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SCIENCE REVIEW OF THE PHASE 2 ADDENDUM TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE BAFFINLAND MARY RIVER PROJECT

1.0 Context

The Nunavut Impact Review Board (NIRB) issued a Project Certificate to the Proponent Baffinland Iron Mines Corporation (BIM) in December 2012, enabling the Mary River Project's Northern and Southern routes to proceed to the regulatory phase. The Mary River Project is an operating open pit iron ore mine located on North Baffin Island in Nunavut (Figure 1). The mine site is connected to the 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 (Figure 1). The Southern Transportation Corridor has not been constructed to date.

Figure 1. Baffinland Iron Mines Corporation Mary River Project location, transportation corridors and shipping routes for the Milne Port (currently operational) and the Steensby Port (not constructed).

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). Since then, BIM has submitted for two Project amendments to increase the volume of ore shipments, including most recently the Phase 2 Final Environmental Impact Statement (FEIS) for technical review to the NIRB. The Phase 2 FEIS 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) and provides an updated effects assessment.

As part of the technical review stage, DFO Fisheries Protection Program (FPP) has requested that DFO Science review and provide advice on the FEIS, with an emphasis on the assessment of impacts to marine mammals and the marine environment.

The objective of this review is to assess whether the Phase 2 FEIS provides sufficient evidence to support the Proponent'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 in the FEIS, and determine if any relevant information is missing and if there are gaps in the analyses;
2. determine if appropriate methods were used in the FEIS to develop conclusions, and if the information presented supports those conclusions;
3. determine the appropriateness and adequacy of the proposed mitigation and monitoring measures in the FEIS, and;
4. if necessary, recommend additional or alternative mitigation and monitoring measures to reduce or avoid impacts to fish and fish habitat, including marine mammals.

This Science Response Report results from the Science Response Process held February 5, 2019 on the Science Review of the Final Environmental Impact Statement Addendum for the Baffinland Mary River Project Phase 2.

2.0 Background

In 2011 and 2012, at the request of DFO FPP, DFO Science conducted technical reviews of the marine component of both the Draft Environmental Impact Statement (DFO 2012a) and the Final Environmental Impact Statement (FEIS) (DFO 2012b), particularly as it related to marine mammals and shipping for the Mary River Project. Following the review, the Nunavut Impact Review Board (NIRB) issued a Project Certificate to Baffinland enabling the Mary River Project to proceed to the regulatory phase. Due to the economy at the time a phased approach was taken and BIM proposed an early revenue phase (ERP) and presented it as an addendum that was also reviewed by DFO Science (DFO 2014).

In 2014, production started with the development of 3.5 million tonnes per annum (Mtpa) road haulage operation from Mary River to a small port facility at Milne Inlet for shipping of iron ore during the open water season (July 15 to October 15). Two amendments were requested as part of the phased production approach; this included an increase in May 2014 to 4.2 Mtpa and in April 2018 to 6 Mtpa. Both amendments were issued, with the latest officially issued on October 30, 2018.

In August 2018, BIM submitted their Phase 2 FEIS to the NIRB; however, the report did not receive conformity. In October 2018, Baffinland resubmitted the Phase 2 FEIS and received conformity, which commenced the technical review. The Phase 2 FEIS describes the activities associated with the second phase of the Project which includes an increase to a total of 12 Mtpa

road and rail haulage, infrastructure development at the Milne Port, and increased marine shipping. The FEIS also provides an updated effects assessment based on the additional activities listed.

The Phase 2 proposal comprises the following main components for review:

Mine Site: The layout of the operating Mine Site will eventually be upgraded to accommodate North Railway and South Railway infrastructure. No information was received by DFO Science to review for the development of the South Railway infrastructure; therefore, this topic is not addressed in the analysis and response.

Northern Transportation Corridor: Ore will continue to be trucked along the Tote Road during the North Railway construction. The trucked volume of ore will increase temporarily during construction. Once operational, 12 Mtpa will be transported to Milne Inlet via the North Railway.

Milne Port: A second ore dock capable of berthing Capesize vessels will be constructed. For ore shipped from Milne Port, the secondary crushing and screening activities will be relocated to Milne Port from the Mine Site.

Northern Shipping Route: The tonnage shipped from Milne Port annually will increase to 12 Mtpa. Other components of the northern shipping route include: the use of Capesize and other various-sized market vessels, the operation of ice management vessels and tugs/line boats during the shipping season, the extension of the shipping season to include periods of ice-break up and ice formation (approximately July 1–November 15), or excluding when the landfast ice is being used by Inuit, and a range of 134–176 (round trip) ore carrying vessels calling at Milne Port annually. Ice management vessels, tugs/line boats and supply ships will also be in operation in the regional study area to support the project.

3.0 Analysis and Response

The comments provided by DFO Science are related to the following Sections of the FEIS reports:

- Addendum to the Final Environmental Impacts Statement (August 2018, Revised September 2018)
- Proponent Information Request Response
- Technical Supporting Document (TSD) – Project Description
- TSD 6 – Climate Change Assessment
- TSD 17 – Marine Environment Effects Assessment
- TSD 21 – Risk Assessment for the Introduction of Aquatic Invasive Species from Ballast Water
- TSD 24 - Marine Mammal Effects Assessment
- TSD 27 – Cumulative and Transboundary Effects Assessment
- TSD 28 – Management and Monitoring Plans Overview
- TSD 28, Appendix V – Shipping and Marine Wildlife Management Plan
- TSD 28, Appendix W – Marine Environmental Efforts Monitoring Plan (MEEMP)

There were gaps in the information provided, such as supporting field study reports from which conclusions were based by BIM, 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. Monitoring reports from previous phases of the project were not provided and are essential pieces of information. Regardless, the potential impacts of the Phase 2 project were evaluated based on the extent possible given the information presented. Many of the comments and recommendations contained in past DFO Science reviews for the Mary River Project remain relevant, or have become more relevant due to the significant increase in vessel traffic and the addition of an ice-breaking component (DFO 2014). Additionally, all review comments concerning the construction of the ore dock at Steensby Inlet and the Southern Shipping Route, including the need for development of baseline monitoring, are still relevant and should be considered prior to any future construction (DFO 2012a, b).

3.1 Project Description

3.1.1. Ships and shipping - route and timing

BIM's position

BIM identifies several types of ore carriers that will be used as part of Phase 2 as a "*variety of vessels will be used, including Supramax (50,000 to 55,000 DWT), Panamax (65,000 to 75,000 DWT), post-Panamax vessels (80,000 to 90,000 DWT) and Capesize vessels (130,000 to 250,000 DWT)*" (TSD02, p.70). The actual number of carriers and transits to be made by each is generally unknown because it depends on the availability of vessels and time of year (e.g., ice presence). However, BIM asserts that there will be a maximum of 176 voyages (round trips; 352 transits) by ore carriers, 48 wet/dry resupply transits, and approximately 20 tug transits (Information Request Response, Appendix 12, p. 4-5).

