SCIENCE REVIEW OF ADDITIONAL DOCUMENTS SUBMITTED JUNE 18–AUGUST 29, 2019 FOR THE FINAL ENVIRONMENTAL IMPACT STATEMENT ADDENDUM FOR THE BAFFINLAND MARY RIVER PROJECT PHASE 2

1.0 Context

The Baffinland (BIM) Mary River Project is an operating open pit iron ore mine located on North Baffin Island in Nunavut. The mine site is connected to Milne Inlet Port via the Milne Inlet Tote Road and ore is transported to Europe via the Northern Shipping Route through Eclipse Sound, Pond Inlet, and Baffin Bay. The Southern Transportation Corridor via Steensby Port has not been constructed to date (see Baffinland 2018, DFO 2019a).

Given the financial costs and risks associated with full implementation of the Project at that time, BIM decided to take a phased approach, beginning with a smaller, less-costly option called the Early Revenue Phase (ERP) which involved shipping 4 million tons per annum (Mtpa) of ore from Milne Port. Since then, BIM has requested two Project amendments to increase the volume of ore shipments from Milne Port via the northern shipping route, including most recently the Phase 2 Addendum submitted to the Nunavut Impact Review Board (NIRB), which describes the activities associated with the second phase of the Project (an increase to a total of 12 Mtpa road/rail haulage and marine shipping through Milne Port) and provides an updated effects assessment.

Throughout the technical review stage, Fisheries and Oceans Canada's (DFO) Fish and Fish Habitat Protection Program (FFHPP; formerly Fisheries Protection Program) requested that DFO Science review and provide advice on the additional materials submitted by BIM to support BIM's conclusions in the Phase 2 Addendum to the Final Environmental Impact Statement (FEIS). The results of these reviews were presented to the NIRB during the first (April 2019) and second (June 2019) technical review meetings (DFO 2019a,b).

The objective of the current review is to assess whether the new supporting and supplementary materials (provided between June 18 and August 29) for the Phase 2 FEIS Addendum provides sufficient evidence to support BIM's conclusions regarding potential ecosystem impacts of the expanded Mary River Project on marine aquatic species and habitats (particularly as it relates to marine mammals and shipping). More specifically, the objectives are to:

1. assess the quality and adequacy of information presented, and determine if any relevant information is missing and if there are gaps in the analyses;
2. determine if appropriate methods were used to develop BIM's conclusions, and if the information presented supports those conclusions;
3. determine the appropriateness and adequacy of the proposed mitigation and monitoring measures;
4. if necessary, recommend additional or alternative mitigation and monitoring measures to reduce or avoid impacts to fish and fish habitat, including marine mammals, and;

5. if necessary, recommend additional information, studies, data collection, etc. that is required for DFO to complete its assessment.

This Science Response Report results from the Science Response Process held September 13, 2019 on the Science Review of Additional Supporting and Supplementary Materials Submitted June 18–August 29, 2019 for the Final Environmental Impact Statement (FEIS) Addendum for the Baffinland Mary River Project Phase 2. Advice from this Science Response Report will be considered by FFHPP in the development of their final written submission to the NIRB.

2.0 Background

On October 5, 2018, BIM submitted an FEIS Addendum for Phase 2 of the project to the NIRB which includes an upgrade to port facilities in Milne Inlet (including a second ore dock to accommodate larger cape size vessels with deadweight tonnage (DWT) of 130,000–250,000 tonnes), construction of a North Railway and increased shipping activities through Milne Inlet to accommodate the planned production increase up to 12 Mtpa. This increase also requires icebreaking in the spring and fall to extend the existing shipping season. On October 12, 2018, BIM received its positive conformity decision from the NIRB initiating the NIRB's technical review process. DFO Science was asked by the DFO FFHPP to review and provide science advice and subject matter expertise on the Phase 2 Addendum (DFO 2019a).

An estimated 176 ore carrier round trips (upper end of range) will occur per season. Shipping will occur seasonally within a window of approximately 135 days between July 1 and November 15, with each chartered vessel making one to three round trips per season. Escort vessels will also be operating during icebreaking activities, specifically in the shoulder seasons.

Between April 8–10, 2019, the NIRB held the first Technical Review meeting with interveners to highlight concerns and information gaps contained within the FEIS impact assessment and/or resolve identified technical issues where the methodology, analysis, or conclusions presented by BIM were not supported by reviewers. The outcome of the Technical Review meeting was a series of commitments from BIM to provide additional supporting materials to address and resolve outstanding issues. As part of the technical review stage, DFO FFHPP requested that DFO Science review and provide advice on the FEIS Phase 2 Addendum and the additional supporting and supplementary materials submitted to DFO Science between May 13 and June 17, 2019 (DFO 2019b).

Between June 18–19, 2019, the NIRB held the second Technical Review meeting with interveners to highlight concerns and information gaps within the FEIS impact assessment, additional supporting documents, and/or resolve identified technical issues with the methodology, analysis, or conclusions presented by the Proponent which are not supported by the reviewers. The second Technical Review meeting resulted in BIM committing to providing new additional supporting materials as well as outstanding documents from the first technical meeting to address outstanding issues.

As part of the technical review stage, DFO FFHPP has requested that DFO Science review and provide advice on the FEIS Phase 2 Addendum additional supporting materials submitted to DFO Science between June 18 to August 29, 2019. FFHPP requested that DFO Science review the assessment of impacts to marine mammals and the marine environment in relation to shipping. The results of this review will be provided to FFHPP for consideration in the DFO Departmental final written submission of comments to the NIRB and discussed at the Public Hearings to be held in November 2019.

3.0 Analysis and Response

The comments presented in this Science Response are related to the supporting and supplementary materials listed in Table 1. They were submitted by BIM to the NIRB between June 18 and August 29, 2019. This Science Response is part of a series of reviews conducted by DFO Science for the Mary River Project environmental assessment and should be considered, as some of the comments here are related to past concerns or information deficiencies (DFO 2019a,b).

Table 1. List of additional supporting and supplementary documents reviewed by DFO Science.

Supporting and Supplementary Document	Science Response Section(s)
Marine Monitoring Plan June 10, 2019	3.1, 3.4, 3.6
Technical Memorandum (Reference No. 1663724-135-TM-Rev0) to DFO: Daily ship exposure periods for Narwhal during shoulder and open water season relevant to the 135, 120 and 11 decibel noise fields	3.5, 3.6
Memo to QIA: Responses to Request for North Water Polynya Mapping	No Comments
Technical Memorandum (Reference #1663724-135-TM-Rev0) TM2 – DFO: Rationale for Identifying “Icebreaking Effects on Sea Ice Habitat for Arctic Cod Species” as a Level 1 Interaction in the Icebreaking Effects Assessment	3.1
Impact of icebreaking activities within the approaches to the Milne Inlet Port Site (Northern Shipping Route to Milne Port)	No Comments
Memo Response to Transport Canada Comments/Requests to Proponent – June 2019 (NIRB File No. 08MN053)	3.1
Memo to WWF: Draft Shipping and Marine Wildlife Management Plan	No Comments
Memo to WWF: Ice Breaking	No Comments
Mary River Project: Environmental Review of Shipping through the Northwest Passage (NWP) Final Report	3.2, 3.3
Draft Adaptive Management Plan	3.1
Draft Baffinland Early Shipping Season – Operational Guide (Icebreaking Management Protocol)	3.4, 3.6
Draft Communications Protocol for Shipping Activities	No Comments
Draft Spill at Sea Response Plan	3.2
Memorandum – Mary River Project – Phase 2 Proposal - Revised Addendum to Technical Supporting Document 27 - Cumulative Effects Assessment	3.6
Memo: JASCO Responses to Technical Comments (Subject: Baffinland Phase 2 Acoustic Modelling: Responses to Technical Comments) and Animation	3.5, 3.6

There were gaps in the information provided and inconsistencies in the material presented in the Addendum. It was consequently difficult to fully assess some of BIM's analyses and therefore, their conclusions in many cases. Many of the comments and recommendations contained in past DFO Science reviews for the Mary River Project remain, or have become more relevant due to the significant increase in vessel traffic and the addition of an icebreaking component (DFO 2014a, DFO 2019a,b).

Additionally, review comments concerning the construction of the ore dock at Steensby Inlet and the use of a year-round Southern Shipping Route remain a concern for DFO Science. Development of baseline monitoring is still relevant and should be considered prior to any future construction (DFO 2012a,b).

3.1 Marine Monitoring

For a monitoring program to be successful, a number of criteria are essential (e.g., DFO 2015a). For example, the ability for a program to distinguish between anthropogenic and environmental factors, which is essential for any impact assessment, requires the development of standardized, long-term and specific established protocols, regular assessments, and the ability to be dynamic rather than static (hypotheses should be revisited regularly to incorporate new findings). Equally important are the criteria for the selection of indicators. Specifically, indicators should be sensitive (respond to the driver[s]), reflective of processes/changes in the area, reflective of anthropogenic drivers or stressors within a relevant timeframe, based on appreciable baseline/historic data, relevant to the monitoring objectives, based on scientific information but not explicit output of scientific research, easily developed and delivered in the field (ideally) and easily detected (DFO 2015a).

BIM's position

"*This Marine Monitoring Plan (MMP, the Plan) describes monitoring actions that Baffinland uses so the Mary River Project (Project) does not unduly prejudice (as defined in the Nunavut Agreement, Section 12.5.5) the integrity of the marine environment and marine wildlife in the Project area. The MMP is a "living" document and will be revised regularly as new information becomes available, methods are further developed, refined or replaced, and/or to account for adaptive management measures. Further details will continually be developed following discussions with the Qikiqtani Inuit Association (QIA), community Hunters and Trappers Organizations (HTOs), the Marine Environment Working Group (MEWG) and other involved parties*" (Marine Monitoring Plan, p. 8).

Within the MMP, BIM describes the relationship to other management plans "*that provide additional guidance with respect to mitigation and monitoring of the marine environment and marine wildlife*" (Marine Monitoring Plan, Section 1.5, p.16). "*The Shipping and Marine Wildlife Management Plan (SMWMP) (Baffinland 2019) is a companion document to the MMP which outlines "mitigation measures and provides guidance to protect and limit disturbances to marine water and sediment quality, marine vegetation, benthic communities, fish and fish habitat, and marine mammals from Project activities*" (Marine Monitoring Plan, p. 24).

Furthermore, BIM states that "*It is important that the individual programs are regarded holistically instead of independently. The results of one program alone may not provide a complete view of potentially emerging trends or impacts (or lack thereof) nor that they stem from Project-related causes*" (Marine Monitoring Plan, p. 24).

DFO Science's analysis and assessment

DFO Science is concerned that there is no comprehensive monitoring framework for the Project (e.g., Milne Inlet, Steensby Inlet). A document is needed that describes the overall monitoring (baseline, surveillance, monitoring) strategies and projects that form a cohesive and comprehensive report to describe/update the status of the environment and/or clearly identify impacts from the Project and/or inform on potential causes. These are necessary elements in order to make informed decisions on management/mitigation measures to offset any impacts or to adapt monitoring protocols. For example, a list provided in the Marine Monitoring Plan does not mention three of the key monitoring programs for the project – the Ship-Board Observer Program, the Bruce-Head Monitoring Program, and Narwhal Tagging Program. Although these are mentioned elsewhere in the document there should be a clear reference to the scope of monitoring and management plans and an overview of how they relate to each other.

DFO Science is also concerned about the use of surveillance-level programs (as defined by BIM) that collect data on Focal Ecosystem Components (FECs) or indicators, but do not connect ancillary data that will be required to determine if changes to those FECs or indicators are in response to BIM activities or natural factors. All monitoring programs should be collecting sufficient data to facilitate interpretation of change(s) in FECs and indicators. Surveillance-level programs would unnecessarily delay adaptive management responses by several years.

Additionally, the Marine Monitoring Plan reiterates that this is a living document, however the *Draft Adaptive Management Plan* does not clearly explain how something is updated, revised or actioned in the event of new information or a threshold being met. The *Draft Adaptive Management Plan* includes statements such as "No [threshold]" or "[threshold] Needs Work", however prior to any shipping volume increase associated with Phase 2 all the marine-related management plans should be completed so that these factors are in place prior to increased shipping.

Furthermore, DFO Science is concerned with the lack of monitoring reports, which were required as a condition of the ERP project approval, provided with the Phase 2 FEIS submissions . This has resulted in a lack of incorporation of previous monitoring results into the impact analyses for Phase 2 as well as a lack of confidence in the design and implementation of such monitoring plans. For example, Appendix C – Marine Mammals – Monitoring Methodology (Marine Monitoring Plan) indicates that a third-party review of the 2015 Marine Mammal Aerial Survey Program "identified deficiencies in survey design, statistical design, field data collection and data analysis that could lead to substantial errors in describing the abundance and distribution of narwhals" (Marine Monitoring Plan, p. 126). Similar deficiencies were identified in a DFO Science review (Matthews et al. 2019).

