10.1093/jcbiol/ruy048/5087934?guestAccessKey=eacb3430-473e-474d-977f-aefabcbf4c67

Daoud D, Battison A, Natalie, LR, Van Geest JL . (2016). Repeated sublethal exposures to the sea lice pesticide Salmosan® (azamethiphos) on adult male lobsters (*Homarus americanus*) causes metabolic dysfunctions, functional hypoxia, and mortality. Ecotoxicology and Environmental Safety. 134:106–115.

Simon CJ, Fitzgibbon QP, Battison A, Carter CG, Battaglene SC. 2015. Bioenergetics of nutrient reserves and metabolism in spiny lobster juveniles *Sagmariasus verreauxi*: Predicting nutritional condition from hemolymph biochemistry. Physiol Biochem Zool 88(3). ePub March 19, 2015. DOI: 10.1086/681000

Ciaramella M, Battison A, Horney B. 2014. Measurement of tissue lipid reserves in the American lobster *(Homarus americanus*): Hemolymph metabolites as potential biomarkers of lipid reserves in the American lobster, *Homarus americanus*. J Crus Biol. 34(5):629-638.

Battison A. 2013. Subcuticular uric acid deposition in an American lobster (*Homarus americanus*): A case report. Vet Pathol. May; 50(3):451-6.

Battison AL, Summerfield R. 2008. Isolation and partial characterisation of four novel plasma lectins from the American lobster *Homarus americanus*. Dev Comp Immunol. 33:198-204

Battison AL, Deprés B, Greenwood SJ. 2008. Ulcerative enteritis in *Homarus americanus*: Case report and molecular characterisation of intestinal aerobic bacteria of apparently healthy lobsters in live storage. J Invert Path. 99(2): 129-135.

Battison AL, Summerfield R, Patrzykat A. 2008. Isolation and characterisation of two antimicrobial peptides from haemocytes of the American lobster *Homarus americanus*. Fish Shellfish Immunol. 25: 181-187.

Battison A. 2006. Tissue distribution and hemolymph activity of six enzymes in the American lobster (*Homarus americanus*): Potential markers of tissue injury. J Shellfish Res. 25(2), 553-560.

Battison AL, Cawthorn R, Horney B. 2004. Response of American lobsters (*Homarus americanus*) to infection with a field isolate of *Aerococcus viridans* var. *homari* (Gaffkemia): Survival and haematology. Dis Aquat Org Nov; 61(6): 263-268.

Battison AL, Cawthorn R, Horney B. 2004. Classification of *Homarus americanus* hemocytes and the use of differential hemocyte counts in lobsters infected with *Aerococcus viridans* var. *homari*. J Invert Path; 84: 177-197.

Battison AL, Cawthorn R, Horney B, MacKenzie A. 2002. Mushroom tyrosinase as a control material for phenoloxidase assays used in the assessment of crustacean 'health'. J Shellfish Res Jun 21(1): 295-298.

Battison A, MacMillan R, MacKenzie A, Rose P, Cawthorn R, Horney B. 2000. Use of injectable potassium chloride for euthanasia of American lobsters (*Homarus americanus*). Comp Med Oct; 50(5):545-50.

Conference Proceedings (Oral Presentation)

Battison A, Lavallée J. 2017. Determination of hemolymph biochemistry reference intervals in American lobsters (*Homarus americanus*). 11th International Conference and Workshop on Lobster Biology and Management. Portland, Maine, USA.

Ciaramella M, Battison A, Horney B. 2012. Hemolymph biochemistry: an indicator of nutritional status? The American lobster in a Changing Ecosystem: A US-Canada Science Symposium. Portand, ME, USA.

Battison A, Lavallée J. 2011. A summary of hemolymph plasma biochemistry profile results from American lobsters (*Homarus americanus*) in Atlantic Canada (2007-2010). 9th International Conference and Workshop on Lobster Biology and Management, Bergen, Norway.

Burton M, Battison A, Lavallée J. 2011. Physiological assessment of American lobsters (*Homarus americanus*) held in a specialized live seafood transport system. 9th International Conference and Workshop on Lobster Biology and Management, Bergen, Norway.

Summerfield R, Battison A. 2011. Examination of protein expression during ovary maturation in American lobsters (*Homarus americanus*). 9th International Conference and Workshop on Lobster Biology and Management, Bergen, Norway.

Battison A. 2009. Hemolymph triglyceride concentration: A potential non-lethal method to assess ovary maturation in the American lobster (*Homarus americanus).* ACCESS conference. University of Prince Edward Island.

Battison A, Summerfield R, Patrzykat A. 2007. Isolation of two antimicrobial peptides from *Homarus americanus* hemocytes. 8th International Conference and Workshop on Lobster Biology and Management. Charlottetown, Canada.

Battison A. 2005. Relative tissue distribution and haemolymph activity of six enzymes in *Homarus americanus* - potential markers of tissue injury. 6th International Crustacean Congress (ICC6), Glasgow, Scotland.

Battison A, Horney B, Cawthorn R. 2002. Hemocytes of *Homarus americanus* stained with a modified Wright-Giemsa stain: description and comparison to current classification schemes. National Shellfisheries Association Conference, Mystic, CT.

Conference Proceedings (Posters)

Battison A, Burton M, Comeau M, Silva A, Summerfield R. 2011. Hemolymph triglyceride and cholesterol concentrations as potential aids to determine ovary maturity in the American lobster. 9th International Conference and Workshop on Lobster Biology and Management, Bergen, Norway.

Battison A. Subcuticular uric acid deposition in an American lobster (*Homarus americanus*): A case report. 2009. Annual meeting of the American College of Veterinary Pathologists and American Society of Veterinary Clinical Pathology, Monterey, CA.

Summerfield R, Battison A. 2009. Bromocresol Green binds to lobster (*Homarus americanus*) hemocyanin. Annual meeting of the American College of Veterinary Pathologists and American Society of Veterinary Clinical Pathology, Monterey, CA.

Summerfield R, Battison A. 2007. Development of an ELISA for the measurement of an N-acetyl-D-glucosamine binding protein in plasma of *Homarus americanus*. 8th International Conference and Workshop on Lobster Biology and Management. Charlottetown, Canada.

Battison A., Summerfield R. 2007. Isolation and characterisation of an N-acetyl-D-glucosamine binding protein from *Homarus americanus* plasma. 8th International Conference and Workshop on Lobster Biology and Management. Charlottetown, Canada.

Battison A, Cawthorn R, Horney B. 2007. Bumper Car Disease - Comparison of Experimental and Naturally Acquired Infections. 8th International Conference and Workshop on Lobster Biology and Management. Charlottetown, Canada.

Battison A, Cawthorn R, Horney B, MacKenzie A. 2003. Plasma prophenoloxidase in American lobsters (*Homarus americanus*): variation in a natural population and changes associated with two infectious diseases. American College of Veterinary Pathologists and American Society of Veterinary Clinical Pathologists Annual Meeting, Banff AB.

Horney B, Battison A, MacKenzie A. 2002. Cytocentrifuge preparations: An alternate method to examine the hemocytes of the American lobster *Homarus americanus*. National Shellfisheries Association Conference, Mystic, CT.

Battison A, MacKenzie A, MacMillan R, Cawthorn R, Horney B. 2001. Gaffkemia: Old disease, new findings. Graduate Studies and Research Days, Charlottetown, PE.

Battison A. 2000. Plasma Prophenoloxidase Activity in American Lobsters (*Homarus americanus*) Infected with the Ciliate *Anophyroides haemophila*. Graduate Studies and Research Days, Charlottetown, PE.

Contract Research Reports

Battison A. 2016. Determination of Hemolymph Biochemistry Reference Intervals for the American Lobster (*Homarus americanus*). Prince Edward Island Fishermen's Association.

Moriyasu M, Allain R, Battison A, Boudreau M, Allard J, Gerber RP, Courtenay S and Hall D. 2015. Establishment of biological baseline information for snow crab *Chionoecetes opilio* in the southern Gulf of St. Lawrence and on the Scotian Shelf. OERA/DFO Collaborative Research Project #300-120-09-34.

Battison A. 2013. Hemolymph biochemistry profile reference intervals for snow crab (*Chionoecetes opilio*): Trawl and trap collection with alternate holding methods. Prepared for Fisheries & Oceans Canada, Gulf Region.

Battison A. 2013. Determination of tissue enzyme distribution in snow crabs (*Chionoecetes opilio*): Fall 2011 sample collection. Prepared for Fisheries & Oceans Canada, Gulf Region.

Battison A. 2013. Determination of refrigerated stability of 23 hemolymph plasma biochemistry profile parameters in snow crab (*Chionoecetes opilio*): Fall 2011. Prepared for Fisheries & Oceans Canada, Gulf Region.

Battison A. 2012. Determination of tissue enzyme distribution in snow crabs (*Chionoecetes opilio*): spring 2012. Prepared for Fisheries & Oceans Canada, Gulf Region.

Battison A. 2012. Determination of refrigerated stability of 23 hemolymph plasma biochemistry profile parameters in snow crab (*Chionoecetes opilio*): Spring 2012. Prepared for Fisheries & Oceans Canada, Gulf Region.