The Addendum further describes the increased shipping activities at Milne Port as "*Tugs and line boats will be used to shift the ore vessels from anchorages onto and off the dock. Market ore carriers transiting towards Milne Port will proceed directly to either an open loading dock, or to one of several anchorages available in the event dock space is full. Six to 10 tugs/line boats are expected to be required to operate the port. Three of these vessels will be ice management vessels for ice management duties at the beginning and end of the shipping period. These boats will be sailed to site at the beginning of each open water season and will sail south at the end of each season. Refuelling will be done by ship-to-ship transfer*." (Addendum, Section 4.1.3. p. 58).

DFO Science's analysis and assessment

Although the Information Request (IR) Response does clarify the number of transits for some vessel types, various documents use different total transit numbers for various calculations. For example, TSD02, Section 5.2 indicates "*up to approximately 200 vessels calling Milne Port annually*".

It is difficult to determine, based on the current information provided, the intensity and frequency of vessel activity at the port, within Milne Inlet and within the entire Northern Shipping Route. DFO suggests that the impact assessment would be better informed by dividing up the larger Regional Study Area (RSA) into smaller areas to further identify the actual impacts and severity of the impacts based on the activities occurring within each area (e.g., Milne Inlet, Eclipse Sound, Baffin Bay).

BIM's position

Baffinland intends to ship mostly during the open water season; however, the actual shipping window will be adjusted to adapt to annual fluctuations in weather and ice conditions while accommodating some additional operational flexibility. "*The shipment of 12 Mtpa of ore during the shipping window will be possible through an extended shipping window of July 1 to November 15 (138 days) and the use of larger ore carriers facilitated by the construction a second ore dock at Milne Port.*" (Addendum, Section 4.1.4, p. 59). The Early Revenue Phase originally indicated that the shipping window would be from July 15 to October 15. Currently the Addendum, Table 1-1 indicates Baffinland actually defined the start of the open water season as July 25 and continued shipping later in the fall (October 31). As a result, a total of 15 days has been added to the beginning of the season and 30 days of shipping added to the end of the season. Furthermore, in the Overview of Marine Operations provided in the BIM Information Request (IR) responses, BIM provided two factors (technical and land use) that will be used to determine when to open and close each shipping season.

The Overview of Marine Operations from the IR Response also indicates that "*24 hours of operation can be expected. Decisions as to when a vessel can/should or cannot/should not proceed are influenced by day light hours; and this is taken into consideration when Captains look to transit to and from Milne Inlet*."

DFO Science's analysis and assessment

There is concern as to how the start and end of the shipping season will be determined by BIM. It is clear that BIM will not be using fixed dates, and the current Addendum is not clear about assessment of ice conditions, except that shipping will not interfere with Inuit ice use. Ecological criteria should also be considered because the ice platform is habitat for a number of ice-dependent pinniped species (e.g., Ringed Seal [*Pusa hispida]*, Bearded Seal [*Erignathus barbatus*]). Ice-breaking operations can cause displacement, separation of mothers and pups, destruction of resting and birth lairs, and vessel-seal collisions (Yurkowski et al. 2019). Furthermore, clarification of the time of day the vessels will be transiting (i.e., twilight, darkness), and if shipping will take place during periods of limited visibility due to adverse weather is missing. In these situations, the ability for Marine Mammal Observers (MMO) to detect marine mammals will be limited.

DFO Science is particularly concerned with ice-breaking activities at the beginning and end of the shipping season and the impact on Narwhal (*Monodon monoceros*). Ice-breaking activities during the fall may impede the formation of ice across the inlets (e.g., ice type, lack of formation, rubble) and result in ice entrapments during the fall migration of Narwhal. Community members in Pond Inlet suggested an entrapment of at least 250 whales in 2015 may have been the result of shipping activity in Eclipse Sound, which may have interfered with the Narwhal's typical fall migration pattern (L. Postma, DFO science pers. comm., Watt et al. 2019). Spring ice-breaking could result in a change in Narwhal migratory patterns and lead to a lack of immigration into the area.

Increased wave action during shipping activities would also delay the formation of a solid ice platform, which would in turn delay use of the landfast ice by Inuit.

Recommendations

- DFO Science would like to know who would ultimately decide when to stop and resume shipping. We recommend that decision would reside with a territorial body or the local community and take into consideration ecological factors, such as key life history stages of

resource species that utilize the ice habitat and consideration of the risk of entrapment during the freeze-up period.

- Future detailed reporting and mapping of vessel traffic within Milne Inlet and the broader RSA should be provided for the entire ship track within Canadian waters, including how much time each of the vessels is present in Milne Inlet, Eclipse Sound and Baffin Bay. Vessel monitoring system data would also provide vessel speed, which would help understand the likelihood that an observer would see a marine mammal in front of the ship, the ability of the ship to avoid a collision and the likely outcome of a collision, or even near miss that would see the animal caught in the ship's wake. This information will allow DFO to conduct a more informed assessment of risk and impact.
- Clarification of the role that both environmental conditions and ecological factors will play in determining start and end dates for the shipping season is needed and how this will be monitored to determine if ice-breaking in the fall season will have an impact on ice formation.
- Marine wildlife officers should be on all vessels throughout the shipping season, not "*select vessels*" (TSD28, Appendix V, Section 5.3, Table 2, p. 166).

3.1.2 Alternative shipping route

BIM's position

In Section 4.5.2 of TSD16, BIM discussed an alternative route: "*We thus conclude that the route to Milne Inlet via Navy Board Inlet and Lancaster Sound should be considered as an alternative only during the open water season and shoulder seasons when ice has not fully formed or is in an advanced state of decay*".

DFO Science's analysis and assessment

DFO expresses concern that no impact assessment for the alternate route was considered, although the alternative shipping route was "*retained as a back-up alternative*". The mouth of Navy Board Inlet is considered an Ecologically and Biologically Significant Area (EBSA) since it is a major migration corridor for many species including Bowhead (*Balaena mysticetus*), Narwhal, Beluga (*Delphinapterus leucas*), and seals (DFO 2015a). Terrestrial haul-out sites have been identified for Walrus on the northern point of Bylot Island (DFO 2019) and haul-out sites along the Pond Inlet floe edge by local community members (TSD05, Figure 3.1, p. 33).

DFO is concerned that no impact assessment has been conducted for this alternate route and conditions under which this back-up route would be used are not delineated.

Recommendations

- Identification of scenarios when alternate routes would be used with probabilities (e.g., ice scenarios).
- Conduct an impact assessment of the alternate route.