Recommendations

- DFO Science recommends the development of a single comprehensive monitoring plan in one document with supporting protocols document(s) for each of the monitoring initiatives (e.g., field protocols for marine fish sampling). This should then be further developed to explain which monitoring programs are linked to each of the management and mitigation measures. Development of a single comprehensive monitoring plan would create linkages among the currently separate monitoring programs that are already collecting data across abiotic and biotic environmental constituents.
- DFO Science recommends all ongoing monitoring plans include the collection of sufficient data (e.g., baseline) on indicator species and species groups and environmental conditions

(biotic and abiotic) in both affected and control/reference sites to facilitate timely assessment of drivers of observed changes and subsequent adaptive management, if warranted.

- Given the lack of monitoring results (which were required as a condition of approval for the ERP), DFO Science recommends that further development of a comprehensive monitoring plan (as identified in the comment above) be required to be submitted by the Proponent and reviewed by the agencies (in addition and separately than the Marine Environment Working Group [MEWG]) prior to any Phase 2 project approvals. This will allow DFO Science to properly understand and assess how marine monitoring program design (including protocols) will be able to identify impacts from the Project and/or measure the effectiveness of mitigation measures to inform adaptive management.
- DFO Science recommends that BIM include the updated Terms of Reference for the Marine Environment Working Group in Appendix A to ensure the roles and responsibilities of that group match with how it is described in the Marine Monitoring Plan.

BIM's position

In general, throughout the *Marine Monitoring Plan* document differing timelines are communicated for the frequency of sampling for the each program – "*Not all programs will need to be conducted on an annual basis throughout the life of the Project"* (Marine Monitoring Plan, p. 24).

DFO Science's analysis and assessment

Based on the information provided in the document, it would be useful in the appendix to have a rough schedule/plan of the frequency of measurement for each program (e.g., which ones are annual, which ones are on a 5-year schedule, etc.). Part of the evaluation of the usefulness of the monitoring program is to review the proposed thresholds and early-warning indicators based on the frequency with which they will be monitored.

Recommendation

- The Marine Monitoring Plan should include a table with frequency of measurements for all programs (e.g., annual, bi-annual) together with rationale for the decided scheduling. DFO Science requires this information in order to conduct a proper assessment.

BIM's position

In the monitoring framework, BIM's process for response to an identified effect includes a feedback loop to evaluate each program and achieve continuous improvement in EEM design and implementation (Marine Monitoring Plan, Figure 3-1, p. 27).

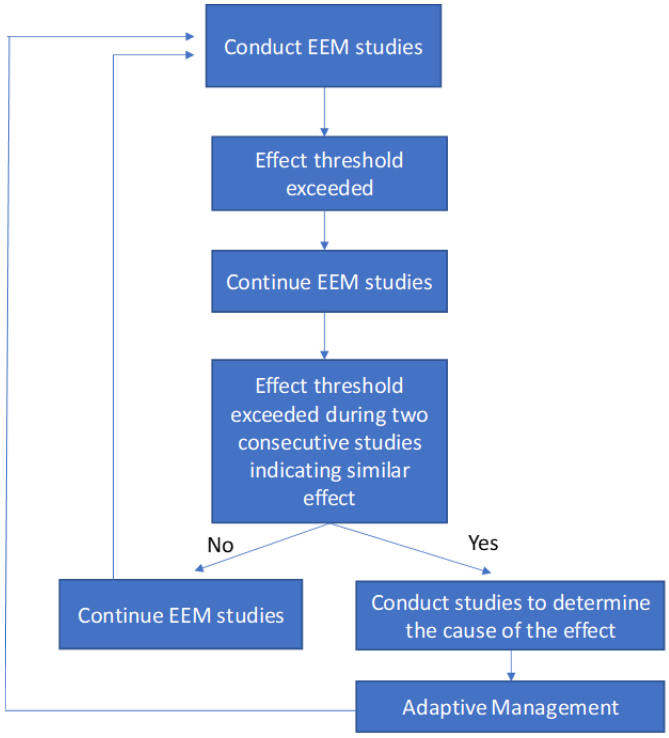

Figure 1. Baffinland Iron Mines Corporation's (BIM) follow-up procedure during early warning indicator/threshold exceedance (from Baffinland Marine Monitoring Plan, Figure 3-1, p. 27).

DFO Science's analysis and assessment

The current procedure for early warning indicator/threshold exceedance allows two consecutive years to pass prior to initiating any studies to determine the cause of the effect (same procedure for surveillance-level monitoring). For any early warning indicator there is a requirement to also consider, in parallel, monitoring the cause (or suspected cause) of the effect. These include some basic parameters that should be monitored in association with the early warning indicator. This would provide information to inform the adaptive management step in BIMs process depending on the effect/indicator/measurable parameter assessed, this framework might not be effective. Some studies take several years to establish a threshold or detect change while others should initiate adaptive management immediately. BIM's monitoring framework is currently missing a number of elements, including power analysis and the ability to adapt sampling method/analysis. The framework should be adapted to address all elements that are found in a fundamental approach to impact monitoring design (e.g., Figure 2).

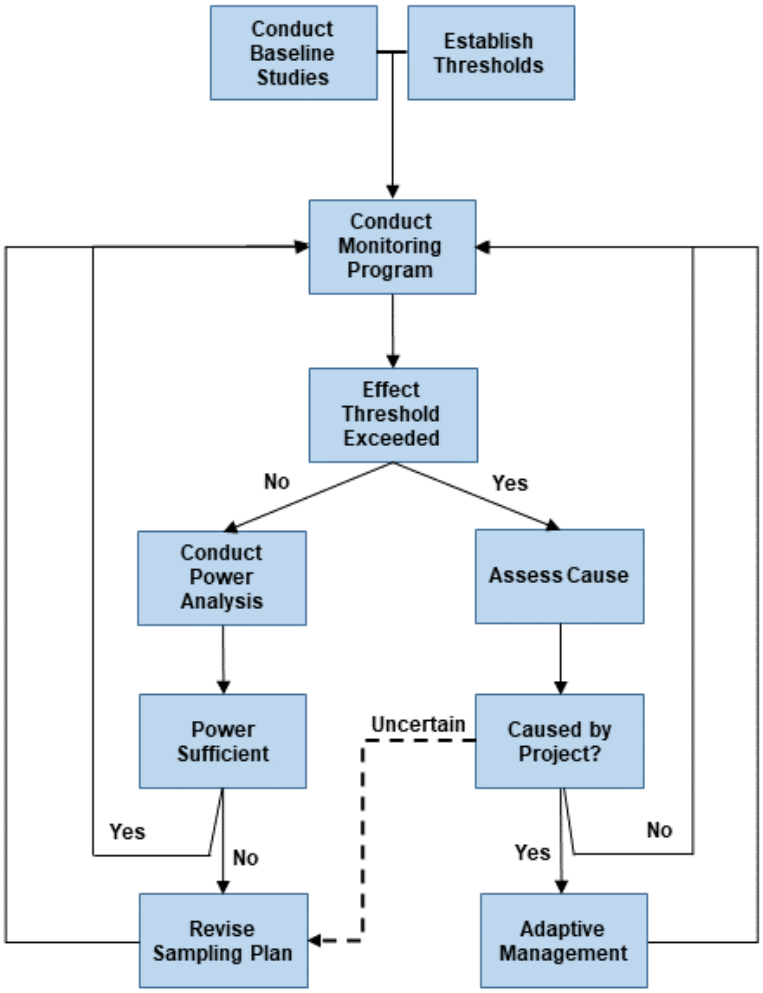

Figure 2. Schematic of a fundamental approach to impact monitoring design.

Recommendation

- The framework (i.e., Figure 1; BIMs procedure when indicator thresholds are exceeded) should consider all types of baseline collections at different stages of the Project (e.g., new baseline collection, pre- and post-construction) and use this data to establish the thresholds (Figure 2). The use of baseline data is needed for the development and revision of thresholds. This information will also inform the development of a monitoring plan/design.
- DFO Science recommends that if studies are conducted on an annual basis, the studies to assess the cause of the effect should start as soon as the effect threshold is exceeded as it may require several years to conduct a study to determine the cause of an effect that would lead to adaptive management. Additionally, for those indicators/thresholds where cause and effect are known, the parameters associated with the effect should be monitored immediately (i.e., measurable parameters) not after an exceedance. The monitoring decision tree should be continuous on different timeframes for assessment (Figure 2). The review of a monitoring program (i.e., decision to revise sampling plan) should not only be

initiated with the exceedance of a threshold, but also reviewed to ensure the monitoring plan is designed to detect change when cause and effect parameters are not well known.

- DFO Science recommends that adaptive management should be adopted as soon as an effect threshold is exceeded (i.e., at the same time a study to determine cause of the effect is initiated). If possible, adaptive management actions should be made based on expert opinion until the cause of the effect can be empirically determined through scientific studies.
- DFO Science recommends a revised figure (i.e., Figure 2) that highlights the necessary revisions.

3.1.1 Marine Water Quality Monitoring and Environmental Parameters

BIM's position

BIM presents monitoring details in Tables 4-1 to 4-6 in the *Marine Monitoring Plan* document.

DFO Science's analysis and assessment

With respect to the design of marine water quality monitoring stations, expected impacts from the release of large volumes of ballast water could have an effect on water quality parameters in the local study area (i.e., beyond marine water quality surveillance stations) that are described in the *Marine Monitoring Plan*. Monitoring beyond the current water quality stations with a randomized stratified approach (i.e., depth and habitats) would be more appropriate to determine the impacts of ballast water on the marine habitat. This was first suggested in the DFO Science (2019b) report that reviewed the Marine Environmental Effects Monitoring Program (MEEMP). Information on parameters such as, salinity, temperature, total dissolved solids (TDS), dissolved oxygen, pH, and chlorophyll-a are relevant to determine cause of impact on a variety of species that use the Local Study Area (LSA).

Additionally, the collection of these parameters will be necessary to update the ballast water dispersion model, this also includes documenting the exact location of ballast release (i.e., when underway but not at the Milne Port). Currently ballast water dispersion modelling is based on the assumption that all ballast water being released is at the most southern point of Milne Inlet. However, the only stipulation known to DFO is that vessels are required to release their ballast in Milne Inlet – not specified as Milne Port.

Recommendation

- DFO Science recommends that BIM update the Marine Monitoring Plan to include water quality/environmental parameters to their monitoring programs as specified above.
- DFO Science also recommends the use of a randomized sample design for water quality/environmental monitoring.
- In order for BIM to accurately predict the zone of impact from ballast water release (Ballast Water Dispersion Model), DFO Science recommends that BIM require all project related vessels report their release coordinates in the ballast reporting forms when it is outside the port/dock area.

BIM's position

In the *Marine Monitoring Plan*, BIM states that "*The objective for marine water quality is to evaluate marine water quality in the LSA/RSA relative to existing CCME water quality guidelines for the protection of aquatic life, whereas for other monitoring measures the objective it to*

evaluate and quantify potential Project-related changes to water quality relative to existing baseline condition" (Marine Monitoring Plan, Appendix B-1, p. 79).

DFO Science's analysis and assessment

DFO Science questions what the justification is for the differences in the objective? It is unclear why the thresholds for water quality (or early warning triggers) are one-half the CCME targets, whereas in the case of benthic species and other monitoring measures the threshold is a change in the indicator; usually 2 standard deviations relative to the baseline.

The CCME water quality thresholds distinguish between impaired/polluted conditions where negative effects on aquatic life are expected above the thresholds. To evaluate changes in water quality as a result of the project, it would perhaps be more appropriate to compare with baseline water quality data and establish ecological/environmental change thresholds or a range for which change is acceptable in water quality variables (i.e., considered to be within the range of natural variability), rather than compare with a CCME thresholds. In many instances, the baseline conditions in Milne Inlet are orders of magnitude lower than CCME thresholds, so there could be large changes in water quality (with potentially cascading effects on productivity/species) before the early warning indicators would be exceeded. For example, nitrate concentrations currently range from 0.04 to 0.58 mg/L (Marine Monitoring Plan, p. 79), and the proposed early warning indicator is 100–750 mg/L. With such a high threshold from the range of natural variability there could be a massive increase in nitrogen, a limiting nutrient for productivity, before any response to this change in water quality would be addressed.