Lavallée J, Battison A. 2011. Lobster Health Programme: Assessment of physiological and biological changes during holding trials with Aqualife Live Seafood Transport System. Prepared for The Lobster Council of Canada.

Battison A, Summerfield S. 2011. Detection of 'Mushy Tail' in Lobster Using the Fish Freshness Meter: Pilot Study. Prepared for corporate client.

Battison A. Investigation of 'Mushy Tail' in processed lobster. 2009. Prepared for a corporate client.

Battison A, Greenwood S, and Lavalleé J. 2005. White Spot Syndrome Virus: Diagnostics, surveillance and transmission - A literature review. Prepared for the Fisheries and Oceans Canada.

Professional Presentations - Invited

Battison A. 2011. Lobster Blood Biochemistry: There's more to it than just protein! Fishermen & Scientists Research Society Annual General Meeting. Truro, NS.

Battison A. 2010. Evaluating Hemolymph: Clinical Pathology in the American Lobster. ASVCP Veterinary Laboratory Professionals Annual Meeting. Baltimore, MD.

Battison A. 2006. Crustacean Immunity & Health Assessment Techniques in the American Lobster (*Homarus americanus*). Saint Francis Xavier Biology Department Seminar Series.

Battison A. 1997. Management of laboratory samples: Improving their diagnostic value. Vermont Veterinary Medical Association. Killington, VT.

Lay Extension

Battison A, Lavallée J. 2011. Lobster health in early life stages. Atlantic Lobster Sustainability Foundation Meeting. Moncton. NB.

Battison A. 2011. Hemolymph Biochemistry: An Indicator of Nutritional Status? 7th Annual Lobster Science Workshop. Charlottetown, PE.

Battison A. 2009. Investigation of Mushy Tail in American lobsters. 5th Annual Lobster Science Workshop. Charlottetown, PE.

Battison A. 2008. In the Lab. 4th Annual Lobster Science Workshop, Moncton, NB.

Battison A. 2006. Ecosystem Health: Lobster as a Sentinel Species. 3rd Annual Lobster Science Workshop, Charlottetown, PE.

Battison A. 2005. Biochemistry profiles- Another tool for assessment of lobster health? 2nd Annual Lobster Science Workshop, Charlottetown, PE.

Battison A. 2001. Questions and answers about blood (hemolymph) protein. Lobster Blood Protein Workshop, Shelburne, NS.

Battison A. 2001. Refractometers: Uses and limitations. Lobster Blood Protein Workshop Shelburne, NS.

Research Funding

Moriyasu M (PI), Lee K, Doane R, Courtenay S, Boudreau M, Allain R, Biron M, Wade E, Surette T, Chassé J, Battison A, Belfry S, Noyes-Hull G, Weilgart L. 2012. Establishment of baseline biological data on snow crab (*Chionoecetes opilio*) offshore Cape Breton for future assessment of potential impacts of seismic noise on snow crab. Offshore Energy Research Association of Nova Scotia (OERA) formerly the Offshore Energy Environmental Research (OEER) Association. (*$661,500*)

Battison A. 2011. Development of a non-lethal test for the determination of ovary maturity in American lobsters. PEI Atlantic Shrimp Corporation. (*87,315*)

Battison A, Summerfield R. 2011. Detection of 'Mushy Tail' in Lobster Using the Fish Freshness Meter: Pilot Study. Project for corporate client. (*$6,900*)

Battison A. 2008. Investigation of mushy tail in processed lobster: A pilot study. Project for corporate client. (*$20,139*)

Cawthorn RJ (PI), Battison AL (co-applicant), Greenwood SJ (co-applicant). 2009. Integrated studies of the effects of Bitter Crab Disease on Atlantic Canadian snow crabs. Funded by National Sciences and Engineering Research Council of Canada, Strategic Project Grant (*$368,261*)

Battison A. 2009. Hemolymph biochemistry profiles in American lobsters: Establishing reference intervals and determining their potential role in the assessment of nutritional status. Funding obtained from the PEI Atlantic Shrimp Corp Inc. (*$77,500*)

Battison A, Greenwood S, Lavallée J. 2008 Atlantic Lobster Moult and Quality. Funding obtained from Atlantic Canada Opportunities Agency, Atlantic Innovation Fund. (*$2.3 million*)

Battison A. 2006. Measuring acute phase proteins in lobsters. Funding obtained from the PEI Atlantic Shrimp Corporation Inc. (*$53,800*)

Battison A. 2005. Identifying antimicrobial peptides in lobster hemocytes. Funding obtained from the PEI Atlantic Shrimp Corporation Inc. (*$34,900*)

Battison A. 2004. Developing a biochemical profile for the American lobster. Funding obtained from the PEI Atlantic Shrimp Corporation Inc. (*$22,340*)

Battison A, Lavallée J, Greenwood S. 2005. White Spot Syndrome Virus in Canada. Funding obtained from the Department of Fisheries and Oceans, Canada (*$50,947*)

Battison A. 2004. Acute phase proteins for the assessment of lobster health. Funding obtained from the PEI Atlantic Shrimp Corporation Inc. (*$49,960*)

Review of Northern Pulp's Focus Report

PREPARED FOR:
GULF NOVA SCOTIA FLEET PLANNING BOARD, PEI FISHERMEN'S ASSOCIATION AND MARITIME FISHERMEN'S UNION

NEXUS Coastal Resource Management Ltd. | November 2019

NEXUS COASTAL

TABLE OF CONTENTS

1 INTRODUCTION

NEXUS Coastal Resource Management Ltd. (NEXUS) was contracted by Jamie Simpson on behalf of Gulf Nova Scotia Fleet Planning Board, PEI Fishermen's Association and Maritime Fishermen's Union to undertake a comprehensive review of the Focus Report regarding the Replacement Effluent Treatment Facility Project proposed by Northern Pulp Nova Scotia Corporation (NPNS).

1.1 EXPERTISE

NEXUS has assembled a group of experienced professionals and academics for this work. The following provides an overview of the qualifications of our team to provide this expertise.

Name	Education	Qualifications/Experience	Contributions to this Report
Chris Milley	M.M.M., M.Sc., B.Sc.	• Specialization in oceanography, chemical oceanography, fisheries, fisheries management, fisheries economics, environmental impact assessments, socio-economic analysis, stakeholder engagement methods/practices	Senior Review of all Sections Sections 1.3, 2.1, 2.2, 2.3, 2.4, 2.5
Dr. Ian Stewart	Ph.D., M.A., B.Sc.	• Research specialization in environmental science, science policy and public dimensions of science, environmental impact assessments	Section 2.1, 2.2, 2.3, 2.4, 2.5
Chris DeBow	CAPM, MDE, B.Comm	• Specialization in economic analysis, socio-economic analysis, fisheries economics	Section 2.3, 2.4, 2.5
Maria Delesalle	M.M.M., B.A.	• Specialization in stakeholder engagement methods/practices, socio-economic analysis	Section 1.3, 2.1, 2.2, 2.3, 2.4, 2.5

1.2 ISSUES ADDRESSED

The following summarizes the key issues NEXUS was asked to address during our review of Northern Pulp's Focus Report.

1. NEXUS specifically addressed the following areas of the EA, including the bio-physical, social and economic impacts of the project on fisheries in the Northumberland Strait.
    a. Major findings and conclusions expressed in the materials filed by Northern Pulp

   b. Reliability of the underlying research relied upon in reaching the findings and conclusions
   c. Information gaps within the materials filed by Northern Pulp
   d. Impacts on the reliability of conclusions made in the materials filed by Northern Pulp
   e. Assumptions that were relied upon in the materials filed by Northern Pulp and their reliability of these assumptions and their impact on conclusions made in the materials
2. Review of the Focus Report and associated supporting documentation, including but not limited to the Terms of Reference for the Focus Report, and relevant sections of the EA registration documents;
3. Desktop research to compile relevant knowledge and supporting experience from other jurisdictions and similar projects to support analysis and preparation of recommendations.

1.3 Approach

NEXUS used the following principles and questions to guide our review of the Focus Report:

Principles:

1. The review is unbiased. Efforts were made to avoid positional perspectives such that NEXUS did not undertake the review in an attempt to prevent or promote the NPNS project.
2. To provide honest, transparent and useful advice.

Questions:

Efforts were made to answer the following questions for each section of the Focus Report reviewed.

1. Is the information in the Focus Report complete?
2. Is the information in the Focus Report reasonable?
3. Are the assumptions made in the Focus Report valid?
4. Are there outstanding issues that should be considered or addressed, particularly from the perspective from the Fishermen's Organizations?
5. Based on the above, what questions or recommendations should the Fishermen's Organizations pose to the Nova Scotia Environment?