3.1.3 Regional study area

BIM's position

In TSD24, Appendix A, p. 92, "*The RSA encompasses all waters of Milne Inlet, Navy Board Inlet, Tremblay Sound, Eclipse Sound and Pond Inlet extending to the entrance of Baffin Bay, consistent with the Nunavut Settlement Area Boundary*". Additionally, BIM states in the TSD24, Section 1.2.2, p. 15, "*This regional area is considered sufficient to encompass the full range of*

direct and indirect effects (incremental and cumulative) resulting from routine Project shipping activities, including those related to shipping noise."

DFO Science's analysis and assessment

DFO disagrees with this statement. Baffin Bay is also habitat for Narwhal, Beluga, Bowhead, Killer Whales, and other southern whales more recently utilizing the Canadian Arctic. The RSA excludes Baffin Bay but if the goal is to consider the full range of direct and indirect impacts, Baffin Bay should be included because large numbers of several species of marine mammals are found there during the current and proposed shipping seasons, especially during the shoulder seasons (e.g., Bowhead and Narwhal migrations into or out of the area, particularly along the coast of Baffin Island, and at the ice-edges), and in winter, when large numbers of animals overwinter throughout the area. For this reason, impacts of shipping should be assessed along the whole shipping route. DFO is also unsure where the ships will sit waiting and idling before they enter the RSA.

Recommendations

- The entire track line followed by ships in Canada on their way to and from the markets, including Baffin Bay and other areas not currently included in the RSA, should be included in the assessment.

3.2 Icebreaking

BIM's position

BIM reiterates that "*the effect of winter shipping through Hudson Strait on Beluga was previously assessed to be not significant (FEIS Vol. 8, Section 5.9.2)*" (TSD27, Section 1.4.14.4, p. 53). BIM had the same findings for Bowhead (TSD27, Section 1.4.14.5, p. 54) and Narwhal (TSD27, Section 1.4.14.3, p. 52).

DFO Science's analysis and assessment

For all marine mammal species, a comprehensive review of the effect of winter shipping is needed given the FEIS (not this Addendum) only covered information available before 2012. For example, Narwhal were identified in Hudson Strait in March (LGL study commissioned by BIM, Elliott et al. 2013), and Hudson Strait was heavily occupied by Bowheads in winter (Ferguson et al. 2010).

BIM's position

Commitment 156 of the IR Response indicates that BIM will *"…undertake an additional stand-alone assessment of ice-breaking effects during the shoulder seasons that addresses this concern and which will include underwater noise modelling of icebreaker transits along the Northern Shipping Route. The acoustic modelling will be based on a conservative scenario for ice-breaking noise based on thickest seasonal ice conditions in the RSA and maximum acoustic propagation potential. The stand-alone acoustic modelling report and icebreaking assessment will be submitted to the NIRB in 2019 once reporting is complete*."

DFO Science's analysis and assessment

DFO Science would like BIM to explain why the icebreaking assessment will only occur for the shoulder season when the IR Response (Appendix 12, Section 4) indicates that "*Ice Breaker(s) will operate from the time of break-up to free-up within the nominal shipping window (July 1-November 15)."* DFO Science would also like to know if the assessment will contain an assessment of ice-breaking on the Valued Ecosystem Components (VECs) identified in TSD17,

TSD24 and on the ecological role of ice itself. There is a potential for shipping in the shoulder season to advance break-up or delay freeze-up. BIM should provide the ecological consequences of advanced break-up or delayed freeze-up from vessel activities. There will be direct and indirect impacts of a reduced ice season on a number of ecological components (e.g., Narwhal, Killer Whale, seal pups). Currently, BIM only *"…considers the ore dock installation as a potential loss and/or alteration of marine mammal habitat*." (TSD24, Section 2.1, p. 12).

Recommendations

- To date "*Monitoring efforts for the ERP are focused on the open-water period when Baffinland shipping will occur*." (TSD28, Appendix V, Section 4.4.2, p. 298). For this reason DFO Science recommends monitoring efforts need to also focus on the shoulder seasons.
- DFO recommends that BIM submit revised monitoring plans that clearly identify dates for the full shipping period including shoulder seasons.
- The extent of sea-ice habitat loss and/or disturbance due to ice-breaking should be assessed for ice-dependent species.

3.3 Monitoring and reporting

BIM's position

Baffinland has previously stated that their ship-based marine mammal surveillance was discontinued in 2016 because of safety of observers and because very few marine mammals were visible to observers. However, in the IR Response to GN 67 BIM indicate that "*the Ship-based Observer (SBO) marine mammal monitoring program ran in 2018 aboard the MSV Botnica during the shoulder seasons*".

DFO Science's analysis and assessment

DFO would like to know how this program was revised to address safety and detection, particularly in light of Condition 107 that requires Baffinland to revise the proposed "*table 3.*" to improve the likelihood of detecting strong marine mammal responses occurring too far ahead of the ship to be detectable by observers aboard the ore carriers. Also, why did the program only run during the shoulder season, when Condition 106 indicates that "*onboard observers are employed during seasons where shipping occurs*".

The results of BIM's monitoring reports are key background documents for the impact assessment. BIM conducts a number of monitoring programs that are not necessarily reported as a single cohesive monitoring plan. A scientific peer-review of the monitoring methodology, results, and reporting would be beneficial to all parties reviewing the FEIS. The results of the 2018 Narwhal monitoring, including the ship-based survey south of Bruce Head, will be important for BIM to consider, particularly since DFO researchers noted differences in Narwhal distribution and abundance in 2018 and this information could have informed Phase 2 FEIS Addendum.

BIM provided information within TSD24 (Appendix A 4.1.5, p. 117) on the results of the community workshops. DFO Science would like to know if this is an inclusive list of all the local knowledge that was shared with Baffinland.

Recommendations

- DFO Science to conduct a peer-review of all marine (and aquatic) related monitoring plans and reports from BIM to ensure that the Proponent's monitoring plans will produce results that are relevant to the monitoring objectives.

3.4 Drift zones and anchoring

BIM's position

Anchorage locations originally established by the Canadian Hydrographic Service (1985), were confirmed as acceptable to the community of Pond Inlet. Three inner Milne Inlet and three Eclipse Sound anchoring locations are shown in Figure 1.5. of the Phase 2 Addendum report (Section 4.1.4).

DFO Science's analysis and assessment

DFO feels that further information on the drift zones would be required to determine any potential effects to the marine ecosystem, including risks to marine mammals or other environmental effects associated with large ships drifting (e.g., potential increase of collisions, change in effects of engine noise, marine mammal occurrence, sensitive benthic habitats). Proposed mitigation measures would also need to be identified in order to address any identified risks. The purpose of the drift zones are not well described; for example, will the area be used as a waiting area if all anchorage locations are taken (if so, for how long) or only in case of emergencies.