Project condition #87 states that "*This program needs to be able to detect changes that may have biological consequences and should be initiated several years prior to any ballast water discharge into Steensby Inlet and Milne Inlet to collect sufficient baseline data and should continue over the life of the Project*" (Marine Monitoring Plan, p. 12), Some of the changes in water quality variables will have biological consequences and will occur well before they would cross the proposed early warning thresholds.

DFO Science also questions if BIM has considered integrating the water quality information into the CCME Water Quality Index (WQI; with appropriate thresholds) rather than reporting individual variables. Thresholds for the WQI would need to be established and trends through time in the index would need to be monitored. This may provide an option to summarize or combine the data (including exceedances in individual parameters) to evaluate the cumulative/combined effects of all water quality variables.

Recommendation

- DFO Science recommends that BIM explore the tools (including WQI) available from the CCME to evaluate water quality parameters. This could also apply to marine sediments monitoring as well.
- DFO Science recommends that BIM develop thresholds for exceedance based on the range in baseline conditions (i.e., range of natural variability).

BIM's position

For water quality parameters in the *Marine Monitoring Plan*, BIM states that "*Total aluminum and iron concentrations in samples collected in 2018 ranged from 0.008 mg/L to 0.048 mg/L and from <0.01 mg/L to 0.093 mg/L, respectively (Golder 2019). There are no CCME WQGs for aluminum and iron*" (Marine Monitoring Plan, p. 80).

DFO Science's analysis and assessment

Although there are no CCME WQ guidelines for iron, it would be important to continue to monitor iron concentrations in the water given the importance/impact of iron on marine primary productivity, in particular for blooms of harmful algal taxa in high Arctic regions such as *Pseudo-nitzschia* spp., for example, which has been linked to high iron concentrations in sea ice melt water (Joli et al. 2018) and concerns over deposition of iron dust in marine environment.

Recommendation

- DFO Science recommends that BIM continue to monitor iron in the marine environment and develop an early warning indicator with subject matter experts. The threshold should consider the current range of baseline conditions for both variables.

3.1.2 Marine Invertebrates and Fishes

BIM's position

In the *Technical Memorandum (Reference #1663724-135-TM-Rev0)* prepared for DFO entitled *TM2 – DFO*: *Rationale for Identifying "Icebraking Effects on Sea Ice Habitat for Arctic Cod Species" as a Level 1 Interaction in the Icebreaker Effects Assessment* (i.e., Rationale for the Exclusion of Marine Fish), BIM states that "*The predicted change in sea ice habitat is considered temporary in nature, short-term (exclusive to the initial period of ice break-up) and below the spatial threshold value of 1% for determination of magnitude (Table 1). Given the limited spatial and temporal extent of this effect, in addition to the fact that cod species in the RSA are not primarily ice-associated species (Mueter et al. 2016) and therefore have alternative habitat areas during this limited time period, icebreaking during the shoulder seasons is predicted to results in negligible effects on these species, and this pathway was therefore not considered further in the residual effects assessment (i.e., it was not deemed necessary to conduct a comprehensive risk assessment of icebreaking on cod during the shoulder season)*" (Technical Memorandum [Reference #1663724-135-TM-Rev0] to DFO: Rationale for Identifying "Icebraking Effects on Sea Ice Habitat for Arctic Cod Species" as a Level 1 Interaction in the Icebreaker Effects Assessment, p. 4).

DFO Science's analysis and assessment

BIM has provided a good background and overview of the ecology of various gadids that could be present at the Mary River Mine port site(s) or along the Northern Shipping Route. Arctic Cod (*Boreogadus saida*) is the gadid most likely to be impacted by BIM activities. DFO Science agrees that the loss of habitat directly from icebreaking is unlikely to occur at a scale that is concerning with respect to population health. Arctic Cod are present in all adjacent habitats and mortalities within the project area are expected to be offset through local recruitment and immigration from adjacent areas. However, DFO Science remains mindful that Arctic Cod start spawning in late fall and icebreaking near the end of the shipping season could coincide with and disrupt Arctic Cod spawning. The degree of impact that late season icebreaking could have on Arctic Cod spawning is uncertain as no data are available regarding the distribution of spawning Arctic Cod in Eclipse Sound, Pond Inlet, or adjacent waters. It is unlikely that BIM has the data required to assess the potential impacts of late season icebreaking on Arctic Cod spawning, however efforts by BIM to collect the required data to support a future analysis would be prudent.

Recommendations

- DFO Science recommends that as part of its baseline data collection program, BIM collect data on the distribution and abundance patterns of Arctic Cod throughout the RSA, particularly in relation to the shipping route and leading up and including late season icebreaking. This baseline data collection and monitoring program could include a hyrdoacoustic survey with regular groundtruthing of acoustic data. This data would be useful to identify a shift in ecosystem structure or function.

BIM's position

BIM states in that the *Marine Monitoring Plan* that "*Project-induced changes to marine fish could result from the following potential Project-related effect pathways:*

- *Treated effluent and site drainage discharges at Milne Port (downstream of camp and maintenance shops, fuel depots and tank farms, wastewater treatment facility and ore stockpiles);*
- *Ore dust dispersion and deposition from stockpiles and during ore loading at the ore dock;*
- *Aquatic Invasive Species (AIS) introductions*" (Marine Monitoring Plan, Section 4.4, p. 35-36).

DFO Science's analysis and assessment

DFO Science notes that BIM has not included ballast water discharge in the possible Project-related effect pathways for marine fishes. Changes in water temperature and salinity from ballast water discharge will represent changes in habitat conditions for marine fishes, invertebrates, and other biota (DFO 2019b).

Recommendations

- DFO Science recommends BIM include ballast water discharge, in particular temperature and salinity changes from the discharge, in the list of potential pathways of impact on marine fishes, fish habitat, and invertebrates for completeness.

BIM's position

BIM provides a brief description on the use and rationalization of only sculpin and Arctic Char as bio-indicator fish species in the *Marine Monitoring Plan* (p. 36).

DFO Science's analysis and assessment

DFO Science questions BIM's decision to categorize sculpin as surveillance rather than a baseline research program. Surveillance implies that we know a lot about something already and that the monitoring is targeted to monitor a specific impact. This is not the case for sculpins in this location.

DFO Science also still questions the choice of only using sculpin as a bio-indicator species and the exclusion of Arctic Cod (see comment above regarding data collection and monitoring of Arctic Cod) (DFO 2019a,b). Arctic Cod are a keystone species that influence Arctic ecosystem structure and function (e.g., DFO 2019c) and impacts may have cascading effects.

DFO Science recommends BIM consider biodiversity (e.g., species presence/absence, assemblage structure) as an indicator. This would be a particularly important indicator for benthic communities which tend to be more stationary.

Recommendations

- DFO Science recommends the monitoring of Arctic Cod in addition to sculpin and Arctic Char. Arctic Cod can be collected using similar methods as sculpin or using small trawls; the distribution of Arctic Cod over large areas can be monitored using hydroacoustics with regular groundtruthing.
- DFO Science recommends that monitoring effort should be targeted rather than opportunistic. Without a well-designed and consistent sampling effort, the ability to report monitoring results and identify potential project impacts is compromised.

BIM's position

BIM states that "*Sculpins, as resident species, were targeted in the mark-recapture study... Throughout the 2014-2016 MEEMP surveys, none of the marked sculpin were recaptured (SEM 2017a) and it was not possible to estimate a population size for the species. Therefore, sculpins were deemed unsuitable as target species to be sacrificed for EEM Program tissue sampling; instead, accidental Arctic char mortalities were used for body burden analysis"* (Marine Monitoring Plan, p. 99).

DFO Science's analysis and assessment

DFO Science recognizes that although sculpin can move considerable distances, Arctic Char do as well, and migrate between marine and freshwater systems every year. Given both species can migrate, it is unclear why Arctic Char are then chosen for the EEM tissue sampling program and not sculpin. DFO Science questions the rational for why a population size assessment of sculpin is required to justify monitoring this species for contaminants and metal effluent in the marine environment. DFO Science also questions the use of Arctic Char since they mainly use freshwater environments throughout the year.

In addition to these questions, DFO Science re-iterates that low recapture rates do not indicate a small population size. This typically indicates poor tag retention, tagging-induced mortality, emigration, or a large population size. The low capture rates are likely related to the capture methods (i.e., fishing gear/protocols, effort).

Recommendations

- DFO Science recommends that BIM include sculpins in the EEM Program tissue sampling.
- DFO Science recommends that BIM revise their sampling plan for the mark-recapture study to improve recapture rates. For example, a small trawl is a good option to get better coverage. DFO Science has had success with this method.

BIM's position

BIM states that "*The objective of the marine fish monitoring program is to evaluate and quantify potential Project-related changes to marine fish and fish health relative to existing baseline conditions and established guidelines*" (Marine Monitoring Plan, Section B-5, p. 97).

DFO Science's analysis and assessment

Ivanova et al. (2018) shows that sculpin movement types and home ranges change significantly in the presence of ships, and since the proposed sampling area is within a prominent shipping corridor, influences of these impacts on the data collected for sculpin is possible.

Recommendations

- DFO Science recommends BIM add a discussion on how the home range and movements of the ideal fish indicator species (i.e., sculpin) could change with presence and movements of shipping vessel (see Ivanova et al. 2018). If BIM has not conducted a study to determine this, one suggestion is to develop a movement study comparing shipping and non-shipping areas with similar habitat types.

BIM's position

BIM presents Tables B-2 to B-5 and states in the *Marine Monitoring Plan* that "*Concentrations of most metals in* H. arctica *tissues were higher compared to levels in Arctic Char tissue sample, aside from mercury which was lower in H. arctica. Mercury concentrations in all* H. arctica *tissue samples were below the Health Canada guideline for human consumption*" (Marine Monitoring Plan, p. 100).

DFO Science's analysis and assessment

Metal and mercury concentrations should be provided for *H. arctica* which can then be compared to filter feeders from other regional studies examining metal pollution (e.g., Sondergaard et al. 2019). Low levels of mercury for a filter-feeder is not surprising given that mercury biomagnifies up the food web and *H. arctica* are near the bottom of the food web.

Additionally, 'control' sample sites for benthic fauna such as *H. arctica* in southern Milne Inlet should be established based on the extent of ballast impacts (e.g., multiple sites at distances greater than 10km from the iron ore loading site [identify based on results of ballast dispersion model]). The farthest site would serve as a site of no or minimal impact form the mine port. The sampling design would show the amount of metal pollution that are taken up by filter feeders which then propagates up the food web to higher trophic level consumers. This same sampling design should be performed for sediment and benthic fauna sampling as the farthest sampling distance from the mine currently is only 3.5 km and is typically within 1-2 km of the ore dock.

Recommendations

- DFO Science recommends that metal and mercury concentrations should be provided for *H. arctica* and compared to filter feeders from other regional studies.
- DFO Science also recommends that appropriate control sites are needed for benthic invertebrates. Justification for how an appropriate control site is identified for a species/species group would be required for an assessment.

BIM's position

BIM states that *"SEM (2014) reported that "the power analyses determined the sample size requirements to detect a change in benthic community were prohibitive (D. Schneider, Pers. Comm.), both in terms of sample collection effort and analytical costs" and, therefore, benthic infauna was excluded as a monitoring target for the MEEMP…Use of sampling equipment that is more adequate for the marine environment, such as Van Veen or Ponar grabs, may increase the statistical power of the analysis"* (Marine Monitoring Plan, p. 90).

DFO Science's analysis and assessment

Given this statement, DFO Science is concerned that BIM has not worked to develop a more adequate sampling design (including equipment). There is currently no power analysis to

determine the sample size required, and results would be difficult to interpret statistically. It is also unclear if thresholds are meaningful at this stage.

Recommendations

- DFO Science recommends that BIM revisit the sampling program for the benthic community so that an adequate sampling design is established for the indicator (DFO 2019b).

BIM's position

BIM states that "*In general, benthic epifauna data collected over the course of the 2014-2017 MEEMP surveys were insufficient for interpretation given the high variability within the benthic ecosystem, coupled with the spatial variability in survey locations from year to year, and detected differences could not be interpreted as indicators of a negative Project-related effect.*" BIM goes on to state that "*The proposed EWI threshold for epifloral and epifauna is an observed change that is greater than two standard deviations of baseline levels"* (Marine Monitoring Plan, p. 95).

DFO Science's analysis and assessment

Similar to benthic infauna, if the variability is too high for interpretation, DFO Science questions how will the proposed thresholds be meaningful (i.e., 2 standard deviations). Given the large variability of two standard deviations, this would be a very large change in communities. DFO Science also questions if any particular group(s) or taxa would be more sensitive to change (early warning indicator species) rather than the entire community.