2 REVIEW & KEY FINDINGS

2.1 FORMAT AND FOCUS

In undertaking this review NEXUS was cognizant of the fact that during the development of the EARD and the subsequent Focus Report changes were being introduced in the nature and approach to impact assessments in Canada. Accordingly, the review of the Focus Report took a broader approach in keeping with the principles of impact assessment that were introduced in Bill C68 (An Act to amend the *Fisheries Act* and other Acts in consequence) and Bill C69 (An Act to enact the *Impact Assessment Act* and the *Canadian Energy Regulator Act,* to amend the *Navigation Protection Act* and to make consequential amendments to other Acts). All of these associated Acts with Bill C68 and Bill C69 have received Royal Ascent. It is clearly understood that the Province of Nova Scotia's Environment Act *(Nova Scotia Environment Act)* is the governing legislation for the Northern Pulp Nova Scotia's EARD and subsequent Focus Report, changes made at the federal level are likely to be reflected in provincial legislation due to the increased awareness of the need to consider social, economic and cultural impacts of projects. In the past, the need to consider project effects on Indigenous communities was similarly adopted by provincial environmental assessment processes after becoming a requirement in federal EAs. The results of NEXUS' review is presented in table format in Section 3.5. Some of the observations made during the review that are pertinent and may be of concern to Fishermen's Associations are also included as reviewers' comments in Table 2 below.

2.2 BIO-PHYSICAL IMPACTS

Many of the concerns that precipitated the need for the Focus Report were both scientific and non-scientific regarding the potential and perceived impacts of the introduction of effluent into the marine environment through a dispersion pipe in Caribou Harbour. Northern Pulp Nova Scotia (NPNS) engaged several environmental engineering consultants and scientists to conduct studies to address the questions raised and set out in the Terms of Reference for the Focus Report (including Addenda).

For the most part, NPNS has provided sufficient information to technically and scientifically address the questions raised, albeit, many of these responses may not satisfy public perception concerns which were based on emotion or lack of trust. NEXUS' review of the Focus Report and Appendices did, however, identify some areas where the level of content and scope of the information provided are not fully satisfactory, in that they either did not fully answer the question or the level of content was inadequate.

In general, the approach to disposal of Compounds of Public Concern (COPC) and Total Suspended Solids (TSS) by discharge into the marine environment has been a contentious issue, internationally, for decades. Consensus within the scientific and technical community is that COPC disposal in marine environments is unacceptable. Considering mounting concerns over the need for more stringent attention to cumulative effects and consideration

of increasing stress indicators of ocean health (Bernier et al, 2018) greater study is required. For this reason, better design options should be considered that make use of best available technologies for minimizing absolute volumes of effluent discharged, or that maximize removal of effluent content of potential concern (Suhr et al, 2015; Kamali et al, 2019).

The results of this Focus Report confirm that the major difference between the proposed ETF and current ETF is simply that comparable effluent (in terms of volumes and content) will be discharged further out to sea, with more rapid dilution performance. This assumption appears to be based on the fact that settlement ponds are ineffective in removing dissolved heavy metals from effluent without the use of additional direct use of physical-chemical processing of effluent water (adsorption on new adsorbents, ion exchange, membrane filtration, electrodialysis, reverse osmosis, ultrafiltration and photocatalysis) or bio-absorption (Gunatilake, 2015 Ayres et al, 1994). Each of these processes involve additional investment and create their own problems, such as the creation of concentrated sludge, with significant potential but unspecified risk to the local environment.

Detailed observations and responses are provided in the Compliance Table (Table 1) and Reviewers Additional Comments and Considerations Table (Table 2) below.

2.3 Economic Impacts

A motivation for those advancing and opposing any new development relates to the economic impact that the project will have on their livelihood and economic wellbeing (economic competition, economic displacement, changes in property values, changes in cost of living etc.). This is true for the NPNS project as well. As noted in Section 3.1, While Impact Assessments, under the new federal *Impact Assessment Act* now include economic considerations as part of the assessment process, it is likely that these considerations should be included in NSE-led assessments to avoid conflict and economic uncertainty in other resource sectors. However, there is little detail in the Focus Report regarding the longer-term economic impacts of the project on other resource users in the area. This should include the impacts of the project on the changing perceptions of the fishery due to the presence of the ETF outflow, changes such as confidence in the fishery as a viable source of income that can impact intergeneration transfer of licenses, value of licenses, public perception of the health safety of the harvest from the area which can change market price, etc.

General comments and recommendations to mitigate potential impacts are provided in the in the Compliance Table (Table 1) and Reviewers Additional Comments and Considerations Table (Table 2) below.

2.4 Social Impacts

Similar to the lack of a robust economic impact assessment, social impacts and concerns were not specifically part of the Focus Report Terms of Reference; however, considering the nature and content of several public responses in the Concordance Table, NPNS should have taken social impact concerns into consideration when preparing responses in the Focus Report. This is also in keeping with the principles set out in the new *Impact Assessment Act,* and which should be considered under a robust and complete assessment under the provincial EA process.

Social considerations and impacts are of particular importance for coastal fishing communities, First Nations and fishing industry participants who are the groups most likely to be impacted by the project with little or no direct benefit from the project.

Specific comments regarding the participation of these most vulnerable groups are provided in the Compliance Table (Table 1) and Reviewers Additional Comments and Considerations Table (Table 2) below.

2.5 COMPLIANCE TABLE

The following table summarizes NEXUS' key findings, comments and considerations during the review of the NPNS Focus Report.

Table 1: Compliance Table

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
1. Public, Mi'kmaq and Government Engagement			
1.1 Provide a response (via a concordance table) to questions and comments raised by the public, Mi'kmaq and government departments, and incorporate these comments into the Focus Report where applicable. Comments may be summarized prior to providing the response.	Concordance Table is complete, however, the nature and level of detail of responses is lacking in several cases (addressed below)	1) Although the Concordance Table seems to address all questions and comments provided by public, Mi'kmaq and government departments in some cases responses are inadequate or incomplete. In particular, with respect to the Marine Refuge Buffer Zone within Scallop Fishing Area 24 (Appendix 1.1 p. 27 of 40), the answers provided do not address the concerns raised.	R1: The responses to the Focus Report by the initial reviewers of the EARD (as recorded in the Concordance Table in Appendix 1.1) should be publicly available. This is advisable, especially given the serious levels of concern expressed by both federal departments (Health Canada, ECCC, DFO) and local communities.
1.2 Provide a plan to share future reports and/or studies relevant to this project with the public and the Mi'kmaq such as the Pictou Landing First Nation, including but not limited to the future Environmental Effects Monitoring results for the new effluent treatment facility.	Incomplete	1) There is not enough specificity as to how and the frequency in which engagement will occur with each stakeholder group within the Stakeholder Engagement Plan. 2) It is important for all stakeholders to understand fully how project information and reports will be communicated so they can be properly prepared.	R1: NPNS should provide reports in a format that are understandable as well as sufficient information to meet the needs of fishermen on a timely basis. R2: Reports should be provided on a routine and regular basis. A timetable should be provided to all stakeholder groups.

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
2. Project Description			
2.1 Provide the following information regarding the on-land portion of the effluent pipeline: o A re-alignment route for the effluent pipeline, given Department of Transportation and Infrastructure Renewal does not permit the pipeline to be placed in the shoulder of Highway 106; o Maps and/or drawings of the new pipeline location; o A list of properties (i.e.., Premises Identification number or PID) that will intersect with the new pipeline alignment.		N/A	
2.2 Conduct geotechnical surveys and provide the survey results to confirm viability of the marine portion of the pipeline route. The surveys must determine the potential impacts of ice scour on the pipeline.	Incomplete	1) The Report does not provide information on the specific sediment types other than size. 2) With respect to ice scouring the survey only used a single year study. There is no mention as to whether this was an average for ice conditions and there was no determination of extreme weather events during ice breakup. These factors could have a significant implication to ice scouring.	R1: Information on the mineral composition of the sediment will be useful in understanding the dynamics between effluent and the sediment, such as chelation and adsorption, which is useful in regard to contaminant dispersion. R2: A multi-year ice scouring survey should be conducted, including an analysis of the effects of changing ice conditions due to climate change.
2.3 Submit data regarding the complete physical and chemical characterization of NPNS' raw wastewater (i.e.., influent at Point A for the Project), to support the assessment of the appropriateness of the proposed treatment technology. The influent characterization results must be	Complete	No comment	

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
compared against the proposed treatment technology specifications.			
2.4 Submit a complete physical and chemical characterisation of NPNS's expected effluent following treatment by the proposed technology. To assess the efficacy of the proposed treatment technology, the following must be included: o Data from laboratory trials on NPNS's raw wastewater that were conducted at Veolia/AnoxKaldnes in Lund, Sweden in May 2018; o Modelling results using the raw wastewater parameters and quality; o A comparison of the effluent characterization results from the laboratory trials and modelling work, against appropriate regulations and/or guidelines.	Complete (partially)	1) It is noted in the Report that "effluent is similar to published effluent composition data from other Canadian jurisdictions indicates that the mills effluent is similar to effluent from other bleached Kraft mills in Canada operating either an ASS or ASF system". There is no mention or discussion as to whether the receiving environments are similar to that of Northern Pulp. More information should be provided to determine specific local environmental efficacy of the system.	R1. While the information provided meets the requirement for the Focus Report, it does not provide sufficient detailed information to assist interested and affected stakeholders to confidently determine the efficacy of the system in the specific local environment.
2.5 Provide any proposed changes to the pipeline construction methodology and other associated pipeline construction work, related to the potential changes to the marine portion of the pipeline route (e.g., infilling, trenching, temporary access roads, excavation, blasting, disposal at sea, and others where applicable).		N/A	