Recommendations

- Conduct an assessment of the potential effects to the marine ecosystem resulting from the use of project anchoring locations (Figure 2) and drifting locations. BIM should explain if they plan on establishing any other anchorages and/or if there are any plans to increase the size of the drift zone. How will ship schedules be managed to ensure there are enough available anchoring locations within Eclipse and Milne?
- Video surveys and field surveys should be conducted to establish bottom type and potential sensitive species or habitat use in the anchoring areas prior to project operations, during and post-project completion.
- Permanent moorings should be considered at anchoring locations and throughout the shipping route to compare relative impacts to the marine ecosystem.

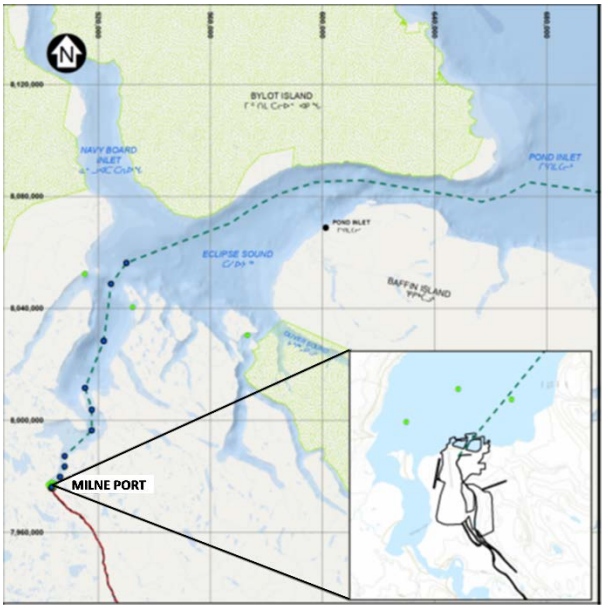

Figure 2. Northern shipping route, including waypoints and anchorage locations.

3.5 Dust Generation

BIM's position

BIM identified that "*For the ore shipped from Milne Port, the secondary crushing and screening activities will be relocated to Milne Port from the Mine Site*." (Addendum, Section 1.2, p. 24). "*This will reduce dust generation at the Mine Site. The existing crushing installation will be retained. Ore stockpiles will be enlarged and railway loading facilities will be installed for the South Railway (railway loading facilities were described in FEIS and permitted under Project Certificate No.005)*." (Addendum, Section 4.1.1, p. 53).

DFO Science's analysis and assessment

The movement of secondary crushing and screening activities from the Mine Site to Milne Port will result in increased deposition in the marine environment. Dust generation at the mine site is less concerning for marine ecosystems than dust generation at the port. The deposition of dust related to the transport, transfer, and storage of ore will negatively impact sea ice, marine productivity, marine habitat, and marine biota. Crushing in the winter will darken snow which in turn will potentially impact the integrity of sea ice and accelerate spring melt (i.e., albedo effect). These will have a negative impact on the marine ecosystem, particularly on ice-dependent pinnipeds (e.g., Ringed Seal, Bearded Seal) which are found in the RSA year round.

BIM's position

In the Addendum to the FEIS (Section 11, p. 136) a Table 11-1 is provided on the sustainability analysis for the Phase 1 Proposal. Within the table the relevant VECs [Valued Ecosystem Components] or Key indicators were identified with BIM's assessment conclusion.

"Project effects on nearshore marine habitat at Milne Port due to prop wash and other dockside activities and noise disturbance on biota; benthic productivity from ballast water discharge, and direct mortality to Arctic char were assessed". The assessment conclusion by BIM is that "*the residual effects on marine habitat and biota as a result of Phase 2 Proposal were expected to be limited to the PDA, occur infrequently and reversible following cessation of Project activities. Therefore, it is unlikely to result in an effect to the preservation of ecosystem integrity or the long-term persistence or viability of marine biota in the local or regional area.*"

DFO Science's analysis and assessment

BIM does not mention the increase in deposition of dust or fines from secondary crushing at Milne Port as well as the transportation, transfer, and storage of ore. BIM should recognize this as an important element that will have an impact on marine habitat and biota. For example, there are relationships between dust, water quality, sediment quality, albedo, and ice melting. The corresponding assessment conclusion for marine habitat and biota also does not reflect the effects of increased deposition.

Recommendations

- DFO Science recommends that prior to starting the crushing operation at the port, BIM should undertake a monitoring plan of dust deposition for Milne Inlet, with attention to ice and indirect impacts on key marine species. Results from this should be incorporated into their conclusions for any future assessment.
- BIM should consider the impact of increased dust deposition on the cumulative effects of climate change.

3.6 Trophic Considerations

BIM's position

There is no mention of 'food chain', 'trophic interactions' or 'food supply' for any of the marine mammals, fishes or marine invertebrates within the Addendum or any of the technical supporting documents, including *TSD12: Migratory Birds Baseline and Impact Assessment*. Marine birds rely on fisheries resources for survival and to support key life history periods (e.g., foraging, survival of offspring, energy budget).

Indirect impacts such as a change in the food sources of fisheries caused by Project activities may adversely affect species (marine invertebrates, fishes, marine mammals) energy budgets and thus their fitness. In TSD24, Section 2.6, p. 42, BIM states that "*Change in habitat caused by construction of new ore dock and freight dock = change (decrease) in suitable foraging habitat in Milne Inlet*". For this reason DFO asserts that BIM should also consider displacement of Narwhal prey, and sound disturbance which can affect foraging ability.

Recommendations

- As was recommended in DFO (2014) for the ERP, BIM should develop a monitoring program that takes into consideration the food sources of marine mammals and marine fishes (including Arctic Char) in Milne Inlet and Eclipse Sound.

3.7 Benthic invertebrates and fishes

BIM's position

Using the Phase 2 Proposal shipping schedule and vessel information, it was determined that ore carriers will discharge exchanged ballast water 176 times per year to allow for loading of ore upon arrival at Milne Port. This is approximately a 3-fold increase compared to the 2012 estimate (SEM 2013). "*At the berth, vessels will discharge approximately 12,500 to 37,500 tonnes of ballast water. A total of approximately 3,023,750 tonnes of ballast water is anticipated to be discharged into Milne Port during the shipping season each year*." (TSD21, Table 3.1, p. 16).

Ballast water originating from the North Atlantic and the Labrador Sea is assumed to have a temperature of 6ºC and salinity of 34 PSU. In Milne Inlet, water temperature in the summer ranges between approximately 5ºC at the surface and -1.5ºC at depth below the pycnocline (5 m to 10 m), while salinity ranges between approximately 23 PSU at the surface and 32 PSU at depth. Because of the density difference, discharged ballast water will sink to the bottom at the discharge point and will follow the depth gradient along the seabed in the offshore direction where the plume will dissipate relatively quickly due to mixing with ambient water.