With respect to the EWI threshold, two standard deviations is a standard metric for a statistically significant change under parametric statistical assumptions. However, consideration should also be given to the physiological threshold for contaminant levels. For example, the threshold for an expected physiological effect from a contaminant level may be greater or lower than the two standard deviations from the baseline level. Therefore, thresholds could also be established as a detected effect size that would indicate a meaningful physiological or body burden change instead of simply a statistically significant change.

Recommendations

- DFO Science recommends that revisions to the sampling design are necessary in order to statistically interpret data. Additionally, consideration of the physiological context needs to be incorporated in the establishment of thresholds.

3.1.3 Aquatic Invasive Species

BIM's position

BIM states that "*Although the potential introduction of aquatic invasive species (AIS) to the marine environment is unlikely*…" (Marine Monitoring Plan, p. 23).

DFO Science's analysis and assessment

Based on BIM's report - *Technical Supporting Document (TSD) 21 Risk Assessment for the Introduction of Aquatic Invasive Species from Ballast Water* (2018) this sentence is not accurate. TSD 21 states that "*there is a very high probability of introduction of AIS*" (Table 3.5, p.10), so how can the Marine Monitoring Plan state "unlikely".

Recommendations

- DFO Science recommends that BIM change the sentence in the Marine Monitoring Plan to reflect the risk assessment report (i.e., very high probability of introduction of AIS) and add the reference in the text to the Marine Monitoring Plan.

BIM's position

In the *Marine Monitoring Plan*, BIM states that "*AIS monitoring will occur during Project construction, operation, and closure. After initial monitoring results become available, Baffinland will discuss with the MEWG the appropriate frequency of continued monitoring*" (Marine Monitoring Plan, p. 38).

DFO Science's analysis and assessment

It is important that BIM conduct frequent monitoring regarding AIS throughout the life of the project if any early detection is going to occur. Further to this, BIM should also develop an early response plan with applicable regulators and local communities so that should an AIS be detected, significant environmental effects or major change to species composition could potentially be avoided if a plan is in place (DFO 2019b).

Recommendations

- DFO Science recommends that BIM develop an early response plan for AIS, similar to an oil spill response plan. The frequency of monitoring will need to be established prior to phase 2 and should be implemented through the environmental assessment rather than the MEWG.

BIM's position

BIM states that *"Underwater video monitoring will be used to characterize substrate type (Table B-3), benthic epifauna and macroflora species within 10 permanent belt transects installed on the sea floor"* and that "*Potential Project-related effects will be assessed by comparing numeric values for benthic community indicators (i.e., macroflora % cover and epifaunal density) in the exposure area (Milne Port) with baseline and reference area values, according to a BACI design"* (Marine Monitoring Plan, p. 96).

DFO Science's analysis and assessment

DFO Science would like to clarify that underwater video monitoring is not an appropriate tool for the identification of specimens to species level (e.g., epifauna, AIS). In many cases, a microscope is necessary to distinguish native species versus closely related non-native species. For species identification DFO Science suggests small scale trawling/sled or diving (quadrats) or a combination.

DFO Science also questions if this is a new monitoring program that is starting in 2019. Will this replace a previous indicator? It is not clear how this is related to thresholds and indicators presented earlier in section B-4.

If this new underwater video monitoring program starts in 2019 (or earlier), it will be important to determine if this will establish a new baseline of data collection to report on an indicator. There will be a need to identify how the past monitoring and baselines collections for this indicator will be merged with this new baseline. For example, earlier baseline data and general knowledge of species distributions can be used to assess if there are new species, but for the more

quantitative measure(s), especially data that is incorporated into the calculation of abundance or % cover an assessment of how the two data sets can be used for monitoring.

Recommendations

- DFO Science would like BIM to clarify if this is a new monitoring program and if so provide their plan to collect and amalgamate past data sets with the new dataset, if necessary.

3.1.4 Environmental Effects of Ballast Water and Vessel Biofouling

BIM's position

In the *Memo Response to Transport Canada Comments/Requests to Proponent – June 2019 (NIRB File No. 08MN053)*, Baffinland provides a response to the following question (p. 5):

"Q: Although Baffinland has elected to conduct ballast water sampling in one randomly selected ballast water tank on all foreign flag vessels arriving directly to Milne Port from international waters, Transport Canada recommends that, at a minimum, four tanks be sampled to ensure that the results of the testing are as representative as possible of the ballast water management situation on board.

A: Baffinland is not certain what the rationale is for testing four tanks versus a single randomly selected tank, or where else in Canada a port requires this. Baffinland believes the results of random sampling a single tank adequately demonstrate compliance with Canadian regulations".

BIM also stated in the past that *"As a matter of due diligence, Baffinland has elected to conduct ballast water sampling in one randomly selected ballast water tank on all foreign flag vessels arriving directly to Milne Port from international waters to confirm that effective exchange has occurred in accordance with the Regulations and the BMW Convention. Specifically, ballast water salinity will be measured prior to discharge to verify that it meets the D-1 threshold (at least 30 parts per thousand [ppt))"* (Ballast Water Management Plan, Section 3.2, p. 13).

DFO Science's analysis and assessment

The rationale to test multiple tanks lies in the variability observed across tanks, especially when tanks are loaded or exchanged at different time points or locations. DFO Science previously recommended minimum of 3 tanks and supports Transport Canada's recommendation of a minimum of 4 tanks.

Recommendations

- DFO Science agrees that BIM should require all ships to conduct self-monitoring of salinity in all ballast tanks following ballast water exchange, reporting salinity for every tank as part of their documentation (DFO 2019b). DFO Science further recommends that BIM ideally strive to verify self-reported salinity values for all ballast tanks on every arriving vessel. This has been routinely conducted since 2005 in the Great Lakes which receive 350–500 ships/year. Recognizing sampling conditions in the Arctic may be more challenging, DFO Science recommends that BIM should verify salinity values in a minimum of three ballast tanks for every vessel, prioritizing tanks with different management histories (ballast origin, or timing/location of ballast water exchange), where applicable (DFO 2019b).

BIM's position

In the *Memo Response to Transport Canada Comments/Requests to Proponent – June 2019 (NIRB File No. 08MN053)*, Baffinland provides a response to the following question (p. 5–6):

"Q: Further to the question posed to Baffinland by TC at the June 18 technical meeting, pending review and further discussions with parties, Transport Canada recommends that Baffinland consider the development of a standard operating procedure (SOP) for monitoring the success of ballast water (BW) management for vessels using any BW treatment. The SOP should also address the fact that vessels may start discharging BW while outside of Milne Inlet before any monitoring/sampling of the ballast water. Transport Canada also recommends that Baffinland provide information on the clear identification of a sampling port for each vessel that will be arriving in Milne Inlet, carrying BW and treating BW using a ballast water treatment system. In order to prevent any introduction of non-native species, Baffinland should have a plan in place to address the scenarios in case that non-native species are found by the monitoring program and in case that BW monitoring indicates that either D-1 or D-2 standards.

A: Baffinland will develop a sampling program to confirm effectiveness of ballast water mitigation measures once Phase 2 enters the operations phase. Baffinland will revise the plan accordingly before finalized for Phase 2".

Recommendations

- As shipping is already occurring, DFO Science recommends such sampling and response programs should be developed and put into effect immediately.

3.1.5 Marine Mammals

DFO manages marine mammals by stock, in order to avoid local depletions or extinctions (Richard 2010). Stocks represent a management unit based on natal philopatry to summering areas. Although they do not necessary reflect genetic segregation of a unique population, they represent the local population that is available for local subsistence. Several species of marine mammals have annual site fidelity to specific areas which might be culturally acquired (Turgeon et al 2012). As a result, marine mammals such as narwhals and belugas, might not recolonize abandoned areas. For example, the local beluga stock in Ungava Bay has been severely depleted by commercial whaling and the number of belugas in that stock remains very low (Reeves and Mitchell 1989, COSEWIC 2004, Gosselin et al. 2009). Therefore, the threshold for the assessment of the impact of the Mary River project on marine mammals should be set at the stock level, not the population level.

BIM's position

In the *Marine Monitoring Plan*, BIM presents Section 5: Marine Mammals (p.39–43) and Tables 5-3 to 5-5 which provides information on the monitoring plan for marine mammal and details measurable parameters for four project effects (habitat loss or alteration, acoustic impacts, ice entrapment from icebreaking operations, and potential ship strikes).

DFO Science's analysis and assessment

DFO Science is concerned that the thresholds proposed for the four effects in this section are not appropriate/useful and that BIM will not be able to detect project effects. Without an appropriate threshold, DFO Science questions how Figure 3-1 (Figure 1; Marine Monitoring Plan, p. 27) will be implemented and decisions on adaptive management be initiated. DFO Science is concerned that the monitoring programs are set on a yearly basis and that the timelines for the early warning indicators are too long.

In Sections 5.1, 5.2, and 5.3 of the *Marine Monitoring Plan* most of the monitoring plans are to measure changes in narwhal abundance and distribution. It should be noted that marine mammal response to noise are highly species- and context-specific (see Gomez et. al. 2016).

Individuals may not always leave an area even if a negative impact is occurring during important life history functions (e.g., calving, feeding). This even more paramount if the animals show a high degree of natal philopatry or site fidelity (e.g., narwhal in Eclipse Sound). In fact, “early” warning indicators (EWI) are very difficult to establish for long-lived marine mammals as potential impacts may take years to detect (e.g., population-level impacts).

BIM should develop other EWIs that are not related to distribution and abundance. For example, the proportion of calves could provide an indication of reproduction rate and could be useful to understand population-level impact.

DFO Science previously provided information to support the identification of Early Warning Indicators and Thresholds to the MEWG in October 26, 2018. The following indicators were suggested:

- Increases in the level of stress hormones (cortisol, aldosterone, and corticosterone, at a minimum) in animals as measured in feces or direct sampling;
- Decreases in body condition (e.g., could be indicative of hampered foraging efficiency or displacement from better feeding areas or prey);
- Changes in calving rates (though this is not really an “early” warning indicator) assessed through aerial photography; and,
- Harvest age, sex, and size composition may also be an indication of population level change(s).

Recommendations

- DFO Science reiterates that indicators not directly related to abundance and distribution need to be created in order to capture project effect on a population level and a local level.

BIM’s position

BIM states that “*The Marine Mammal Effects Assessment identified no significant impacts to marine mammals from Project activities, however impact prediction confidence was limited for narwhal due to the limited information available regarding short-and long-term behavioral effects of underwater noise on this species and the general uncertainty on how narwhal will respond to increased shipping and the introduction of icebreaking activities in the waterways of Milne Inlet…*” (Marine Monitoring Plan, p.39).

DFO Science’s analysis and assessment

DFO Science is concerned that only narwhal was identified as having low confidence based on limited information and that monitoring, surveillance, and baseline will be only be considered for this species. This is the case for other marine mammal species as well (i.e., lack of information or confidence). This is the rational for baseline (research) within the monitoring framework.

Recommendations

- DFO Science recommends a comprehensive monitoring plan in one document with supporting protocols document(s) for each of the monitoring initiatives (e.g., field protocols for marine fish sampling). This should then be further developed to explain which monitoring programs are linked to mitigation measures.

BIM's position

In Table 5-3 , BIM identifies the threshold for "*narwhal monitoring*: *movement"* as *"Narwhal occurrence within the RSA equivalent to the prediction made in the Project Impact Assessment"* (Marine Monitoring Plan, p. 41).

DFO Science's analysis and assessment

BIM states that the measurable parameters for narwhal movements include: "*Change in travel direction, surface travel speed, orientation relative to vessels, horizontal displacement (distance from shore, distance from shipping lane), surface time, dive rate, bottom dive depth, time at depth, total dive duration, descent speed*" then, BIM sets the threshold for narwhal movement that "*narwhal occurrence within the RSA equivalent to the prediction made in the Project Impact Assessment*."

There is a disconnect between the measurable parameters and the threshold. DFO Science is concerned that BIM will not be able to assess if the threshold is exceeded given the measurable parameters.

Recommendations

- DFO Science recommends that BIM set scientifically appropriate thresholds associated to relevant measurable parameters.

BIM's position

In Table 5-4, BIM states that the measurable parameters for narwhal communication is "*Underwater noise levels relative to established acoustic thresholds*; *Underwater noise exposure periods relative to established acoustic thresholds*; *Change in narwhal call rate, call frequency, call type*" and that the threshold is "*Narwhal occurrence within the RSA equivalent to the prediction made in the Project Impact Assessment*". Finally, BIM states that the scope of the monitoring is "*Annually (during summer) for first three years post-construction, then every third year*" (Marine Monitoring Plan, p. 42).