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
3. Facility Design, Construction & Operation and Maintenance			
3.1 Submit treatment technology specifications (e.g., optimal performance range of the technology) and an assessment of the efficacy of the proposed treatment technology for use at the NPNS facility, to the satisfaction of NSE. For example, peak effluent temperature is proposed to be above the generally accepted range of temperatures to achieve optimal biological treatment. Explain how the proposed higher than optimal treatment temperature would affect the treatment performance.		N/A	
3.2 Provide effluent flow data to support the proposed peak treatment capacity of 85,000 m3 maximum flow of effluent per day. At a minimum, data from 2017 and 2018 is required. Provide flow data for Point A, clarify source of the effluent flow volumes given in the EARD, and provide other relevant data and information to support the proposed treatment system design. If the 85,000 m3 cannot be justified based on historical data, identify water reduction projects, or re-evaluate the treatment system design and update the receiving water study accordingly.		N/A	
3.3 Effluent discharge parameters must be updated (where necessary) based upon the results of the effluent characterization in Section 2.4 and relevant additional studies. Refer also to Addendum item 2.0	Complete	1) While characterization of the effluent discharge parameters has been updated, there remains the issue related to the impact on the receiving environment.	R1: See "R1 in Section 2.4"

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
3.4 Provide the following information regarding the spill basin: o Submit information to assess the sizing and appropriateness of the design of the spill basin. The EARD indicates a retention time of 10-13 hours at a design capacity of 35,000 m3. The basis of this design has not been provided. If flows exceed 85,000m3 per day on a consistent basis (e.g., during summer months), confirm that there will be sufficient recovery time in the treatment system to empty the basin before the additional volume is required; o Explain where the overflow will be directed in the event of unforeseen scenarios (e.g., power outage).		N/A	
3.5 Provide the following information regarding the effluent pipeline: o Provide viable options including the selected option for leak detection technologies and inspection methodologies, with specific consideration to any portion of the pipeline located in the Town of Pictou's water supply protection area; o Provide viable options including the selected option for the enhanced pipeline protection, such as trench lining and justify how the chosen option is an adequate option for secondary containment. Be sure to address any potential changes in flow regimes, especially within the Town of Pictou's water supply protection area, due to the installation of the pipeline and secondary containment. If different options are provided for different areas of the proposed re-aligned pipeline route, the locations for each option must be identified.	Incomplete	1) The proposed pipeline will have <u>NO</u> leak detection capacity in its marine phases (Focus Report, p. 62). Effluent in final 4km of pipe to diffuser will flow under gravity (from max height of 1300m; Focus Report. p. 60). Assumption is that subsurface burying of the pipeline (3m) will protect against vessel traffic and ice scour to the marine portion of the pipe (Focus Report p. 39 and Appendix 3.5). Precise location of the diffuser and its integrity are a significant part of the proponent's plan to mitigate environmental impacts. Thus, compromises to this marine portion of the pipe or the diffuser could impact this plan. 2) Relatedly, the integrity of the diffuser ports (Focus Report 4.2.2, p. 86) depend on	R1: It is suggested that an installation of a detection system or regular monitoring of the marine portion of the pipeline be conducted to determine whether leaks, of any scale, result in local non-dispersed effluent accumulate in the local marine environment. R2: Request that information regarding the selected inspection regime be available to all stakeholders in order to properly assess and monitor the diffuser port integrity.

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
		the flexibility of the one-way rubber valves being maintained. The diffusion capacity of these ports is a significant part of NPNS's argument that the new system constitutes an improvement, and that rapid dilution will take place as per modelling in RWS.	
3.6 Clarify where the potential releases of waste dangerous goods at the Project site will be directed for treatment and/or disposal. It is important to note that the new treatment facility is not proposed to treat waste dangerous goods based on the information provided in the EARD and requirements of NSE.		N/A	
4. Marine Water and Marine Sediment			
4.1 Conduct baseline studies for the marine environment (such as marine water quality and marine sediment) in the vicinity of proposed marine outfall location.	Complete	1) The baseline studies do not examine mineral composition of sediments (other than grain size). Information on sediment composition would be useful in understanding the nature of the interaction between the receiving environment and the effluent.	
4.2 Update the receiving water study to model for all potential contaminants of concern in the receiving environment (based on the results of the effluent characterization and/or other relevant studies such as Human Health Risk Assessment). Baseline water quality data for Caribou harbour must be applied to this study. Refer also to Addendum 3.0.	Complete	No comment	

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
4.3 Provide results of sediment transport modelling work to understand the impacts of potential accumulation of sediment within near field and far field model areas. This should include chemical and physical characterization of the solids proposed to be discharged by NPNS as well as a discussion of how these solids will interact with the marine sediments and what the potential impact will be on the marine environment as a result.	Incomplete	1) According to Focus Report, App. 4.3, 90% of the Total Suspended Solids (TSS) will, depending on diffuser height (from seabed), and depending on which mean current speeds are used, be deposited within 1 to 4.8 kms or 4.2 to 21.1 kms of the diffuser. Given the wide range of these figures, and given that a high proportion of TSS will be non-easily biodegradable (refractory) cellulose fibres (Focus Report p. 25), there is a reasonable concern of impacts to fish habitat (benthic smothering) by sediment of such fibrous material within fishing grounds (see Focus Report figures 7.3-4 - 7.3-7). 2) The potential effect of TSS is dependent on the type of raw material introduced to the natural environment and the nature of the receiving environment. Therefore, comparison of models using effluent from mills in other regions is irrelevant and can lead to inaccurate conclusions.	R1: NPNS should give consideration to alternative and newer treatment technologies (e.g. centrifugal systems widely used in other mills) to reduce TSS, including cellulose fibres, not currently planned to be captured by the proposed new ETF system. R2: NPNS should review the statement regarding confidence levels of the conclusion of Appendix 4. 3 that "it is unlikely that sediment will build up in either the near- or far-field." (p. 6). The data presented in Appendix 4.3 undermines this confidence.
5. Fresh Water Resources			
5.1 Complete a wetland baseline survey along the proposed re-aligned effluent pipeline route (if wetlands are expected to be altered).		N/A	

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
5.2 Provide monitoring methodologies for areas with significant risk of pipeline leaks or spills (e.g., two areas where the pipeline crosses the Source Water Protection Delineated Boundary for the Town of Pictou wellfields; below water table; important wetlands; watercourse crossings; etc.).		N/A	
6. Air Quality			
6.1 Provide a revised inventory of all potential air contaminants to be emitted from the proposed project, including but not limited to, speciated volatile organic compounds, semi-volatile organic compounds, reduced sulphur compounds, polyaromatic hydrocarbons and metals.		N/A	
6.2 Update the air dispersion modelling for the pulp mill facility for all potential air contaminants of concern related to the Project.		N/A	
6.3 Complete an updated ambient air monitoring plan for the Project site based on the air dispersion modelling results. This plan must include the potential air contaminants to be monitored and proposed air monitoring location(s).		N/A	

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
7. Fish and Fish Habitat			
7.1 Conduct fish and fish habitat baseline surveys for the freshwater environment, to the satisfaction of Fisheries and Oceans Canada.		N/A	
7.2 Conduct fish habitat baseline surveys for the marine environment, to the satisfaction of Fisheries and Oceans Canada.	Incomplete	1) As noted in the Focus Report, baseline surveys have not been completed.	R1: Baseline surveys should be completed for all commercially important species before a final decision is reached.
7.3 Conduct additional impact assessment of treated effluent on representative key marine fish species important for commercial, recreational and Aboriginal fisheries. This must be based upon updated information, additional studies and/or an understanding of expected movement of contaminants. Assessment methodology must first be agreed upon by NSE in consultation with relevant federal departments.	Incomplete	1) The Focus Report deals with Valued Ecological Components (VECs) related to fisheries. In the EARD the social and economic ('socio-economic') environment was identified as a VEC in consideration of the potential interactions with local communities, how land and water is used in the vicinity of the project, and the potential interaction between the project and the economic well-being of these communities. These potential interactions are of concern to regulatory agencies, non-governmental organizations, and the general public because they can have a direct influence on the everyday lives of those living and working in the vicinity of a project. The socio-economic environment VEC includes land and water uses such as community resources and recreation, and economic industries, infrastructure. Furthermore, Appendix 7.3 references the socio-economic	R1: NPNS should commit to undertaking a socio-economic effects monitoring program related to the implementation of the NPNS ETF on local commercial fishing activities.

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
		importance of American lobster, rock crab and Atlantic mackerel that may have a higher potential for interaction with the project than some other indicators that were assessed specific to the Marine Fish and Fish Habitat VEC, it is recommended that EA Follow-up Monitoring be undertaken. There is, however, no indication of the intention to monitor socio and economic effects on this important resource sector.	

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
7.3 Continued.	Incomplete	1) Spatial boundaries for the assessment of environmental effects on the socio-economic environment include the following: a) the project footprint area (PFA) is defined as the physical footprint of the project including the location of the new replacement ETF on the NPNS mill property, the overland portion of the effluent pipeline, and the marine portion of the effluent pipeline and the marine outfall. The PFA is defined in Section 5.1.1. b) the local assessment area (LAA) is the maximum area within which environmental effects from the project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. The LAA can be thought of as the "zone of influence" of the project. For the socio-economic environment, the LAA is represented by the communities whose regular activities intersect with the PFA: Pictou Landing First Nation, local residents, and local industries located in the Municipality of Pictou County or the towns of New Glasgow, Stellarton, Pictou, Westville, and Trenton. Since the PFA is deemed to terminate at the marine outfall downstream impacts were not considered.	R1: Downstream impacts, such as drift of the effluent and its impact on adjacent fisheries, should be considered. Accordingly, a socio-economic baseline study should be conducted, which will include all the communities in the LAA to determine future socio-economic effects. This survey should include demographic profile of the towns and regions, industrial profile, including business counts, and labour force profile.