Ballast water will rapidly cool and be diluted to ambient conditions, but there may be exceedances of CCME guidelines for temperature (±1ºC; CCME 2014) and salinity (±10% expressed in ppt; CCME 2014) at the discharge point. These differences, however, will occur only within a limited area at the discharge location. CCME (1999; 2003) recommends allowance for an initial dilution zone (IDZ) while applying these guidelines. No exceedances of CCME guidelines for temperature and salinity are expected outside of the ballast water IDZ. Even within the IDZ, the changes will be temporary; temperature and salinity of ambient water will return to their background conditions as soon as discharge is terminated.

Modeling of ballast water dispersal in Milne Inlet predicted that there would be a low magnitude effect on water quality from ballast water discharges and no effect on sediment (Section 2.1.3). Ballast water would contribute less than 0.1 % of the changes in water properties that occur

naturally in Milne Inlet on an annual basis. Pelagic and benthic biota would be exposed to a small increase in temperature (by more than 1ºC) and decrease in nutrient concentrations from ballast water over a small spatial extent. Overall, the magnitude of ballast water effect on marine habitat and biota through water and sediment quality change was determined to be low.

DFO Science's analysis and assessment

BIM does not describe where the ballast water exchange will occur outside of the EEZ. Depending upon what water mass the exchange occurs in Baffin Bay/Labrador Sea, the temperature and salinity can be quite different than the assumed values provided by BIM (see Tang et al. 2004).

The amount of ballast water that has been estimated will be the 3rd largest port in terms of ballast water discharges in the Atlantic/Great Lakes, following Sept Iles and Port Cartier. Given the number of vessel trips per open water season, ships will be continuously discharging ballast at the port, and the likelihood is high that physical/chemical water properties will not exactly match the surrounding environment at all times; the ballast water of higher density will sink to the bottom, and spread along the seabed slope and could result in a long lasting alteration to fish habitat in an undetermined area of influence. Arctic marine fish and invertebrate communities are often characterized based on their relationship to water masses (e.g., Carmack and Macdonald 2002, Conlan et al. 2008, Roy et al. 2014). Some sessile species of marine fish and invertebrates may be adapted to sudden changes in water masses, such as could occur with the discharge of ballast water in the vicinity of the Milne ore dock, but others may not be able to tolerate these changes; with the potential to result in a harmful alteration or destruction of fish and fish habitat well beyond the immediate vicinity of the loading dock given the projected ballast water volumes and frequency of discharges during the shipping season.

BIM's position

Because the presence or absence of a swim bladder may have a role in hearing, a fish's susceptibility to injury from noise exposure depends on the species as well as the presence and possible role of a swim bladder in hearing. Thus, different thresholds were proposed for fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Fish eggs and larvae were considered separately (TSD21, Section 3.6.6, p. 71).

DFO Science's analysis and assessment

It has long been believed that most fishes with open swim bladders (i.e., physostomous) were not particularly susceptible to high dB sounds, and it had been assumed that fluid filled organs such as the inner ears critical for balance would be very robust to physical effects of sound in water. Physoclistous fish (i.e., closed swim bladders) are of course susceptible to high intensity sounds due to the potential for swim bladder rupture. However, Sapozhnikova et al. (2018) have demonstrated that intense sounds in the water will affect the hair cells of the inner ear that are essential for maintaining balance. So, anthropogenic sound not only disrupts communications in the (relatively) few species that are known to communicate using sound, but also can affect balance in all others.

BIM's position

In the summary of EEM studies, BIM concludes that sedentary marine species (e.g., sculpins) are not in adequate abundance, and that Arctic Char although commonly captured, are highly migratory in the marine environment, and have a freshwater phase of life cycle, which can confound cause and effect changes to populations (TSD28, Appendix W, Table 3.1). Also they

are harvested for recreational, subsistence or commercial use in the arctic. BIM concludes therefore Arctic Char (*Salvelinus alpinus*) are not suitable for EEM monitoring. BIM states that both of these species may be useful for surveillance level monitoring, and opportunistically sampled for contaminant analyses.

DFO Science's analysis and assessment

DFO agrees with BIM conclusion that Arctic Char are not suitable for EEM monitoring for the reasons presented above. However, DFO does not consider the fishing efforts sufficient to determine whether suitable abundances of marine species occur in the study area for use in EEM. For instance in 2016, gillnets were set for one day at each of 13 stations (sets ranged from 1.9–9.8 hours). A single day of sampling per station is not likely to allow an adequate assessment of the marine fish community (seasonal abundance and diversity). Sculpins have been successfully sampled in other arctic locations and deemed suitable species to assess diet, trophic structure, and impact of vessel traffic (e.g., Ivanova et al. (2018) and references within).

BIM's position

DFO noted during the review that the level of metal concentrations within some fishes was concerning. More specifically, BIM states that "*Concentrations of these metals in fish tissue were, in general, consistent from 2010 to 2016.*" (Addendum, Section 8.2.6.2, p. 87), and that "*Several metals (including cadmium and iron) were present in such low concentrations that they were generally below the analytical level of detection. Mercury concentration at Milne Inlet exceeded the CCME guideline for the protection of marine aquatic life in two samples collected from Milne Inlet.*" (Addendum, Section 8.2.6.1, p. 86).

DFO Science's analysis and assessment

If this assessment is based on monitoring data, then the statistical significance and/or trends should be presented. It is difficult to determine what is meant by "in general". It would be helpful if BIM would provide the actual values for trace elements, and, using supporting literature comment on the population level impact on the fishes.

BIM's position

With reference to the sediment sampling, BIM states that "*Sediment sampling will continue to evaluate if the trends observed between 2014 and 2017 will continue and to determine whether these are attributed to Project-related activities or natural variability*." (Addendum, Section 8.3.9, p. 99).

DFO Science's analysis and assessment

The Proponent has stated they are taking a precautionary approach to environmental effects monitoring, therefore the default assumption would be that observed changes are attributed to the mine, unless evidence to the contrary is available.

BIM's position

Initially, benthic infauna data collected in 2010 and 2013 were assessed through power analysis to determine sample size requirements to detect changes in benthic infaunal community structure as related to Project activities. The benthic community is a common monitoring target for environmental effects in the marine environment and is frequently included in monitoring programs conducted under Environment Canada's Metal Mining Effluent Regulations (MMER). The benthic community at Milne Inlet however, was characterized by low species diversity and abundance and had a depth stratified structure (SEM 2014). 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. Consequently, benthic infauna is not included as a monitoring target for the MEEMP. Benthic infauna were considered inadequate for EEM because of the high yearly and within-in year variability. Benthic infauna will be collected as part of the AIS monitoring program (TSD28, Section 3.2.4).