DFO Science's analysis and assessment

There is a disconnect between the measurable parameters and the threshold. In particular, BIM does not state what the underwater noise level and exposure noise level thresholds are for these parameters.

Recommendations

- DFO Science recommends that BIM set clear noise level and noise exposure level threshold based on international standards.
- DFO Science recommends that the acoustic monitoring continues every year during the life of the project.

BIM's position

In the *Marine Monitoring Plan* (Section 5), the frequency of monitoring (i.e., "*scope of monitoring work*") for the various narwhal monitoring parameters are presented as "*Annually (during summer) for first three years post-construction, then every third year*".

DFO Science's analysis and assessment

DFO Science is concerned that BIM will not be able to detect that a threshold is exceeded if the monitoring takes place only every third year.

Recommendations

- DFO Science recommends that the ship-based observer (SBO) program takes place every year.
- In addition, DFO Science recommends that the SBO program also takes place outside of the RSA. The higher risk of ship strike is outside the RSA where the ship speed is not limited. In addition, most of the ship's journey is outside the RSA. This recommendation is important to monitor the cumulative impact of the project.

BIM's position

BIM states that in the generalized linear mixed model (GLMM) *"used for narwhal count data, vessel distance from the substratum, its direction relative to the substratum centroid, and whether the vessel was north- or southbound will be modelled as fixed terms".* BIM also states that "*A key confounding factor in attempting to determine the effects of large vessel transits on narwhals is the frequent occurrence of narwhal hunting at the base of Bruce Head and in surrounding areas*" (Marine Monitoring Plan, p. 114).

DFO Science's analysis and assessment

DFO Science is concerned that only the fixed effects are listed but not the random effects. What variables would the random effects be? The random effect accounts for pseudo-replication in the data and if counts are provided per day, then a temporal component to the analysis needs to be included here. Narwhal abundance is also count data and should be modelled using a 'Poisson' distribution which is the proper distribution to use for count data.

The report also states that hunting pressure is a confounding factor, but this can be included in the overall model and not just listed as a caveat to model output.

Recommendations

- DFO Science recommends BIM provide additional detail regarding the data analysis, as it is incomplete as currently written.
- DFO Science recommends the inclusion of the number of hunter camps being used that day on days of narwhal counts to determine if hunting pressure has any effect.

BIM's position

With respect to the integration of narwhal monitoring studies in the *Marine Monitoring Plan*, BIM states "*Large numbers of narwhals seemingly regularly move from one area to another in very short periods of time. This has been documented as "herding" events during the shore-based study at Bruce Head (see Smith et al. 2015) and extreme variation in narwhal numbers during back-to-back aerial survey replicates of the same area (Elliott et al. 2015; Thomas et al. 2015). This presumably natural variation in narwhal distribution and abundance makes it virtually impossible to use a single study in real-time to determine whether adaptive management procedures for Baffinland shipping should be implemented. We cannot, in real time, readily attribute changes (i.e., cause and effect relationship), even seemingly obvious changes, in narwhal distribution and abundance to the passage of a large vessel(s)… Results from all marine mammal monitoring studies need to be considered in an integrated fashion each year and reviewed to determine whether shipping effects on narwhals necessitate adaptive management activities and if so, what level of response is warranted*" (Marine Monitoring Plan, p.118).

DFO Science's analysis and assessment

DFO Science questions the use of the term 'extreme' variation and requires clarification for its intent. There are typically large congregations of narwhal in Tremblay Sound and Koluktoo Bay. DFO Science disagrees with the statement from BIM that there is too much variability in Milne Inlet to determine where narwhal congregate. Though fine-scale movement variability does occur by them entering/exiting certain systems (i.e., Tremblay Sound) throughout the open water period, these areas could be considered narwhal 'hotspots' (Yurkowski et al. 2019a, Doniol-Valcroze et al. 2013).

Monitoring abundance and distribution of narwhals in the area is vital, however, there are other indicators that could be considered as well. For example, a possible approach would be to use a Pathways of Effects type model of the expected effects of shipping on marine mammals. Monitoring and reporting on collisions and noise disturbance is needed in order to set thresholds (e.g., noise thresholds could be based on literature).

DFO Science is concerned that BIM has not considered the use of existing pre-project acoustic data for comparison to assess the impact on narwhal. This would help establish a relative frequency and intensity measure of noise in the environment (relative quantitative parameter). A baseline for noise levels in 2012 (or start of the project) should be compared to noise levels in 2018 when a large number of ships were transiting the area. This comparison would allow an assessment of how much noise has increased in terms of spatial extent, temporal persistence, and decibel level. BIM should evaluate the effects of vessel noise on marine mammal presence over this time frame.

Recommendations

- DFO Science recommends that BIM develop models that incorporate variability in narwhals movement and distributions as well as a variety of indicators to assess the impact of the mine.
- DFO Science recommends a comprehensive monitoring plan in one document with supporting protocols document(s) for each of the monitoring initiatives (e.g., field protocols for marine fish sampling). This would facilitate the ability to conduct an analysis that combines the different monitoring programs for marine mammals and report.

BIM's position

BIM presents Figures C-3 and C-4 (Marine Monitoring Plan, p. 120-121) which shows the locations of the acoustic recorders that were deployed near Bruce Head in 2018 and those in Eclipse Sound in 2019 (Figure 3).

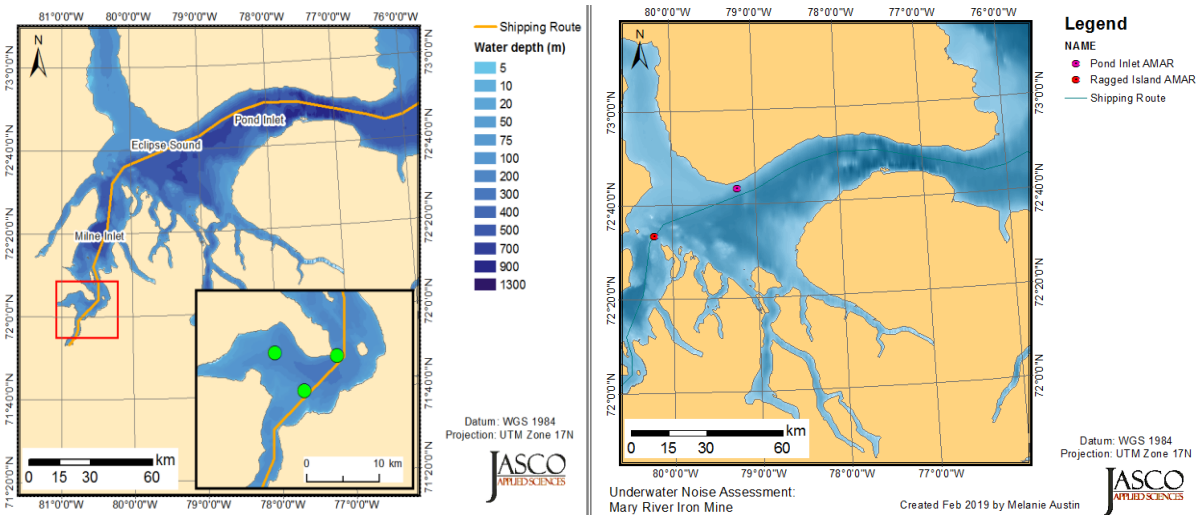

Figure 3. Baffinland Iron Ore Mines (BIM) acoustic monitoring stations within the Local study area and the regional study area (from Figures C-3 and C4 in Marine Monitoring Plan, p. 120-121).

DFO Science's analysis and assessment

BIM states in the Marine Monitoring Plan that one of the monitoring principles is to "*Compare Project effects against predictions made in the impact assessment"* (p. 24). However, the locations of some of the recorders are far from the location of the noise propagation modelling performed in *TSD 24 Marine Mammal Effect Assessment* (Section 2.6.2.2, Figure 2.2, p. 35). In addition, the location of the hydrophones does not allow BIM the ability to compare the level of icebreaking noise to the modeled level in the *Assessment of Icebreaking Operations during Shipping Shoulder Seasons on Marine Biophysical Valued Ecosystem Components* (VECs) (Section 5.3.3, Figure 5.3, p. 51) (see Figure 3 in this Science Response).

Recommendations

- DFO Science recommends BIM modify the location of the recorders to allow for a comparison with the modelling results.
- DFO Science also recommends adding hydrophones to capture the noise produced by ice breaking for monitoring.

BIM's position

BIM states that "*AMARs were deployed at 5 stations (C-3) between 4 Aug and 28 Sep 2018 from the Ocean Raynald T. All AMARs were retrieved as planned from the same vessel using acoustic releases. All AMARs recorded as planned from deployment until retrieval, for an average recording duration of 56 days"* (Marine Monitoring Plan, p.119).

DFO Science's analysis and assessment

DFO Science questions why the sampling design is changing (see *Marine Monitoring Plan* p.120) in 2019. The site "AMAR 3" could be compared with others along the shipping corridor. Will the acoustic data be comparable between years (i.e., same stations continued in 2019)? DFO Science questions if the same instrumentation is being used as 2018? It is not clear why the program was changed (e.g., redundant data between certain AMAR stations).

Project Condition (PC) #109 states that "*The survey shall be designed to address effects during the shipping seasons, and include locations in Hudson Strait and Foxe Basin, Milne Inlet, Eclipse Sound and Pond Inlet. The survey shall continue over a sufficiently lengthy period to determine the extent to which habituation occurs for narwhal, beluga, bowhead and walrus*" (Marine Monitoring Plan, p. 13). DFO Science questions if this sampling design addresses all areas outlined in PC #109.

Recommendations

- DFO Science requires justification why the program goes from 5 to 3 sites and then the addition of other sites. Some explanation for continuity and understanding the design of the monitoring program is needed.
- DFO Science requires the collection of baseline noise data in Hudson Strait and Foxe Basin for baseline data collection.

BIM's position

For BIMs 2018 passive acoustic monitoring overall approach (Marine Monitoring Plan, p. 120), BIM states in the methods that *"The two recorders in Eclipse Sound/Pond Inlet will monitor sound levels from icebreaking activities that are expected to occur in 2019…"*.

Recommendations

- DFO Science recommends this monitoring should continue beyond 2019, as long as icebreakers are active in Eclipse Sound. This will establish a baseline (research) for future monitoring.

BIM's position

With respect to aerial survey design BIM states that "*In 2015, an extensive grid was surveyed during each of four survey periods, i.e., every two weeks (early August, mid-August, late August, mid-September) similar to that flown in 2014"* (Marine Monitoring Plan, p. 126).

DFO Science's analysis and assessment

DFO Science requires clarification on what 'extensive' means in this context. A value of survey effort should be provided.

Recommendations

- DFO Science recommends BIM include a value of survey effort in results.

BIM's position

In Figure C-6 – Proposed Survey Study Aarea for Phase 2 Aerial Survey, BIM presents the large scale general areas for survey (Marine Monitoring Plan, p. 129).

Recommendations

- DFO Science recommends highlighting the different strata areas in this map.

3.2 Alternate Shipping Route

BIM's position

The objective of the document entitled "*Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report*" is to "*review potential shipping routes through the*

NWP for ore carriers from Milne Port, the existing biophysical conditions along those routes and identify issues of greatest potential concern with respect to potential interactions between Project-related shipping and the environment" (Section 1, p. 1).

DFO Science's analysis and assessment

As a general comment, BIM does not present any conclusions as to the significance of residual environmental effects. DFO Science is concerned that the document appears to be an overview report not an assessment. The conclusions do not identify issues of greatest potential concern.

Recommendations

- DFO Science strongly suggests that if BIM intends to use the Northwest Passage (NWP) as an alternate route, they should conduct a thorough assessment including an effects assessment, development of mitigations, revisions/updates of applicable plans, and consultation prior to the use of the alternate route. The scope of the assessment should consider Valued Ecosystem Components (VEC) and indicators for the alternate route(s) including the Western Arctic (e.g., Ecologically and Biologically Significant Species and Community Properties; DFO 2018).

BIM's position

In Section 4.5 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* Ecological Biological and Sensitive Areas (EBSA) were highlighted by BIM in order to determine potential interactions between Project-related shipping and the environment (p. 16-17).

DFO Science's analysis and assessment

DFO Science would like to highlight that the acronym for EBSAs stands for Ecologically and Biologically Significant Areas (EBSAs). Also, as noted in the DFO (2011) report, as new information becomes available EBSAs are updated and refined. This refinement exercise or re-evaluation has occurred for both the Western and Eastern Arctic biogeographic regions (DFO 2014b, 2015b). Companion documents to this advice with more technical details are Cobb et al. (2014) and Schimnowski et al. (2018).