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
7.3 Continued.	Incomplete	1) The Impact Assessment only addressed biophysical environmental impacts. There was no consideration of social and economic impacts, particularly in relation to other key economic sectors in the region. See comments in "Reviewers Comments and Considerations" Section. 2) Monitoring is only for the bio-physical and chemical effects in the physical environment. There is no monitoring of bioaccumulation of effluent born compounds (for example, PAHs, mercury, dioxins and furans, etc.) in commercially important species. 3) Section 5.4 of Appendix 7.3 states "...will continue to investigate the feasibility of performing toxicity testing...". There is documented evidence that pulp and paper mill effluent cause physiological changes in fish as well as changes in physical and reproductive behaviour (Lehtinen et al 1990 Munkittrick et al, 1998). Thus, NPNS should agree to conducting toxicity testing on local fishery species of importance. 4) Section 5.3 of Appendix 7.3 states "Following completion of the HHRA, the potential utility of a continued fish tissue monitoring program following commissioning of the effluent treatment system and subsequent discharge will need	R1: Consideration should be given to the social and economic impacts that the treated effluent may have on key marine fish species (key economic sector). R2: Fishermen should be involved in all aspects of the EEM program, including selecting the EEM parameters and in monitoring activities. R3: It is requested that more information be provided on the predicted effects of effluent on resident species of fish, shellfish and crustaceans, including foraging species, through regular toxicity testing. R4: These discussions should commence **prior** to the initiation of construction to ensure certainty that tissue sampling and analysis studies be conducted by NPNS. R5: The Fishermen strongly urge the NSE to require **ALL** baseline studies to be completed prior to the approval of the NPNS ETF EARD.

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
		to be discussed with First Nations, stakeholders and government agencies. 5) The Focus Report further states in Appendix 7.3 that "The potential studies are still likely to target: lobster, rock crab, scallop, blue mussel, softshell clam, oyster, and locally relevant finfish (e.g., Eel, Smelt, Gaspereau, Striped Bass, Mackerel, Atlantic Herring). Given the likely timing for EA approval and the subsequent construction and commissioning of the proposed ETF, it will be possible to target collections of any of the species identified above that have not already been collected for baseline purposes (i.e., predevelopment) should engagement indicate the need."	R6: The Fishermen further request that NPNS consult closely with the Fishers Associations to ensure baseline studies include a broader range of species, to include commercially important species, and the foraging species upon which these economically important resources depend.
7.4 Submit an updated Environmental Effects Monitoring (EEM) program based on the results of various relevant baseline studies and an updated receiving water study. Refer also to Addendum item 4.0	Incomplete	1) Beyond the existing design of the effluent diffuser, no indication is made in the Focus Report about what mitigation steps could be taken if a post-construction EEM program discovers an unacceptable toxicological effect on fisheries resources. 2) The Environmental Effects Monitoring (EEM) program does not include studies on the bioaccumulation of effluent within key economically important species. This has significant social and economic implications as well as biological implications to the viability of the local resource. 3) There is insufficient information regarding the specificity and processes	R1: Fishermen should be involved in all aspects of the EEM program, including selecting the EEM parameters and in monitoring activities. R2: Fishermen should be involved in discussion and decisions regarding appropriate mitigation measures.

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
		involved in the EEM program. As a result, the opportunity for stakeholder groups to provide input and recommendations on how to enhance the EEM program so that monitoring measures are acceptable is not apparent or available.	
7.5 Clarify what contingency measures will be in place to mitigate potential impacts (e.g., thermal shock to fish) due to potential large and rapid fluctuations in water temperature in the winter at the diffuser location during low production or maintenance shut down periods.	Complete	1) There remains a question that while the Focus Report addresses routine contingencies there is no discussion on what measures are in place for catastrophic events that could result in rapid or unmanaged discharge of effluent into coastal waters.	R1: NPNS should consider an emergency response plan as a part of their contingency measures.
8. Flora and Fauna			
8.1 Complete a plant baseline survey along the proposed re-aligned effluent pipeline route.		N/A	
8.2 Complete a migratory bird survey along the re-aligned pipeline route.		N/A	
8.3 Complete a bird baseline survey for common nighthawk (Chordeiles minor), double crested cormorants (Phalacrocorax auratus), owls, and raptors and raptor nests, for the entire project area which includes the re-aligned pipeline route.		N/A	

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
8.4 Complete a herptile survey for the Project area which includes the re-aligned pipeline route.		N/A	
9. Human Health			
9.1 Complete baseline studies for fish and shellfish tissue (via chemical analysis) of representative key marine species important for commercial, recreational and Aboriginal fisheries in the vicinity of the proposed effluent pipeline and diffuser location.	Incomplete	1) The baseline surveys did not include several commercially important species, such as scallops and other benthic invertebrates. 2) While the baseline survey includes tissue analysis of commercially important species and food resources for First Nations, the EEM does not indicate that this will be continued to determine the level of bioaccumulation of effluent in these species.	R1: A complete baseline survey is necessary to ensure compliance with the requested information in the Focus Report Terms of Reference and useful for the development of an effective EEM program. R2: The EEM should include tissue analysis to determine health risks resulting from potential bioaccumulation and to determine potential economic impacts on the fishery.
9.2 Commence a Human Health Risk Assessment (HHRA) to assess potential project-related impacts on human health. The risk assessment must consider human consumption of fish and other seafood, consumption of potentially contaminated drinking water, exposure to recreational water and sediment, outdoor air inhalation, and any other potential exposure pathways. The analysis must inform the identification of contaminants of concern and updating of the receiving water study.	Incomplete	1) The Seafood Intake Survey did not include an analysis of the food ingested to determine the presence or absence of compounds that may be present in effluent (useful and essential background information for future studies). 2) Impact from consuming commercially important species from the area can have wider impact on the economic viability of the fishery in the region as a whole (e.g. amnesic shellfish poisoning in PEI affected the Atlantic fishery).	R1: The Food Intake Survey should include analysis of presence of heavy metals, PAHs, dioxins and furans in the foods after preparation for consumption. R2: See "R2 in Section 9.1"

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
10. Archaeology			
10.1 Complete an Archaeological Resource Impact Assessment for the marine environment related to the Project.		N/A	
10.2 Complete shovel testing for areas in the terrestrial environment that are identified to have elevated or medium potential of archaeological resources, to confirm the presence or absence of these resources.		N/A	
11. Indigenous People's Use of Land and Resources			
11.1 Complete a Mi'kmaq Ecological Knowledge Study (MEKS) for the Project.		N/A	
ADDENDUM: Items Raised by Reviewers Requiring Clarification			
1.0 Provide information regarding whether and when new technology and equipment will be installed at the NPNS pulp mill to improve the effluent quality, including but not limited to the following: o Will O_2 delignification be installed at the NPNS pulp mill? o What other technology and equipment will be installed at the NPNS pulp mill? o How will each proposed new technology and/or equipment improve the effluent quality?	Complete	No comment	

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
2.0 With respect to the effluent discharge parameters: o Explain why the total nitrogen parameter has changed to 6 mg/L (daily maximum) from the 3 mg/L (proposed in the August 11, 2017 receiving water study); o Provide data to support assertions that chemical oxygen demand (COD) can be reduced to the proposed limit.		See Section 3.3 above.	
3.0 With respect to the updating of the Receiving Water Study: o Provide a response to questions and comments on the receiving water study (not already outlined in this document) from Environment and Climate Change Canada's EARD review submission dated March 18, 2019, and update the receiving water study as applicable; o Explain how the initial mixing and dispersal of the plume was taken into account when simulating far-field extent and concentrations of effluent in Section 3 of Appendix E1 of EARD. It appears that the far-field model simulations were run before the near-field model. One could expect that the behaviour of the plume further afield depends a large extent on how it behaved at the diffuser, i.e. how quickly it mixed and spread and rose to the surface; o Confirm dilution ratios and distances required to achieve background level for water quality parameters in Appendix E1 of the EARD, as the dilution ratios and distances may be overestimated; o Explain if the salinity and temperature differential between the effluent and the receiving waters has been accounted for in the model. When the buoyancy differential between the effluent and receiving waters are	Complete	No comment	

Requirements from Terms of Reference	Completeness	Review Comments & Considerations	Additional Issues/Suggestions for Consideration
greater in winter, it results in a faster rising plume. This can potentially affect the visibility of the effluent in the receiving environment. Has this been accounted for in the model? Also provide results for winter conditions; o Explain if re-entrainment of effluent and sediment at the diffuser location was accounted for in the one-hour period surrounding slack tide. Support this explanation with model results using a smaller time step (30 minutes) if necessary.			
4.0 It is important to note that the following field study and monitoring are likely to be required as part of an EEM program regulated under the Pulp and Paper Effluent Regulations for the Project if it is approved: o Field delineation of treated effluent plume to confirm the prediction from the receiving water study; o Monitoring of marine water quality and marine sediment quality; o Sublethal toxicity testing and chemistry testing of the treated effluent; and o Biological monitoring studies including benthic invertebrate community study, fish population study, and dioxin and furan levels in fish as applicable.	Complete	See Section 4 above	