With respect to the choice of video recording of epibenthic fauna, "these differences must be interpreted cautiously given the high variability within the system coupled with the difficulty in collecting data over the exact same area from year to year. Transects will continue to be re-sampled in future years to increase the power of analysis. The ability to re-sample the same transects in future years will continue to depend on field sampling conditions but every effort will be made to replicate the same transects, to satisfy conditions required for repeated measure design." (SEM 2016, EEM report, p. 241).

DFO Science's analysis and assessment

Benthic infauna is being collected in a systematic fashion for AIS monitoring, so why cannot they also be used for some benthic community level analyses? Benthic densities are commonly highly clumped and are therefore highly variable. That should not preclude all the valuable species richness and the relative abundance of species from being used in the EEM monitoring program (e.g., see SEM 2014, where several metrics of benthic communities were calculated, or in 2016 where there was a cluster analysis of benthic stations, and diversity indices calculated). It is quite likely that any serious impacts (e.g., accidents and spills, unpredicted changes to marine environment near the port from ballast dumping, or introduction of highly aggressive invasive species) will be so catastrophic that the metrics used in the 2016 SEM report will be important Early Warning Indicators, and at the very least point to a more intensive sampling program to better understand the impacts (SEM 2016).

BIM's position

The collection of zooplankton and benthic infauna constitutes a major component of the BIM AIS program (TSD28).

DFO Science's analysis and assessment

DFO notes that different labs have conducted taxonomic analyses, and differences within lab sample processing has occurred to date. Consistent expertise for taxonomic analysis is important for the comparability of data over time and the interpretation of possible changes in the system. Some rarer species may be named differently depending upon how familiar taxonomists are with the literature.

Recommendations

- DFO science recommends that seasonal water sampling be conducted in a manner to gather necessary information to allow modelling and assessment of long term changes to fish and fish habitat surrounding the port resulting from ballast water discharge (prior to project operations, during and post-operations).
- DFO recommends that BIM take recent research on effects of noise on swim bladders of fish (Sapozhnikova et al. 2018) into consideration when assessing the range of impacts to marine fish in the vicinity of the Milne port resulting from construction and operation of the facility.
- In order to assess the marine fish community in relation to water masses (pre- and during operation of the new port when large volumes of ballast water will be discharged), DFO

recommends a more intensive seasonal sampling for marine fish, and recommends the employment of temperature, salinity depth instruments on the nets to better reflect oceanographic conditions at exact locations where fishing occurred in relation to the port.

- DFO recommends BIM re-examine the use of benthic infauna data in EEM monitoring. Benthic invertebrates are mostly sessile organisms and gross changes in communities resulting from project specific impacts, or from changes in near bed water quality from ballast water can best be assessed using invertebrates. Infauna should be used in addition to epifauna, which the Proponent also concludes has high variability based on video sampling (SEM 2016). This monitoring program should commence prior to use of Milne Inlet as proposed in this FEIS.
- DFO recommends the long term value of staying consistent with respect to sample lab taxonomy and lab methodology in sample processing. This has not been the case in this project.

3.8 Marine mammals

BIM's position

In TSD27 (Section 10.5, Table 10-5, p. 126), BIM states that the *"Overall, the residual effects of the Project on marine mammals are predicted to be: Adverse in direction; Low in magnitude given planned mitigation; Geographically confined to the LSA; Infrequent; Of a duration that extends throughout the life of the Project; and Reversible with additional mitigation and the cessation of Project activities."*

DFO Science's analysis and assessment

As we have discussed throughout our science advice, the data as presented in TSD24 either do not support these predictions, or information and analyses are not adequate to allow a complete assessment of impacts to marine mammals.

DFO suggests BIM review the effects assessment tables for Bowhead, Beluga, and Narwhal. DFO Science believes that BIM did not assess the effects adequately for any of these species (TSD24, Section 2.7, p. 55; TSD24, Section 2.8.5.4, p. 60; TSD24, Section 2.6.6.5, p. 50). The extent of shipping extends beyond the RSA as ships continue transiting to their foreign markets. Therefore this is not a localized impact. Additionally, *disturbance/frequency* should be a level III since shipping will be continuous throughout the time Narwhal and Bowhead are in the summering region. For the *disturbance/duration* category, BIM should acknowledge that the disturbance could be long-term. For example, Narwhal may not return to the area if a disturbance is large enough, particularly on the shoulder seasons. Narwhals are sensitive to noise and changes in the ice during their migration (Laidre et al. 2012, Heide-Jørgensen et al. 2013). DFO has concerns that ice-breaking in the fall may confuse Narwhal and inhibit migration out of the area, potentially resulting in entrapments. In the spring season, ice-breaking noise may deter whales from entering Eclipse Sound. For the disturbance/reversibility, there is consensus that there is not enough information available to know if the impact would be reversible and in some instance, the impact would not be reversible (e.g., mortality by definition is not reversible, and we don't know if Narwhals would return to traditional areas after years of noise excluding them).

BIM's position

"*In April 2006, COSEWIC combined both populations into a single unit for Atlantic Walrus (*Odobenus rosmarus*) in Canada and the species was designated as a species of Special*

Concern (COSEWIC 2006b). Based on geographical distribution, genetics, and lead isotope data, four populations or 'stocks' ranging from Nova Scotia to the high Arctic have been recognized for management purposes in Canada (COSEWIC 2006b). These populations inhabit 1) South and East Hudson Bay, 2) Northern Hudson Bay-Davis Strait, 3) Foxe Basin, and 4) Baffin Bay (High Arctic). It is the Baffin Bay (High Arctic) population of Atlantic Walrus that is expected to occur within the RSA." (TSD24, Appendix A, 3.1.5.1, p.120).

DFO Science's analysis and assessment

The COSEWIC reference is outdated, as a new COSEWIC (2017) report has since been made available. There is confusion in the terminology in using Baffin Bay population (considered a stock by Canada) interchangeably with the High Arctic population, which encompasses the Baffin Bay stock and the adjacent West Jones Sound and Penny Strait-Lancaster Sound stocks. Recent tagging in Greenland showed Walrus movements among all three stocks (Heide-Jørgensen et al. 2017), such that all Walrus in the High Arctic population could potentially be impacted by the Project, not just the Baffin Bay stock.

BIM's position

BIM states that "*the residual disturbance effects on Narwhal from pile driving and shipping are predicted to be moderate in magnitude (Level II), confined to the LSA (Level I), intermittent (Level II) in frequency, short-term (Level I) for pile driving and medium-term (Level II) for shipping, and fully reversible (Level I). The residual environmental effect is predicted to be 'Not Significant'*." (TSD24, Section 2.6.6.1, p. 49, Table 2.7).