In addition, DFO Science conducted an assessment of habitat sensitivity as part of a risk assessment for Alternate Ballast Water Exchange Zones (ABWEZs) in the eastern Arctic (Stewart et al. 2015, Goldsmit et al. 2019), which should be considered for any future assessment of the NWP

Recommendations

- DFO Science strongly suggests using the most recent EBSA maps for their current assessment and any future assessments. DFO Science suggests that Figure 4 (Section 4.5, pg. 17) and Table 12 (Section 5.4, p. 70-71) be updated to reflect the most current information.
- DFO Science suggests that there is more current literature that could be used to identify and/or highlight important areas (e.g., Stewart et al. 2015, Goldsmit et al. 2019).

BIM's position

BIM notes in the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* that "*Pond Inlet will remain the primary transit corridor for the Project;*

however, some Ore Carriers may proceed through Navy Board Inlet under several specific circumstances..." (Section 2.1, p. 3).

DFO Science's analysis and assessment

DFO Science requires clarification from BIM as to what are the circumstances under which ore carriers may proceed through Navy Board Inlet and the NWP. These circumstances should be clearly described and criteria given for their enactment/approval. What is the threshold for which so many more vessels are taking alternate routes in a year/month that would impact populations differently than currently assessed with the Eclipse Sound/Pond Inlet route.

Recommendations

- DFO Science requires clarification on the circumstances and/or criteria for which BIM would chose to use Navy Board Inlet and the NWP. What is the threshold for number of vessels and vessel transits that would suggest that there would be impacts on the populations and the marine environment.
- DFO Science suggest BIM develop a plan to monitor and report use of alternate routes.

BIM's position

BIM states in the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* that shipping would occur during the open-water season (ice conditions of < 1/10) (Section 2.1, p. 3).

DFO Science's analysis and assessment

DFO Science requires BIM to identify the anticipated dates when shipping through the western route may occur and how frequently. On previous occasions BIM offered the definition of 'open water', however it differs from this report. Is the definition of the open-water season different for the NWP? Also, DFO Science requires clarification from BIM as to whether ice management vessels are also needed through the NWP. If support vessels are required this will have an impact on the assessment as well.

Recommendations

- DFO Science requires some estimation of frequency (i.e., how often in a year, month, day) and intensity (i.e., number of vessels) BIM anticipates using this alternate route.
- DFO Science requires clarification of the definition of open-water.

BIM's position

In the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* BIM provides a list of species in the Biological Environment Overview (Section 5.3) that will interact with the alternate shipping routes (Section 5.3.4, p. 36–37 and Section 6.2, p. 86).

DFO Science's analysis and assessment

DFO Science questions the exclusion of Killer Whales (*Orcinus orca*) and Greenland Shark (*Somniosus microcephalus*). Killer whales are typically seen in the Eclipse Sound area and the NWP during the summer shipping months and should be assessed in this and subsequent documents and analysis. Similarly, Greenland sharks, who are also top predators, are commonly found throughout the Eclipse Sound area and NWP (MacNeil et al. 2012) during the shipping season.

Recommendations

- DFO Science recommends these species also be assessed within the alternate route(s).

BIM's position

In Section 4.6 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report*, BIM provides a description of the Human Environment (p. 18–22).

Recommendations

- DFO Science suggests that the information be provided in a map; similar to maps produced by the Inuit Heritage Trust.

BIM's position

BIM presents the low impact shipping corridors based on Carter et al. (2018a,b,c,d) in the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (Section 4.6.5, p. 20–21).

DFO Science's analysis and assessment

DFO Science reviewed these sections and noted that only 4 community perspectives are referenced – Pond Inlet, Cambridge Bay, Paulatuk and Sachs Harbour. As BIM is aware, there are a number of communities along the alternate shipping routes that will impact other communities.

Recommendations

- DFO Science recommends BIM consider Inuit perspectives on low-impact shipping corridors for other communities along the route.

BIM's position

In Table 7 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (p. 38–39) BIM provides a summary of conservation status.

DFO Science's analysis and assessment

DFO Science notes a few corrections for the table.

Recommendations

- DFO Science recommends BIM update the table to include: Eastern Beaufort Sea beluga "not at risk" and Eastern Arctic-West Greenland bowhead population for *Species at Risk Act* (SARA) as "no status".

BIM's position

In Figure 10 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (p. 45) BIM provides a map of the Eastern High Arctic-Baffin Bay and Eastern Beaufort Sea beluga populations.

DFO Science's analysis and assessment

DFO Science questions why those are the only two populations highlighted in the figure. All Canadian population distributions are provided for other marine mammal species, so the same should be included for beluga.

Recommendations

- DFO Science recommends BIM update the figure to include all beluga populations on one map for readers.

BIM's position

In Table 12 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (p. 70) BIM provides a list of important properties for each of the EBSAs identified in DFO (2011, 2015b).

DFO Science's analysis and assessment

DFO Science is concerned that BIM is not using the most up-to-date information on Ecological and Biological Significance Areas. For example, important ringed seal pupping and nursing habitat over the winter exists in Eclipse Sound and Milne Inlet (Yurkowski et al. 2019b).

Recommendations

- DFO Science recommends BIM update the table to include important areas identified for all VECs using the most recent literature.

BIM's position

In Table 13 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (p. 75–79) BIM provides a list of important areas and includes information specific to each, including "key species" and "other species".

DFO Science's analysis and assessment

DFO Science questions why BIM did not complete the same format of table for the marine mammals.

Recommendations

- DFO Science recommends BIM update the marine mammal table to include key species and other species.

BIM's position

In Table 14 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (p. 83–85) BIM provides a brief overview of potential interactions between valued components and shipping in the NWP.

DFO Science's analysis and assessment

In general, DFO Science notes that BIM has only identified changes in behaviour and mortality for marine mammals, when physiological impacts should also be included (see Wright et al. 2007, DFO 2019a,b). More specifically, for ringed and bearded seals BIM should also add the additional consequences of increased risk of mother-pup separation and destruction of habitat (i.e., birth and resting lairs; Wilson et al. 2017, Yurkowski et al. 2019b).

Recommendations

- DFO Science recommends BIM include physiological impacts to marine mammals in their assessment and some of the additional impacts highlighted above. DFO Science submitted a review for early warning indicators to the MEWG in October 2018 which also included a list of potential effects/impacts from seismic noise on marine mammal physiology, behavior, and ecology that was adapted from DFO (2015d).

BIM's position

In Section 6.2.2 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (p. 87) BIM provides a brief discussion of changes in ringed seal behaviour. Similarly, in Section 6.2.4.1 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (p. 89) BIM states that "*Timing of vessel routing to avoid these locations would reduce effects to beluga*."

DFO Science's analysis and assessment

DFO Science requires clarification on how BIM will time their transits through the NWP to avoid seasonal aggregations of marine mammals. The associated effects and consequences of icebreaking on ringed seals are not mentioned in this section but based on earlier comments it is not clear as to the timing of shipping in the alternate route and the ice conditions throughout the NWP. Impacts of icebreaking on phocids have been documented in the literature and include increased mortality and sub-lethal effects such as higher incidences of mother-pup separation, displacement from habitat, destruction of birth and resting lairs, and vessel-seal collisions (e.g., Wilson et al. 2017, Yurkowski et al. 2019b).

Recommendations

- DFO Science recommends BIM include physiological impacts to marine mammals in their assessment and some of the additional impacts highlighted above.

BIM's position

In Section 6.2.5.1 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (p. 90) BIM states that *"…speed restrictions for project vessels is 9 knots (section 2.3)*."

DFO Science's analysis and assessment

DFO Science requires clarification from BIM if this speed restriction is applied to the entire NWP route(s).

Recommendations

- DFO Science requires BIM to identify the speed restrictions along all possible NWP routes.

BIM's position

In Section 7.0 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* BIM states that *"…site-specific mitigative measures that may be developed in consultation with harvesters, hunting and trapping organizations, and Inuit communities*" (p. 93).

DFO Science's analysis and assessment

DFO Science requires BIM to identify when these consultation activities will occur and with what Inuit communities. The local communities have a wealth of information, especially where few scientific studies have occurred.

Recommendations

- DFO Science requires BIM to identify the consultation plan for communities and organizations along the NWP route.

BIM's position

As a general comment for Section 7.0 (Summary and Conclusions) of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (p. 93).

DFO Science's analysis and assessment

BIM does not clearly identify how icebreaking may impact the NWP ecosystem. On page 3 of the same document, BIM states that Navy Board Inlet may be used under specific conditions related to prevailing ice conditions and thus would transit parts of the NWP. Associated impacts of these icebreaking events should be discussed at a broader ecosystem-scale perspective.

Recommendations

- DFO Science requires BIM to conduct an assessment of icebreaking in the NWP. Without this information DFO Science is unable to conduct a proper assessment.

BIM's position

BIM presents a *Draft Spill at Sea Response Plan*.

DFO Science's analysis and assessment

DFO Science conducted a review of the *Draft Spill at Sea Response Plan*. There are no specific comments, rather a more general recommendation for the NWP.

Recommendations

- The *Draft Spill at Sea Response Plan* would need to be completely overhauled to make it route specific (e.g., assessment of navigational hazards, communications protocols, identification of response resources) should BIM decide to ship through the NWP (as with all relevant shipping related plans). Without this information DFO cannot conduct a proper assessment.

3.3 Anchorages

BIM's position

In Figure 2 of the *Mary River Project: Environmental Review of Shipping through the Northwest Passage Final Report* (Section 2.2, p. 5–6) an anchorage location is identified at the mouth of Tremblay Sound as well as along the coast of an island near Oliver Sound.

DFO Science's analysis and assessment

Tremblay Sound is an important area for summer aggregations of narwhal and potentially an important quiet refuge in the area from vessel traffic. DFO Science is concerned that vessels anchored at the mouth of Tremblay Sound might discourage narwhal to utilize the area and cause displacement of narwhals.

It was previously discussed that the impact of anchoring at the mouth of Tremblay Sound was not assessed and therefore DFO Science cannot complete an assessment of impact. At the second technical review meeting, BIM noted that they will not be using this anchoring location and that the location will be removed from the Instruction to Mariners and other documents. BIM also recently noted that they will not be anchoring in locations other than Ragged Island and around Milne Port.

Recommendations

- DFO Science recommends that BIM clarify why these anchorages are noted in this report and either remove the anchoring locations or assess the impact of anchoring at these locations. (DFO 2019a,b).

3.4 Marine Mammals – Icebreaking impacts

BIM's position

In Section 5.2 of the *Draft Baffinland Early Shipping Season – Operational Guide* (p. 7), BIM provides the following mitigation measures:

"*1) Between the period of 01 July and 30 July, a maximum of one transit or two half-transits) will occur per day (24-h period) where ice concentrations of 6/10 or greater cannot be avoided along the shipping route.*

2) Between the period of 01 July and 30 July, a maximum of two transits or four half transits will occur per day (24-h period) where ice concentrations less than 6/10 but greater than 3/10 cannot be avoided along the shipping route".

DFO Science's analysis and assessment

The potential impacts of icebreaking on narwhals and other marine mammals are not restricted to only the beginning of the shipping season (i.e., 01 July to 31 July), rather impacts will also be observed at any time during the shipping season that icebreaking could potentially occur (e.g., later than July 31, August, September and October).

Recommendations

- DFO Science recommends the proposed mitigation measures should be applied to the entire duration of icebreaking (i.e., whenever icebreaking is occurring).

BIM's position

BIM states that "*There will be some overlap between icebreaking operations and narwhal during their seasonal migratory movements (i.e., between early-July to mid-August) in the Regional Study Area and the mitigation measures in the following subsection have been developed to reduce the potential effects of this overlap. [They] will manage its vessel traffic during the Eclipse Sound narwhal summer stock spring migratory period.*" (Draft Baffinland Early Shipping Season – Operational Guide, Section 5.1.4, p. 7).

The *Draft Baffinland Early Shipping Season – Operational Guide* then lists mitigation measures number 11 and 13 that state that "*11) All icebreaking, ice management and ice escort activities will be conducted outside of the period of ringed [seal] parturition, nursing, and breeding periods*" and "*13) All vessels will be provided with standard instructions to not approach within 300 m of a walrus or polar bear observed on sea ice*". This was presented in the Operational Icebreaking Assessment (p. 48), the Socio-economic Icebreaking Assessment (p. 13), and the Early Shipping Season – Operational Guide (Baffinland Early Shipping Season – Operational Guide, Section 5.1.4, p. 7-9).