Table 2: Additional Reviewer General Comments & Considerations

Additional Reviewers Issues	Review Comments and Considerations	Comments for Consideration
Issue: Major Findings and Conclusion from the Report	1) In the Focus Report it is summarized that "through appropriate mitigation, no significant adverse residual environmental impacts have been predicted" (vi) which is a reflection of the overall content and conclusions of the Focus Report and its appendices. However, despite the Focus Report's presentation of this overall finding as "scientific" and "science-based" (i, ii), there are significant questions and uncertainties that remain. 2) Predictions based on modelling in the Focus Report suggest that the proposed ETF will meet current federal and provincial regulatory requirements. However, new federal guidelines (e.g. PPER in accordance with the *Fisheries Act*) have not yet been published; assumptions about the content of the new PPER are acknowledged within the Focus Report as being "speculative" (n. 1, Table 2.4-2). Thus, the Focus Report's overall conclusion that "proposed future" (Focus Report, p. xxxi) regulations will also be met by the new ETF is premature and introduces additional uncertainty. 3) The Focus Report does not conform to best practice of impact assessments that clearly requires full disclosure of uncertainties so as to adhere to the precautionary principle, for many years now a guiding principle in impact assessment in Canada. Such disclosure is necessary to allow for full participation of potentially impacted communities to contribute to determination of acceptable levels of risk.	R1,2,3: The responses to this Focus Report should be included in a continued engagement process that allows for a collaborative review of public responses, and collaborative decision-making involving impacted stakeholder groups, proponents and regulators as an extension of this review process prior to regulatory approval. This will enable stakeholder groups to be fully aware of uncertainties that are unstated in the Focus Report. This will be consistent with the principles of Free, Prior and Informed Consent (FPIC) that should guide this process.
Issue: Assumptions in the Focus Report	1) The assumption made within the Focus Report is that dilution of the effluent in receiving water is sufficient to avoid significant, adverse and residual impacts on the environment. However, there is growing evidence that this assumption is being questioned in other jurisdictions whereby environmental monitoring programs are requiring more stringent	R1,2,3: Greater effort must be made to fully characterize the receiving ecosystem, particularly completing all baseline studies and economic analysis of the receiving environment (bio-physical and socio-economic). These

Additional Reviewers Issues	Review Comments and Considerations	Comments for Consideration
	regulations for Environmental Effects Monitoring (EEM), including cumulative effects, lower toxicity thresholds (sub-lethal effects), and introduction of more advanced technologies for effluent treatment and disposal. 2) The assumption in the Focus Report that meeting current Pulp and Paper Effluent Regulations (PPER) is enough to ensure that the new Effluent Treatment Facility (ETF) will not cause an acceptable significant adverse residual negative impact is questionable considering changes being proposed to create new and enhanced PPER (Bill C-68). 3) The impact assessment methodologies employed by NPNS and documented in the Focus Report (and EARD) rely on the comparability of effluent parameters to other kraft mills operating in Canada and internationally (e.g. Focus Report pp. xxvi-xxviii; App. 2.4). Best practices of impact assessments now follow ecosystem (social, economic, and biophysical) assessment approaches. Conclusions drawn in this Focus Report on the basis of such comparisons, particularly those with respect to "significant adverse residual impacts", ought to be treated with caution. The proposed NPNS ETF is the first in Atlantic Canada, and certainly for this distinctive ecosystem of the Northumberland Strait, which is different and unique even to other areas within Atlantic Canada. The closest relevant ecosystem comparison is to the existing BHETF, which clearly has left a "negative legacy" (Focus Report, p. xxxix). 4) iv. The approach to disposal of COPC and TSS by discharge into the marine environment has been a contentious issue, internationally, for decades. Consensus within the scientific and technical community is that COPC disposal, particularly those identified as endocrine disruptors and persistent (not or not easily and safely biodegradable) pollutants in marine environments is of mounting concern (Singh and Chandra, 2019; Chandra et al, 2018) and that conventional treatment options (including activated sludge processes as proposed in this ETF) are considered to be insufficient	studies will help determine cumulative effects and appropriate mitigation strategies. R4: The corporate social responsibility and public interest should be married through greater collaboration between affected stakeholders, regulators, and NPNS in decision-making, such that conditions of approval include strategies to continually strive to reduce and eliminate at-sea effluent disposal.

Additional Reviewers Issues	Review Comments and Considerations	Comments for Consideration
	to address concerns regarding commercial fisheries (Hubbe et al, 2016). This is particularly in light of mounting concerns over the need for more stringent attention to cumulative effects and consideration of increasing stress indicators of ocean health (DFO state of the ocean report 2019). For this reason, better design options should be considered that make use of best available technologies for minimizing absolute volumes of effluent discharged, or that maximize removal of effluent content of potential concern (COPC, TSS). The results of this Focus Report confirm that the major difference between the proposed ETF and current ETF is simply that a comparable effluent (in terms of volumes and content) will be discharged further out to sea, with more rapid dilution performance. (It has been noted in the review of the Focus Report that heavy metals require the use of additional direct use of physical-chemical processing of effluent water (adsorption on new adsorbents, ion exchange, membrane filtration, electrodialysis, reverse osmosis, ultrafiltration and photocatalysis) or bio-absorption (Gunatilake, 2015 Ayres et al, 1994)	
Issue: General comments regarding Socio-economic Assessment	1) The Focus Report makes reference to and draws conclusions about socio-economic impacts but provides no analysis, quantification, or justification to support these conclusions. a) Identified socio-economic impacts are not quantified, including the economic impact of construction spending. b) The EARD contains no apparent socio-economic analysis. c) Reference to disruption of economic activity during construction is too narrowly defined as disruptions to use of land and water resources. Potential changes to market and consumer perception / behaviour resulting from the project are not addressed (e.g. changes in demand for seafood harvested in the PFA).	R1: Socio-economic impact assessment should consider: what is the nature of the impact (e.g. employment, production, revenue, cost, etc.)? What could drive it (i.e. changes in labour demand, consumer perception)? What is the potential scale and direction of the interaction (i.e. size of the impact, positive or negative)? There appears to have been no effort made to estimate the extent (qualitatively or quantitatively) of these potential interactions between the NPNS ETF and other economic sectors during and after construction. Therefore, NPNS should undertake an assessment of potential interactions to

Additional Reviewers Issues	Review Comments and Considerations	Comments for Consideration
	d) EARD does not include an analysis of potential economic opportunities related to the project (e.g. supply chain, employment, training, local industry capacity-building, local construction / employment income spending). e) Impacts to property values in the PFA have not been considered. f) Potential interactions and impacts to fisheries, tourism, transportation, and other sectors have not been estimated or quantified. It should be noted that some impacts to sectors such as tourism can be "sticky", meaning temporary changes in access to or perceptions of tourism destinations and activities can result in longer-term consumer behaviors that are difficult to alter. Similarly, temporary changes in seafood markets because of public perceptions from the environment in which they are harvested can have long-term implications to the local as well as regional marketability of seafood products.	determine and describe the nature and extent of the impact on the local and wider Nova Scotia economy.
Issue: Significance Criteria	1) The significance criteria defined for NPNS ETF project does not fully consider the social and economic environment. A significant adverse residual environmental effect on the socio-economic environment is one where project-related activities directly interfere with the use of the land or water such that their intended use is no longer possible. This would include interference with land uses, recreational uses, employment and economic impacts in the community, region, or province. A significant positive residual environmental effect of the project on the socio-economic environment is one that results in project-related sustained increased level of employment and economic activity in the community, region, or province, or enhances land and water uses.	R1: Criteria could be expanded beyond "the use of land or water such that their intended use is no longer possible." Could include: Impacts to land or water such that their intended or desired use is affected in any way (negatively or positively). Impacts to fisheries – increase or decrease in fish stocks, changes in consumer perception of or demand for seafood originating from the PFA. Impacts to tourism / recreation based on actual or perceived impacts of the project. Negative residual environmental effects of the project on the socio-economic environment resulting in decreased levels of (or negative shifts in) employment and economic activity in the

Additional Reviewers Issues	Review Comments and Considerations	Comments for Consideration
		community, region, or province. For example: demand for local project-related labour causing shifts away from existing local industry.
Issue: Compensation	1) The Focus Report discusses compensation only in terms of habitat compensation as it relates to HADD, however, the EARD does address compensation in the commercial fishery in only general terms. As stated in the EARD: a) "In advance of and during construction, communication with the fishing industry will allow for strategic planning and limit risk of impacting movement through Caribou Harbour into the Northumberland Strait." b) "The area of disturbance will be small, particularly in comparison to the licensed fishing areas. Impact, if it occurs, would be limited to a small number of individual fishers who may be able to compensate for that loss by adjusting their fishing patterns. The impact to income is not expected to be significant."	R1a: Since communication and strategic planning requires cooperation measures should be taken to ensure that effective communication and cooperation and NPNS and fishermen takes place. This important to ensure mitigation will include opportunities to avoid detrimental effect on the commercial fishery and that suitable compensation can be negotiated. R1b: The area of disturbance may be physically small; however, the impact can be global because of the fact that the Atlantic lobster fishery is perceived as a common resource in the marketplace. Consumer perception and demand for seafood is important and consumers are becoming increasingly sensitive to the environment from which seafood products are harvested. Therefore, NPNS is well advised to effectively engage the commercial fishery on an ongoing basis.