DFO Science's analysis and assessment

BIM does not evaluate the impact of shipping disturbance to Narwhals outside the LSA, therefore, we cannot evaluate the residual disturbance effects level. In addition, BIM does not provide information to support their assessment that the disturbance from shipping is fully reversible.

BIM's position

"*The footprint of the new dock structures was calculated to determine the amount of potential Narwhal foraging habitat that may be directly lost for the life of the Project. The total area of the new dock structures corresponding with water depths adequate for Narwhal access was calculated to be 1.8 ha. This minor change (i.e. loss) in habitat caused by the new dock structures was lower than the threshold value of 10% and was considered to result in a negligible, low magnitude effect. The residual environment effect is predicted to be "Not Significant".* (TSD24, Section 2.6.1, p. 43).

DFO Science's analysis and assessment

BIM should have considered Narwhal calving habitat in their assessment of loss of habitat and threshold calculation. Similarly, criteria used to define areas of heightened ecological significance (AMAP/CAFF/SDWG 2013) should include calving habitat (TSD24, Appendix A, p. 98, Table 2.3). Foraging and calving habitat losses should also be considered for the anchorage and drifting sites.

BIM's position

With reference to the interaction table found in TSD24, Table 2.3, p. 31.

DFO Science's analysis and assessment

BIM should include the interaction of ice-breakers on seals hauled out on sea ice during their moult season. Ice-breaking represents a serious threat for pinniped species utilizing the ice for moulting. Their ability to evade vessels is limited on ice compared to in the open water. Ice-breaking will result in direct and indirect impacts to these species (e.g., risk of predation, inability to get to haul-out site (Yurkowski et al. 2019). Ice breaking will destroy habitat for seals during their moulting season, and thus should be considered a loss of habitat for that phase of their seasonal life cycle.

Recommendations

- DFO recommends monitoring along the full shipping route and specific methodology employed to assess the negative consequences of disturbance during critical life history periods of pinnipeds.

3.8.1 Impact of port construction and operation

BIM's position

For the construction of the new ore dock, BIM maintains that "*The majority of construction work, particularly in shallow water (e.g., access causeway), will take place in winter as land-fast ice is formed. It is expected that, as construction gradually moves offshore, ice will thicken and become grounded. Therefore, ice surrounding construction areas will act as a barrier limiting particulate deposition and spills in surrounding water.*" Furthermore, in the shipping season "*Proposed mitigation measures included the use of a bubble curtain to reduce peak sound pressure levels emitted from the pile. With mitigation, the zones of avoidance and disturbance onset were estimated at 0.5 km and 2 km (respectively) for Narwhal; and 0.3 km and 2 km for seals. Based on corrected aerial survey densities, 47 Narwhal were predicted to occur within the disturbance zone (<2 km) at a given time in August (estimated four Narwhal in September); potentially resulting in minor behavioral responses amongst these animals. Five Narwhal were predicted to occur within the avoidance zone (<0.5 km) in August (estimated one Narwhal in September), potentially resulting in localized and temporary avoidance behavior amongst these animals.*" (TSD24, Section 2.1.2, p. 23).

BIM then states that, "*Although pile driving was determined to be the loudest noise source during construction and operations, most of the noise was predicted to be confined to within 12 km of the piling site due to the configuration of Milne Inlet*." (TSD24, Section 2.1.2. p. 23).

DFO Science's analysis and assessment

DFO Science would like clarification as to when BIM will start pile driving in winter; if it is based on land-fast ice formation the start date could be quite variable making it difficult to assess the impacts to marine mammals. In order to determine impact, DFO (2014) recommended that marine mammal observers should be present for the entire duration of pile driving. It was also recommended that BIM should either provide a warning sound prior to each piling operation or should use a "soft start" to warn marine mammals within the area. The soft start consists of gradually augmenting the intensity of piling before reaching full impact.

The number of animals predicted to occur in their disturbance zone needs to have errors (i.e., there are times there are hundreds if not thousands of Narwhals in that area – unless shipping is already having an impact on their occurrence there). In order to further assess the impact BIM should explain what their survey density is corrected for (e.g., availability or perception bias).

BIM's position

"*Implementation of a 30 minute pre-operational search for marine mammals prior to start-up of active impact pile driving or dredging, and that hydrophones are being used at the site to periodically measure sound levels of the construction*." (TSD24, p. 23).

DFO Science's analysis and assessment

DFO Science would like to know how BIM will modify their search procedure when visibility is limited to under 1 km, such as during foggy weather? It is unclear whether BIM will also use hydrophones to determine if marine mammals are within the 1-km exclusion zone.

Recommendations

- The 2017 Bruce Head shore-based monitoring program has established methods for before-after impact and it is recommended that this program be revised to determine if there is a change in behavior of marine mammals (e.g., seals) from pile driving at the port site.
- It is recommended that hydrophones be used during the pre-operational search when weather conditions would impede visibility to detect Narwhals.

3.8.2 Impact of shipping – noise (disturbance)

BIM position

With respect to Project Certificate Terms and Condition #111 (NIRB Project Certificate No. 005, December 2012) "*The Proponent shall develop clear thresholds for determining if negative impacts as a result of vessel noise are occurring. Mitigation and adaptive management practices shall be developed to restrict negative impacts as a result of vessel noise. This shall include, but not be limited to:*

a) *Identifications of zones where cumulative noise could be mitigated due to biophysical features (e.g., water depth, distance from migration routes, distance from overwintering areas, etc.); and*
b) *Vessel transit planning for all seasons, to determine the degree to which cumulative sound impacts can be mitigated through the seasonal use of different zones*."

DFO Science's analysis and assessment

DFO is not aware that noise thresholds have been established (either from global literature, or through experimental/monitoring studies specific to the Project). For this reason, it is suggested that any statistically significant change detected in any parameter measure should represent an 'early warning indicator'.

Recommendation

- DFO Science recommends BIM fulfill condition #111 by establishing noise thresholds.

BIM's position

BIM states that "*Many toothed whales show considerable tolerance of vessel traffic*". (Richardson et al. 1995a in TSD24, Section 2.6.2.2, p. 44). In addition, BIM assesses that the project interaction and environmental effect between Narwhal and "*Hearing impairment caused by underwater noise from pile driving and shipping*" is "*Potential hearing impairment (temporary or permanent)*" (Table 2.6 of TSD24, Section 2.6, p. 42). BIM also states that "*There is some uncertainty in terms of how Narwhal will respond to more frequent ore carrier traffic in the narrow waterways of Milne Inlet. There exists similar uncertainty concerning masking effects on Narwhal communication from increased ship traffic in these areas. Although no significant*

residual effects are predicted for Narwhal, Baffinland will continue to conduct tailored environmental effects monitoring programs to evaluate Narwhal responses to ore carrier traffic along the shipping corridor." (TSD24, Section 3.0, p. 64).