DFO Science's analysis and assessment

DFO Science acknowledges that BIM has recognized and provided sufficient mitigation measures for the March to May critical life-history period for ringed seals (parturition, nursing, and breeding). However, ice provides an important platform for not only reproduction, but also

for rest and moulting. Ringed seals haul-out on ice floes during the moulting period in June and July in areas above 10% ice concentration (Lone et al. 2019). During this period, movements are still restricted (see Luque et al. 2014, Harwood et al. 2015, Kelly et al. 2010), and indicate possible territorial distribution related to nursing and mating earlier in the spring.

There is risk that seals will be disturbed due to icebreaking activity in June and July during their moult season. During this time, ringed seals are spending considerable time hauled out on ice (30% of their time in July and 60% in June; see Kelly et al. 2010). Also, their ability to evade vessels is limited when there is ice cover compared to open water habitats. Monitoring measures should also be considered during this time period.

Additionally, DFO Science recommends that BIM should apply the same monitoring measures in November and December for territorial setup as ringed seals are defending overwintering areas prior to and during ice formation. Ringed seal movement are more restricted at this time (see Kelly et al. 2010, Hamilton et al. 2016, Harwood et al. 2015, Yurkowski et al. 2016). Some recognition by BIM that the November ice-breaking shoulder season could affect ringed seal habitat choice during this time is required.

DFO Science is only suggesting the 300 m buffer zone be implemented in the event icebreaking takes place during the critical life-history periods for ringed seals during March, April and May. This will minimize behavioural disturbances to ringed seals during this important time. For example, in the Caspian Sea, seals were disturbed by icebreaker operation at distances within 250 m (Wilson et al. 2017). The icebreakers in the Caspian Sea study are much smaller and were also operating at a slower speed than proposed by BIM; therefore a buffer of at least 300 m is appropriate. Given the distribution of seals throughout the RSA throughout the year, this buffer zone is not suggested for the period mid-July to mid-November.

Again, the use of marine wildlife observers (MWO), or an alternative, to record behavior of ringed seals that are hauled out on sea ice, with respect to distance away from the ship (in front and beside), during shipping in the shoulder seasons is recommended for monitoring impact(s) of marine mammals (DFO 2019a,b).

Polar bear distribution is highly correlated with the presence of seals (e.g., ringed seals; Stirling and Archibald 1977, Hamilton et al. 2018), especially during spring when ringed seal pups are present. As identified in the Marine Monitoring Plan, "*Of the ten species of marine mammals with potential to occur in the RSA during the shipping season, polar bear are the only species protected under SARA where they are listed as Special Concern (Schedule 1)*" (p. 9) and therefore are identified as a valued ecosystem component (VEC). Given that ringed seals are the main prey item for polar bears and influence polar bear distribution, they could be used as a proxy to sight a polar bear and apply the 300 m buffer zone.

Additionally, DFO Science has repeatedly stated that the 300 m buffer zone is not a sufficient distance for walrus on sea ice year-round (DFO 2019a,b,d).

Recommendations

- DFO Science would like to reiterate that no icebreaking should occur where and when seal density is relatively high within the regional study area (e.g. March, April, May). These areas of relatively higher aggregations occur in closed embayments and inlets where landfast ice exists (i.e., sea ice concentration 90% or greater and/or bathymetry < 100 m) (e.g., Yurkowski et al. 2019b). For example, Western Eclipse Sound and southern Milne Inlet are important areas (e.g., pupping) for ringed seals and although the majority of

pupping occurs until the end of June, this habitat is important if and where it exists throughout the RSA (e.g., DFO 2019b, Yurkowski et al. 2019b).

- DFO Science recommends adding ringed seals to the 300 m proposed buffer zone for seals that occupy the described habitat in months of March, April and May (DFO 2019b). DFO Science also recommends that BIM develops mitigation measures during the fall shoulder season (November and December) when ringed seals are setting up territories and will defend these overwintering areas prior to and during ice formation.
- If and when icebreaking does occur, DFO Science recommends that BIM be required to document behavioral responses and report mortalities of marine mammals with an appropriate survey methodology (e.g., Wilson et al. 2017). For example, monitoring wildlife officers can record behavioural response data by observing flight response (i.e., dive into the water) or displacement with respect to distance away from the vessel. This is very important behaviour to record to quantify potential behavioural disturbances of ice-breaking on ringed seals.
- DFO (2019a,b,d) recommended that walrus haulout buffer zone guidelines set by the US Fish and Wildlife Service (USFWS) and the US Federal Aviation Administration (FAA) be followed in the absence of similar guidelines in Canada (stemming from lack of scientific data on the same). The USFWS Guidelines (2012) stipulate that marine vessels ≤ 50 ft (~ 15.2 m) in length should remain at least a 0.5 nautical mile (~ 0.9 km) away from hauled out walruses; those 50-100 ft (~ 15.2 to 30.5 m) should remain at least 1 nautical mile (~ 1.9 km) away; and those greater than 100 ft (30.5 m) should remain at least 3 nautical miles (~ 5.6 km) away. All vessels are to refrain from anchoring and other activities within 3 miles (~ 4.8 km) of hauled out walrus, and to maintain a 0.5 nautical mile (~ 0.9 km) exclusion zone around feeding walruses. The FAA recommends that all aircraft maintain a minimum altitude ranging from 2000-5000 feet (~ 610-1524 m) above ground level within a 0.5 to 3-mile (800 m to 4.8 km) radius of walrus haul-outs.

3.5 Noise Assessments

BIM's position

With reference to the *Technical Memorandum (Ref. No. 1663724-135) on Daily Ship exposure periods for narwhal during shoulder and open water season relevant to the 135, 120 and 110 decibel noise fields* (Section 1, p. 2), BIM uses an avoidance threshold of 135 dB for narwhals based on Finley et al. (1990).

DFO Science's analysis and assessment

BIM uses a threshold of 135 dB for avoidance reaction from narwhal based on observations by Finley et al. (1990). However, in Finley et al. (1990), there is no reference to avoidance thresholds of narwhals. No other justification for the choice of a 135 dB threshold is provided by BIM. In addition, there is no temporal aspect to the threshold (i.e., narwhals may avoid an area with noise at levels lower than 135 dB if the noise is continuous over a long period of time).

Recommendations

- DFO Science recommends to use a precautionary approach and revise the avoidance analysis or provide justification for the values and threshold of the current analysis.

BIM's position

BIM references Southall et al. (2007) in both the *Memo: JASCO Responses to Technical Comments* (including animation) and the *Technical Memorandum (Ref. No. 1663724-135) on Daily Ship exposure periods for narwhal during shoulder and open water season relevant to the 135, 120 and 110 decibel noise fields.*

DFO Science's analysis and assessment

DFO Science noted previously that Southall et al. (2019) have published new guidelines for the calculation of SEL_{24} and thresholds for auditory injury (DFO 2019b).

Recommendations

- DFO Science previously recommended that the authors of the Memos either provide new calculations based on the new guidelines (Southall et al. 2019) or provide comments on the difference in methods and the rational for continuing to use the 2007 version (DFO 2019b).

3.6 Cumulative Effects

Cumulative effects in the sense of the Environmental Assessment means that effects in conjunction with other impacts (e.g., cruise ships, tourism, community resupply).

BIM's position

With respect to the *Technical Memorandum (Ref. No. 1663724-135) on Daily Ship exposure periods for narwhal during shoulder and open water season relevant to the 135, 120 and 110 decibel noise fields* and *Memo: JASCO Responses to Technical Comments (Subject: Baffinland Phase 2 Acoustic Modelling: Responses to Technical Comments) and Animation* and the associated sound field together with sound exposure level (SEL) of 4 worst case scenarios.

DFO Science's analysis and assessment

BIM provides the daily ship exposure levels for narwhal associated with different icebreaking scenarios and vessel type per vessel transit. However, in order to conduct a proper assessment, DFO Science requires the total cumulative number of hours narwhals would be exposed to noise related to all vessel traffic each day. For example, according to Table 4 in the *Technical Memorandum (Ref. No. 1663724-135) on Daily Ship exposure periods for narwhal during shoulder and open water season relevant to the 135, 120 and 110 decibel noise fields*, a stationary narwhal would be exposed to noise at 120 db from a cape size ore carrier for 2.2 hours. In *TSD 24 - Marine Mammal Effect Assessment*, Section 2.5.2.2, BIM estimates 176 ore carrier round trips as an upper limit estimate, peak shipping months for Phase 2 would be July, August, September and October, which would see an estimated 19, 56, 55, and 46 trips past Pond Inlet respectively". Therefore, in August, narwhal would be exposed to an average of 1.81 vessel trips per day or 3.61 vessel transits. Potentially, narwhal could be exposed to cape size ore carrier noise at 120 db for 7.9 hours per day. Without more information, DFO Science cannot accurately evaluate the number of hours narwhal are exposed to noise. Therefore, DFO Science cannot properly assess the impact of this on the local narwhal population.

DFO Science requires an estimate of the number of hours narwhals will be exposed to different levels of noise over a 24-hour period. This information could be derived from the maps of the animation. However the data associated with the animation was not provided and therefore DFO Science cannot evaluate the potential impact of project related noise on narwhals. Information on noise emitted for each vessel passage is provided in *Technical Memorandum*

(Ref. No. 1663724-135) on Daily Ship exposure periods for narwhal during shoulder and open water season relevant to the 135, 120 and 110 decibel noise fields (p. 2), however DFO Science requires the cumulative noise to conduct a proper assessment.

Recommendation

- DFO Science requires information on the cumulative noise period (i.e., how many hours in one day would a normal narwhal be exposed to noise > 120dB) for all vessel types, including cumulative vessel noise (e.g., cruise ships).

BIM's position

In the *Memorandum – Mary River Project – Phase 2 Proposal – Revised Addendum to Technical Supporting Document 27 – Cumulative Effects Assessment*, BIM states "*It is anticipated that, should multiple vessels transit through a given area, the cumulative noise field will increase spatially (TSD-24; Golder, 2018a). However, given the physics of underwater sound, the cumulative sound level is not predicted to increase when multiple vessels are present in the same area (TSD-24)*" (p. 35). In the same document, BIM also states that "*However, the cumulative sound level ('loudness') is not predicted to increase when multiple vessels are present in the same area - it would remain roughly equivalent to that of the single (larger) vessel at any single point within the zone of acoustic overlap. This is due to the logarithmic nature of sound underwater (i.e., the cumulative effect of multiple co-occurring noise sources is not linear in scale)*" (p. 35).

DFO Science's analysis and assessment

DFO Science notes that the cumulative noise of two vessels with the same source level is louder than the noise of one vessel by 3 dB. Given that sound levels are represented by a logarithmic scale it means that an increase of 3 dB is equivalent to doubling the perceived noise level.

Recommendations

- DFO Science recommends that the cumulative noise of several vessels is calculated given that differences of 3 dB might be significant.

BIM's position

BIM notes in the *Draft Baffinland Early Shipping Season – Operational Guid*e (p. 7) that there is "*a maximum of one transit or two half-transits"* with a transit being *"defined as the distance of the voyage between Milne Port to the eastern end of the RSA (73˚W longitude). A half transit is defined as the equivalent of half or less of the distance between Milne Port to the eastern edge of the RSA (73˚W longitude). Nominally the half-way point is represented as being within Eclipse Sound to the northeast of Ragged Island. A single transit may include one or multiple vessels".*

DFO Science's analysis and assessment

DFO Science requires information on mitigation measures when half-transits are implemented. Ships will then be parked near Ragged Island for 24 hours. Will ships be drifting with engines on during this time? DFO Science cannot conduct a proper assessment without this information.

Recommendations

- DFO Science requires clarification on the maximum number of hours that a vessel will be anchored and the level of noise, including cumulative noise (all anchored or drifting

vessels) at Ragged Island. This could be included in the JASCO animation model to demonstrate the amount of noise at Ragged Island.

BIM's position

In Section 4.3.1 of the *Memorandum – Mary River Project – Phase 2 Proposal – Revised Addendum to Technical Supporting Document 27 – Cumulative Effects Assessment*, BIM discusses the cumulative effects on ringed seals but only for noise (p. 35–36).

DFO Science's analysis and assessment

This section is supposed to detail cumulative effects on ringed seals within the area but only addresses effects of noise. DFO Science is concerned that behavioural disturbances and mortality are not also considered under the cumulative effects. For example, impacts of ice-breaking on phocids include increased mortality and sub-lethal effects, such as higher incidences of mother-pup separation, displacement from habitat, destruction of birth and resting lairs, and vessel-seal collisions.

Recommendations

- In order to make a proper assessment, DFO Science requires the Proponent conduct a thorough analysis and assessment examining all the combined impacts of all the project activities inside and outside the study areas. Past recommendations suggests that BIM conduct an analysis for combined impacts, not individual (DFO 2019a,b).