APPENDIX A: REFERENCES

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APPENDIX B: CVS

CHRISTOPHER MILLEY (B.SC., M.SC., M.M.M.)

Location: Halifax, NS ● **Phone:** 902-441-6104 ● **Email:** cmilley@nexuscoastal.com

PROFESSIONAL SUMMARY

Chris Milley is a marine scientist and resource manager with over 30 years of experience in local, regional and international marine management projects with significant experience throughout Nova Scotia.

EDUCATION

- Dalhousie University, 1995 (Masters of Marine Management)
- Dalhousie University, 1983 (Master of Science – Oceanography)
- Mount Allison University, 1979 (Bachelor of Science)

ADDITIONAL TRAINING

- Middle Management Orientation Program Public Service Commission, Ottawa, 1990
- Project Management by Activity, Bureau of Management Consultants, Georgetown,

Mr. Milley has an intimate familiarity of the human and environment-related issues of indigenous and non-indigenous coastal communities with a specific emphasis of the relationships between tradition, culture and local environment. He has significant experience with governments in conducting Environmental Assessment reviews and in research that advance marine resource management policies and processes.

Mr. Milley is an Adjunct Professor in the Marine Affairs Program at Dalhousie University where he has taught graduate courses in Contemporary Issues, Community-based Co-management, Fisheries Management, Culture & Resource Management, Indigenous Rights-based in Resource Management, and Citizen & Community Engagement.

SAMPLE PROJECT EXPERIENCE

Technical Support to Facilitate Long-Term Enhancements of Livelihoods and Human Well-being for Eastern Caribbean Flyingfish Fishery (CRFM) Research and analysis on the socio-economic and value chain components of the flyingfish fishery. Included on the ground engagement activities, interviews and surveys in order to identify recommendations on how best to enhance livelihoods and human well-being.

Guysborough LNG Socio-economic Effects Management Plan Lead social impact analyst for a study and detailed assessment of economic effects, impacts, and mitigation strategies related to the development of two proposed LNG plants in the Municipality of the District of Guysborough. The work involved extensive stakeholder consultation and the mapping of key economic and social assets in the region.

Meliadine Mine Environmental Impact Statement Review,

Project Manager for a review of the environmental assessment of the proposed Agnico Eagle Meliadine Mine, Nunavut. The review was conducted to identify informational requests and condition of non-compliance.

Meliadine Mine Road Environmental Assessment Review

Project Manager for a review of environmental assessment documents prepared for the construction of a road to the proposed Meliadine Mine, Nunavut. This review was conducted to identify informational requests and condition of non-compliance.

Pangnirtung Harbour Regulatory Applications, Pangnirtung, Nunavut

Organized and implemented field studies to assess potential at-sea disposal sites for the Pangnirtung, Harbour development environmental assessment and permitting.

Black Point Quarry Environmental Assessment

Coordinating inputs and facilitating aboriginal community engagement for Environmental Assessment of a proposed quarry development of in eastern Nova Scotia.

AC LNG Melford, NS

Team lead for an Environmental Assessment of a proposed LNG Terminal in eastern Nova Scotia. Also conducting aboriginal engagement and liaison activities for a proposed LNG terminal in Goldboro LNG.

Goldboro LNG Fisheries EA

Team lead for EA and EEM of for a proposed LNG terminal in Goldboro LNG. Responsibilities included chairing the ongoing fisheries liaison committee for this project.

Nunavut Regulatory Review

Conducted an evaluation and providing recommendations for the enhancement of the regulatory procedures for water licensing and lands permitting in Nunavut.

Nunavut Parks Environmental Policy and Process

Managed preparation and provided technical review of the Nunavut Parks Environmental Assessment Policy and Environmental Assessment Process.

First Nations Consultation –New Page Port Hawkesbury

Provided advisory support and facilitated the review and completion of FSC-certified forest management plans.

Fisheries Act Legislation Review and Advisory Support (Government of Nunavut) Managed the Project Team to conduct research and analysis on fishery regulations, legislation, Nunavut Land Claims Agreement and more.

Strategic Environmental Assessment, CNSOPB Conducted indigenous and fisher stakeholder engagement and consultation as a part of the Canada-Nova Scotia Offshore Petroleum Board's Strategic socio-economic and environmental assessment of the offshore regions in northern and eastern Cape Breton.

Beaufort Sea Regional Environmental Assessment Framework - Cumulative Effects Framework, Indigenous and Northern Affairs Canada Conducted stakeholder and governmental workshops to design and documented a cumulative effects monitoring and management framework for the Beaufort Sea Region as part of a multi-sectoral, intergovernmental program to define approaches to sustainable development of offshore and onshore oil and gas.

Atlantic Climate Adaptation Solutions Association (ACASA) Coastal Adaptation Guidance Project focused on developing planning and engineering guidance for the selection of sustainable coastal adaptation strategies to climate change for the rural communities of Atlantic Canada.

IAN G. STEWART (PH.D., M.A. B.SC)

Location: Halifax, NS ● **Phone:** 902-877-9838 ● **Email:** istewart@nexuscoastal.com

PROFESSIONAL SUMMARY

Dr. Stewart is an academic professor with both natural and social science training, with a research specialization in environmental science, science policy, and public dimensions of science. He also practical experience outside the classroom, with several years working at the intersection of government policy, industry, NGOs and academia. He brings to NEXUS several years of research expertise and knowledge mobilization experience in the sub-field of environmental impact assessment (EIA), including legislative, operational and public engagement aspects of EIA in Canada.

EDUCATION

Cambridge University, 1999 (PhD, History and Philosophy of Science)
University of Toronto, 1990 (M.A.) History and Philosophy of Science and Technology
Trent University, 1988 (B.Sc. Hons). Physics and Mathematics

ACADEMIC APPOINTMENTS & AFFILIATIONS

Assistant Professor (tenured), University of King's College, Halifax, NS
Adjunct Professor, Marine Affairs Program Dalhousie University, Halifax NS
Senior Researcher, Environmental Information: Use and Influence (www.eiui.ca)

RELEVANT EXPERIENCE

Dr. Stewart leads a pan-Canadian research initiative involving social science and humanities scholars, practitioners and government across Canada to help develop next-generation approaches to EIA at both federal and provincial levels in the context of evolving legislative landscape. Collaborative publications and conference presentations on the oil and gas development and transport sectors have included: analysis of CEAA EAs for scientific rigour and policy adherence; conflicting perceptions of 'impact benefit' analyses; quality of consultation and stakeholder engagement.

Knowledge mobilization

Dr. Stewart has assisted numerous government departments and agencies at the federal level on policy and operational aspects of EAs. He is also a regular contributor to government-led technical workshops in this field. He has assisted NGOs and community organizations in their involvement in this space.

Select publications and presentations

Karabanow, J., & Stewart, I.G. (2019a). Between policy and practice: Ethical challenges in longitudinal applied social science research. In F. McSweeney & D. Williams (Eds.),

Designing and conducting research in social science, health and social care (pp. 75–89). New York: Routledge.

Stewart, I.G. (2019b). The unavoidable tension in the "science vs policy" divide [Review essay of *Discerning experts: The practices of scientific assessment for environmental policy*, by Michael Oppenheimer et al.]. *Proceedings of the Nova Scotia Institute of Science, 50*(2) (forthcoming)

Stewart, I.G. (2019c). Some perspectives on socio-epistemic challenges of impact assessment. Advancing Impact Assessment in Canada's Natural Resources Sectors, University of Alberta, Edmonton, AB.

Stewart, I.G. (2019d) Public engagement in oil spill preparedness and response (OSPR): Challenges and possibilities. Panel organization (with Chris Milley, Nexus, and Elise deCola, Nuka); 42nd ECCC AMOP Technical Seminar, Halifax.

Stewart, I.G. (2019e). Environmental assessments and co-production. Working with Co-Production Workshop, University of Ottawa, ON.

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Stewart, I.G. (2018b) Who's benefitting from the Kinder Morgan pipeline? Reflections on a word in different legal contexts. Commission on Legal Pluralism, Ottawa, ON. http://commission-on-legal-pluralism.com/nl/home August 2018.

Stewart, I., Desjardins, I., Walker, T., & Doelle, M. (2018c). Socio-epistemic contours of deliberation in CEAA-led EAs: The case of BP's Scotian basin exploratory drilling project. Inaugural Meeting of the Advancing Social Sciences and Humanities Scholarship for Impact Assessments in Canada Project, Toronto, ON. (July 20, 2018).

Westwood, A., et al. (2018d). *Strong foundations: Recap and recommendations from scientists regarding the federal environmental and regulatory reviews*. Report submitted to the Government of Canada, *Environmental and Regulatory Reviews*.

Stewart, I., & McMahon, D. (2016). Building bridges with the public. *World Pipelines 16*(11), 70–75.

CHRISTOPHER DEBOW (B.COMM MDE, CAPM)

Location: Halifax, NS ● **Phone:** 902-421-1720 ext. 4 ● **Email:** cdebow@gardnerpinfold.ca

PROFESSIONAL SUMMARY

EDUCATION

- Certified Associate in Project Management, PMI, 2017
- Master of Development Economics, Dalhousie University, 1998
- Bachelor of Commerce (Finance), Saint Mary's University, 1993

Mr. DeBow is a Senior Associate and Economist with NEXUS Coastal Resource Management Ltd. He has a Master's degree in development economics and more than a decade working across many aspects of provincial, national, and international economic sectors, most notably fisheries and coastal marine resources. He has extensive experience in areas of resource economics, community consultation, business and strategic planning, research, statistical analysis, project management, and group facilitation. His academic background in economics, business, and international development add a unique perspective to his work.

RELEVANT PROJECTS

Technical Support to Facilitate Long-Term Enhancements of Livelihoods and Human Well-being for Eastern Caribbean Flyingfish Fishery, *CRFM*

Lead Economist of the Project Team to conduct research and analysis on the socio-economic and value chain components of the Eastern Caribbean flyingfish fishery. This work also required on the ground engagement activities, interviews and surveys in order to identify recommendations on how best to enhance livelihoods and human well-being related to the flyingfish fishery.

Economic Impact Study of Canada's Independent Marine Ports (Baseline and Update), *IMPAC*

This study involved measuring the economic impact of individual ports and the shipping industry in Atlantic Canada using conventional indicators (GDP, employment and labour income). It identified and quantified the role of the port in economic growth and development, with a focus on the linkages between shipping/port activity and local industry, while identifying and analyzing policy issues related to port financial viability and long-term sustainability.

Guysborough LNG Socio-economic Effects Management Plan, *MODG*

This study involved the detailed assessment of economic effects, impacts, and mitigation strategies related to the development of two proposed LNG plants in the region. The work

involved extensive stakeholder consultation and the mapping of key economic and social assets in the region with a large focus on fisheries and coastal marine resource sectors.

Nova Scotia Ocean Sector Economic Study, *NS Department of Economic Development*

The purpose of this study was to provide decision makers, planners, industry and the public with a measure of the economic importance of ocean-related sectors. To this end, the main objectives were to estimate the direct and spin-off economic benefits to Nova Scotia's economy attributable to the ocean; estimate the direct and spin-off benefits to Nova Scotia's economy of each component of the ocean economy; and to estimate the growth potential for each component of the ocean sector in NS.

Economic Impacts of Marine-Related Activities in Canada, *Department of Fisheries and Oceans*

This study examines the economic activities related to the marine environment including fisheries and aquaculture, national defense, energy, transportation, marine construction, tourism and recreation, research and development. The study results are presented by province and by large ocean management area (LOMA).

Socio-economic Study for the Maritime Link Project, *Emera*

The objective of this study was to provide an appropriate and useful understanding of the existing (baseline) socioeconomic environment, with due consideration of the nature and geographic scale of the Maritime Link project's potential interactions with the socioeconomic environment.

Climate Change and Emergency Management in Nova Scotia, *NS Emergencies Measures Organization*

This study evaluated selected municipal emergency plans, provincial emergency management legislation, and gather key stakeholder input with the aim of adapting emergency planning, management, and legislation in Nova Scotia to better incorporate future climate change impacts. A full report with findings and recommendations was produced and presented at a regional climate change conference

Analysis of the Commercial Benefits Associated with NS' Protected Areas System, *NS Environment*

This study examined and documented the socio-economic, environmental, and commercial benefits associated with the province's system of protected areas. Opportunities for enhancement of benefits, barriers, and the identification of required investments were produced.

Development of a Proactive Land Asset Management Model for Nova Scotia, *NS*

This study provided detailed revenue estimates and a high-level business plan for implementing proactive land asset management. An economic analysis was conducted to identify and quantify the nature and scope of approximately ten commercial activities. The results of the analysis were used to develop a revenue model for implementing a proactive land asset management model for Crown land.

Assessment of Integrated Resource Management in Nova Scotia, *NS Department of Natural Resources*

This study documented and assessed business processes, governance structures and methodologies used to deliver an integrated resource management process. It identified opportunities for future enhancements and developed recommendations to redesign IRM in Nova Scotia. Research was conducted through stakeholder interviews and focus group discussions.

Pictou Waterfront and Heritage Quay Business Case and Tourism Development Plan, *Town of Pictou*

This study involved the preparation of a five-year operational business plan and feasibility analysis of potential realistic and achievable cultural tourism development opportunities through a focused strategy that builds upon past achievements, current strengths, future product development, and untapped market opportunities. The analysis aimed to enable the Town and its partners to implement actions that support further tourism product development of the Pictou Waterfront and Ship Hector Heritage Quay as a world-class tourism destination.

MARIA 'BUGSY' DELESALLE (B.A., M.M.M.)

Location: Halifax, NS ● **Phone:** 902-441-9852 ● **Email:** MBDelesalle@nexuscoastal.com

PROFESSIONAL SUMMARY

Maria Delesalle is a resource management consultant with a focus on fisheries management and stakeholder engagement. Ms. Delesalle is accustomed to operating in a team environment, being efficient and well organized, with the experience of working with industry, government, academia and a number of Indigenous communities. Ms. Delesalle has experience in leadership and supervisor positions, delegating and executing tasks, public speaking and workshop facilitation. She has garnered an understanding, through education and work experience, of how deeply environmental, economic and social needs are intertwined and what is required to have them work to each other's benefit.

EDUCATION

- Dalhousie University, 2011 (Master of Marine Management)
- University of Northern British Columbia. 2009 (Bachelor of First Nation Studies and Human Geography).

ADDITIONAL TRAINING

- ArcGIS 10.1
- Media Training
- Piktochart Infographics
- Photography

SAMPLE OF RELEVANT PROJECTS

- Socio-economic Profile of the Eastern Shore, NS (Fisheries and Oceans Canada)
- Indigenous Engagement Plan for Environmental Effects Determination Update 2018, Maritime Forces Atlantic Routine Exercises in the Arctic
- Technical Support to Facilitate Long-Term Enhancements of Livelihoods and Human Well-being for Eastern Caribbean Flyingfish Fisheries (CRFM)
- Technical Support to Enhance Data and Information Management for Decision Support to the Eastern Caribbean Flyingfish Fishery (CRFM)
- Fisheries Act Legislation Review and Advisory Support (Government of Nunavut)
- Technical Support on Implementation of Management/Stress Reduction Measures in the Eastern Caribbean Flyingfish Fishery (CRFM)
- Socio-economic Market Analysis and Environmental Scan of the Sealing Sector in Nunavut (Government of Nunavut)
- Socio-economic Profile of the Eastern Shore, NS (Fisheries and Oceans Canada)
- Fisheries Management Plan (Sipekne'katik First Nation)
- Indigenous Fisheries Management and Governance Model (Listuguj First Nation)
- Stakeholder Engagement and Facilitation for a Tidal In-Stream Energy Conversion (TISEC) Project (FORCE)
- Atlantic Salmon and Arctic Char Traditional Knowledge Report & Peer Reviewed Journal Article (Torngat Wildlife, Plant & Fisheries Secretariat)
- Lobster Catchability Study (FORCE)
- Citizen Engagement and Consultation Course Development and Delivery (Dalhousie University – School of Planning)

- French Version Interactive Data Visualization Tool of Shipping in Canada (Clear Seas)
- Stakeholder Mapping and Conceptualization of Capelin Workshop (WWF- Canada)
- Sambro Ledges EBSA Stakeholder Identification and Facilitation (WWF- Canada)
- Finding Alternative Bait for Canada's Lobster Fisheries (WWF- Canada)
- Interactive Data Visualization Tool of Shipping in Canada (Clear Seas)
- Formation of Inuit Qaujimajatuqangit (IQ) Committees
- Labrador Marine Atlas Strategy (Torngat Wildlife, Plant & Fisheries Secretariat)
- Community Engagement Activity Assessments, Natural Resources Canada (NRCan)
- Inuit Qaujimajatuqangit (IQ) Study for Qikiqtani Region, Multi Klient Invest (MKI), Nunavut
- Atlantic Climate Adaptation Solutions Association (ACASA) Coastal Adaptation Guidance
- Food Social and Ceremonial Fisheries Management Plan, Glooscap First Nation
- Stakeholder Engagement for C-NLOPB Regulatory Review- Southeast Grand Banks, Multi-Klient Invest
- Stakeholder Engagement for C-NLOPB Regulatory Review- Labrador Sea, Multi-Klient Invest
- Stakeholder Engagement for C-NSOPB Regulatory Review, Tangier 3D Seismic Survey, BP, Nova Scotia
- Mi'kmaq Ecological Knowledge Studies for Four Wind Turbines in Nova Scotia, Strum Environmental
- Mapping Inuit Knowledge of Narwhal, Grise Fiord, Nunavut, World Wildlife Fund
- Facilitated Community Engagement Sessions, 2D Seismic Survey, RPS Energy, Nunavut
- Community Engagement Strategy for NEB Regulatory Review, 2D Seismic Survey, RPS Energy, Nunavut