BIM's position

In Section 4.3.2 of the *Memorandum – Mary River Project – Phase 2 Proposal – Revised Addendum to Technical Supporting Document 27 – Cumulative Effects Assessment*, BIM states that "*…narwhal is likely to tolerate/habituate to short-term increased levels of underwater noise and remain in the area, or leave temporarily and return once the noise subsides"* (p. 36).

DFO Science's analysis and assessment

DFO Science requires BIM to provide references (scientific support) to support their affirmation that narwhal are likely to tolerate/habituate to the short-term increased levels of underwater noise and remain in the area, or leave temporarily and return once the noise subsides. DFO Science requires the number of hours that narwhals will be exposed to different noise levels every day to be able to assess the potential behavioural effect of the project on narwhals. Given that vessel traffic will increase from 122 to 392 vessel transits, the current reaction of narwhals to shipping cannot be used to infer the reaction of narwhals to 392 vessels transits. This level of shipping traffic exposure on narwhals has never been documented before. Therefore, prediction on the impact of noise level on narwhals should follow the precautionary approach.

Recommendations

- DFO Science requires that BIM provide evidence for their claim that narwhal will tolerate or habituate to short-term increased levels (DFO 2019a,b).
- DFO Science requires information on the number of hours narwhals will be exposed to noise above 110 and 120 db. Without this information, DFO Science cannot assess the impact of project-related noise (including cumulative noise [e.g., tourism, resupply]) on narwhal (DFO 2019b).

BIM's position

Within the *Memorandum – Mary River Project – Phase 2 Proposal – Revised Addendum to Technical Supporting Document 27 – Cumulative Effects Assessment*, BIM states that there is "*No residual effects from the Phase 2 proposal on polar bear are anticipated"* including the effect of shipping (Section 4.3.5, p. 37)

DFO Science's analysis and assessment

DFO Science questions this conclusion as there is no evidence provided to support the claim. The consequences of ice-breaking on ringed seals (increased risk of mother-pup separation, displacement and destruction of key habitat [i.e., birth and resting lairs]) can be prominent if occurring in ringed seal hotspots (western Eclipse Sound and southern Milne Inlet) and in turn, can negatively impact the local seal population. Ringed seals are the main food source of polar bears and if there are changes in prey abundance or habitat use, this will directly impact polar bear distribution and habitat use in the area.

BIM's position

BIM states in the *Memorandum – Mary River Project – Phase 2 Proposal – Revised Addendum to Technical Supporting Document 27 – Cumulative Effects Assessment* that "*any avoidance behavior is predicted to be temporary and localized* " and "*fully reversible*" for narwhal (p. 36, beluga (p. 36-37) and bowhead (p. 37).

DFO Science's analysis and assessment

DFO Science requires BIM to provide support for why they predict the avoidance will be temporary and localized as well as fully reversible. There is no scientific support and justification to support this affirmation. DFO Science requires precision of what a temporary and localized avoidance is defined as in this context. Without this information, DFO Science cannot conduct a proper assessment.

Recommendations

- DFO Science requires BIM to provide scientific support and justification for residual disturbance effects being fully reversible and recommends that BIM identify this as unknown (DFO 2019a,b).
- DFO Science suggests that a long-term study with the objective to determine avoidance behavior and the ability of valued ecosystem components (e.g., narwhal, ringed seal) to habituate should be established under the marine monitoring plan (DFO 2019b). In addition, the energetic cost of habituation should also be evaluated and set in a context of individual fitness and stock level impact.

4.0 Conclusions

As stated in previous DFO Science reviews, based on the material presented in the FEIS and the new supporting documents that were submitted by BIM from June 18–August 29, 2019, DFO Science is concerned with the current monitoring efforts to support their conclusions. The statements and conclusions are not always supported by evidence (information, data, analyses), justification, or rationale (e.g., ability of narwhal to tolerate or habituate to short-term increased levels). These concerns have been raised in past reviews (DFO 2012a,b, 2014a, 2019a,b) and the conclusions provided here should be considered in conjunction with these past reviews as well.

More specifically, the review detailed in this Science Response concluded the following:

- DFO Science recommends a comprehensive monitoring plan in one document with supporting protocols document(s) for each of the monitoring initiatives (e.g., field protocols for marine fish sampling). Development of a single comprehensive monitoring plan would create linkages among the currently separate monitoring programs that are already collecting data across abiotic and biotic environmental constituents. This should then be further developed to explain which monitoring programs are linked to each of the management and mitigation measures.
- DFO Science recommends all monitoring plans should include the collection of sufficient data (e.g., baseline) on indicator species and species groups and environmental conditions (biotic and abiotic) in both affected and control or reference sites to facilitate timely assessment of drivers of observed changes and subsequent adaptive management, if warranted. This should also be followed up with power analysis and a process to review and assess the effectiveness of the monitoring plan (Figure 2). An important component of the monitoring framework is to ensure that revisions to the sampling plan (Figure 2) allow for comparison across years and data sets or, if necessary, a new time-series is created.
- DFO Science recommends that BIM develop thresholds for exceedance based on the range in baseline conditions (i.e., range of natural variability). With respect to the early warning indicator (EWI) threshold, two standard deviations is a standard metric for a statistically significant change under parametric statistical assumptions. However, consideration should also be given to the physiological threshold for contaminant levels.
- DFO Science recommends that adaptive management should be adopted as soon as an effect threshold is exceeded (i.e., at the same time a study to determine cause of the effect is initiated). If possible, adaptive management actions should be made based on scientific expert opinion and best available information until the cause of the effect can be empirically determined through scientific studies.
- BIM intends to regularly update program design based on annual monitoring results and/or recommendations provided by the MEWG and the NIRB. However, DFO Science is concerned that there is no mechanism and accountability for the implementation of recommendations provided by both the Marine Environmental Working Group (MEWG) and DFO Science (DFO 2019b). DFO Science recommends that BIM include the updated Terms of Reference for the Marine Environment Working Group in Appendix A to ensure the roles and responsibilities of that group match with how it is described in the Marine Monitoring Plan.
- DFO Science recommends that BIM update the Marine Monitoring Plan to include water quality/environmental parameters to their monitoring programs and use a randomized sample design.
- DFO Science recommends the monitoring of Arctic Cod in addition to sculpin and Arctic Char. Arctic Cod distribution and abundance patterns should also be monitored, particularly in relation to the shipping route and leading up to and including late season icebreaking. This baseline data collection and monitoring program could include a hyrdoacoustic survey with regular groundtruthing of acoustic data.
- DFO Science recommends that BIM revise their sampling plan for the sculpin mark-recapture study to improve recapture rates. For example, a small trawl is a good option to get better coverage.

- DFO Science recommends that BIM be required to report coordinates for ballast water release in ballast reporting forms for all vessels. This will provide information on where ballast is being released in Milne Inlet (i.e., not at the port/dock) so that the dispersion model can be updated and more accurately predict the zone of impact from ballast.
- DFO Science recommends that BIM develop an early response plan for AIS, similar to an oil spill response plan. The frequency of monitoring will need to be established prior to phase 2 and should be implemented through the environmental assessment rather than the MEWG.
- DFO Science agrees that BIM should require all ships to conduct self-monitoring of salinity in all ballast tanks following ballast water exchange, reporting salinity for every tank as part of their documentation (DFO 2019b). DFO Science further recommends that BIM ideally strive to verify self-reported salinity values for all ballast tanks on every arriving vessel. This has been routinely conducted since 2005 in the Great Lakes which receive 350–500 ships/year. Recognizing sampling conditions in the Arctic may be more challenging, DFO Science recommends that BIM should verify salinity values in a minimum of three ballast tanks for every vessel, prioritizing tanks with different management histories (ballast origin, or timing/location of ballast water exchange), where applicable (DFO 2019b).
- DFO Science would like to reiterate that EWIs identified for narwhal only include abundance and distribution. However other EWIs (e.g., physiological impacts and behavior) should be developed in association with marine mammal specialists in order to capture project effect at an individual and stock level. In addition, clear thresholds should be associated to measurable parameters.
- BIM needs to provide more information regarding the alternate Northwest Passage (NWP) shipping route. DFO Science strongly recommends that if BIM intends to use the NWP as an alternate route, they be required to conduct a thorough assessment including an effects assessment, development of mitigations, revisions/updates of applicable plans, and consultation prior to the use of the alternate route. This is an outstanding issue, as DFO Science is unable to assess the potential impacts, including cumulative impacts along the NWP.
- DFO Science is concerned that baseline and monitoring programs for the Southern Shipping Route (for the use of Steensby Inlet) and the NWP are not in place. Information collected from these programs would have informed this review as well as future impact assessments. Monitoring programs should be established in order to determine project impacts (DFO 2019b).
- The Spill at Sea Response Plan would need to be completely overhauled to make it route specific (e.g., assessment of navigational hazards, communications protocols, identification of response resources) should BIM decide to ship through the NWP (as with all relevant shipping related plans).
- Icebreaking activities should not occur. In particular, DFO Science is concerned with icebreaking activities at the beginning and end of the shipping season and the impact on marine mammals (e.g., ringed seals and narwhals). DFO Science recommends the proposed mitigation measures should be applied to the entire duration of icebreaking (i.e., whenever icebreaking is occurring). In addition, when icebreaking does occur, DFO Science recommends that BIM be required to document behavioral responses and report

mortalities of marine mammals with an appropriate survey methodology (e.g., Wilson et al. 2017).

- The cumulative noise soundscape is a necessary component of this assessment. Noise will have a negative impact on marine mammals. DFO Science is concerned that narwhal will be exposed to continuous noise >120 dB. BIM's assessment should include all vessel traffic (e.g., cruise ships, community resupply) and vessels at anchor (e.g., Ragged Island). Without this information DFO Science cannot conduct a proper assessment.
- For approach limits, DFO Science recommends that seals need to be included and have appropriate buffer limits when landfast ice (90 % or greater) is present and bathymetry is < 100 m (DFO 2019a,b). In the absence of data, DFO Science recommends using the same or greater buffer zones as polar bear and walrus. However, DFO Science has repeatedly stated that the 300 m buffer zone is not a sufficient distance for walrus on sea ice year-round (DFO 2019a,b,d).
- DFO Science also notes that many key components of the ecosystem received little consideration in the FEIS (e.g., benthic invertebrates, fishes). In addition, there was limited to no discussion of trophic effects, sub-lethal effects, or delayed mortality resulting from the Project. The cumulative effects assessment is not sufficiently comprehensive or quantitative enough to allow for a thorough environmental impact assessment of the Project. This also includes the assessment of impacts from climate change (DFO 2019a,b).
- DFO Science is concerned about the lack of a scientifically rigorous approach to the collection of baseline and monitoring data for impact assessment of many of the project activities and their conclusions. For example, BIM does not provide scientific justification for their conclusions that residual disturbance effects are fully reversible (DFO 2019a,b).

5.0 Contributors

- Sarah Bailey, DFO Science, Central and Arctic Region
- Steve Ferguson, DFO Science, Central and Arctic Region
- Kevin Hedges, DFO Science, Central and Arctic Region
- Kimberly Howland, DFO Science, Central and Arctic Region
- Marianne Marcoux, DFO Science, Central and Arctic Region
- Cory Matthews, DFO Science, Central and Arctic Region
- Joclyn Paulic, DFO Science, Central and Arctic Region
- Lianne Postma, DFO Science, Central and Arctic Region (Chair)
- Justin Shead, DFO Science, Central and Arctic Region
- Cortney Watt, DFO Science, Central and Arctic Region
- David Yurkowski, DFO Science, Central and Arctic Region
- Mark D'Aguiar, DFO Fish and Fish Habitat Protection Program, Central and Arctic Region
- Laura Watkinson, DFO Fish and Fish Habitat Protection Program, Central and Arctic Region
- Jacquie Bastick, Protected Areas Establishment and Conservation Directorate, Parks Canada

- Ryan Eagleson, Protected Areas Establishment and Conservation Directorate, Parks Canada
- Chantal Vis, Protected Areas Establishment and Conservation Directorate, Parks Canada

6.0 Approved by

Lianne Postma, Central and Arctic Region, A/Division Manager

Sen Wang, Central and Arctic Region, Regional Director Science

(October 25, 2019)

7.0 Sources of information

This Science Response Report results from the Science Response Process of September 13, 2019 on the Science Review of Additional Supporting and Supplementary Materials submitted June 18 – August 29, 2019 for the Final Environmental Impact Statement (FEIS) Addendum for the Baffinland Mary River Project Phase 2.

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Center for Science Advice (CSA)
Central and Arctic Region
Fisheries and Oceans Canada
501 University Crescent
Winnipeg, Manitoba
R3T 2N6

Telephone: (204) 983-5232
E-Mail: xcna-csa-cas@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

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