DFO Science's analysis and assessment

Narwhal are relatively naïve to any shipping traffic and their interactions with shipping could be different from other species that are found in areas where shipping occurs. As a result, DFO Science suggests that the environmental effects (physiological, behavioural, ecosystem level) of underwater noise from pile driving and shipping are broader than suggested by BIM (Table 1).

Table 1. List of potential effects/responses and potential impacts/consequences of seismic airgun sounds on marine mammal physiology, behavior and ecology (adapted from Table 1 in DFO (2015b)).

Potential effects/responses	Direct potential impacts/consequences	Indirect potential impacts/consequences
Physiological effects		
Non-auditory physiological effects	Emboli formation, organ/ tissue damage, neurological effects, increased stress hormones	Stranding/near-stranding/at-sea death, reduced socializing/foraging, malnutrition, reduced reproduction/survival
Auditory physiological effects (e.g., Temporary hearing thresholds (TTS) and permeant (PTS))	Loss of hearing sensitivity	Reduced socializing/foraging, malnutrition, starvation, increased exposure to threats, reduced reproduction/survival
Behavioural effects		
Changes in dive and respiratory patterns	Stranding/near-stranding, emboli formation, tissue damage, increased energetic cost, reduced socializing/foraging	Stranding/near-stranding/at-sea death, malnutrition, increased exposure to threats, reduced reproduction/survival
Displacement and migratory diversion	Increased energetic cost, reduced socializing/foraging	Malnutrition, increased exposure to threats, reduced reproduction/survival
Changes in social behavior (e.g., hampered parental care and bonding, hampered breeding, etc.)	Reduced socializing/foraging	Calf mortality, reduced reproduction/ survival
Changes in vocalization patterns (e.g., hampered communication and echolocation)	Reduced socializing/foraging	Malnutrition, reduced reproduction/survival
Changes in time budget (e.g., proportion of time spent performing various activities such as resting, foraging, socializing)	Increased energetic cost, reduced socializing/ foraging/resting	Malnutrition, increased exposure to threats, reduced reproduction/ survival
Changes in cognitive processes (e.g., distraction)	Reduced socializing/foraging	Malnutrition, increased exposure to threats, reduced reproduction/ survival
Ecosystem effects		
Hampered passive acoustic detection of prey, predators, and conspecifics	Predator-related injury/mortality, reduced socializing/foraging	Malnutrition, increased exposure to threats, reduced reproduction/ survival
Hampered avoidance of anthropogenic threats (e.g., ship strikes, bycatch, etc.)	Anthropogenic injury/mortality	Increased exposure to threats, reduced reproduction/ survival
Hampered use of critical habitat/reduced occupancy	Reduced socializing/foraging	Reduced reproduction/ survival

The average number of individuals potentially affected by shipping noise each year can be determined by multiplying the zone of impact around a ship track (i.e., with noise levels in excess of 120 dB re 1 µPa) by local marine mammal density estimates. This simple calculation assumes that whales are homogeneously distributed and provides an index of the number of whales disturbed by shipping noise.

Table 2. Values calculated to determine the footprint of noise from shipping along the Northern Shipping Corridor.

	Transit length (km)±	Width of 120 dB noise footprint Post-Panamax (km)*	Area covered by noise (km²)	Width of 120 dB noise footprint for a Cape size (km)¥	Area covered by noise (km²)
Koluktoo Bay	40	5	200	5	200
Milne Inlet	47	15	704	15	704
Eclipse Sound	77	17	1304	25	1925
Pond Inlet	99	10	990	15	1485
TOTAL	**263**		**3198**		**4314**

±Calculated based on Figure 2.
*Measured from Figures E-7, E-8, E-9 and E-10 of Appendix B of TSD-24.
¥Measure from Figures E-19, E-20, E-21 and E-22 of Appendix B of TSD-24.

Assuming a density of Narwhals in the LSA of 1.24 Narwhals/km^2 (0.78-1.97 95% confidence intervals [95% C.I.]; DFO 2015c), we estimated that 3,966 Narwhals (2494-6307 95% C.I.) will be disturbed by the noise of a Post-Panamax carrier and 5,350 Narwhals (3359-8492 95% C.I.) will be disturbed by the noise of a Capesize carrier, at each transit (one-way), which represents between 40 and 50% of the Eclipse Sound summer aggregation of an estimated 10,500 (6596-16679 95% C.I.) Narwhals.

Assuming a density of Bowhead Whales of 0.0038 Bowhead/km^2 (0.001-0.01 95% C.I.; DFO 2015d), we estimated that 12 Bowhead whales (3-44 95% C.I.) will be disturbed by the noise of a Post-Panamax carrier and 16 Bowhead whales (4-59 95% C.I.) will be disturbed by the noise of a Capesize carrier, at each transit (one-way) which represents between 40 and 50 % of the estimated 32 Bowhead whales in the LSA.

Assuming that the shipping season is 106 days (between July 1 and October 15) and that there will be 368 ship transits, 40 to 50% of the Narwhals and Bowhead in the LSA with be disturbed 3.5 times each day by the noise related with shipping activity. DFO Science concludes a large number of whales will be affected by Project noise.

BIM's position

BIM reports noise levels between 120 dB to >180dB (TSD24, Section 2.6.2.2, p. 46). Also, TSD24, Appendix B, p. 243, states "*that the measured levels were adjusted to the modelled speeds of 9 and 5 knots using Equation A-1*". Appendix B Section 5.1 also presents various sound models in Milne Inlet (e.g., E1, E3, E26, E 27).

DFO Science's analysis and assessment

DFO Science recommends a better representation of range of noise from 100dB to > 180dB particularly since these levels can be heard by Narwhals.

DFO Science questions the choices of the parameters for the sound propagation modelling. According to Jasco's measurement, transiting carriers travelled at 9-13 knots, however Jasco modelled using speeds of 5 and 9 knots. The difference between 9 and 13 knots could result in an increase in sound level of about 4 dB, more than doubling the perceived noise level.

The sound exposure levels (SEL) of the different carriers seem low compared to SEL published in the literature (e.g., Simard et al. 2016). Was the ANSI S12.64 Standard protocol followed (ANSI, Quantities and Procedures for Description and Measurement of Underwater Sound From Ships – Part 1: General Requirements, ANSI/ASA S12-64 (Acoustics Society of America, New York, 2009), 21 pp). This is the only internationally recognized protocol. Could BIM comment on the difference between their measured level and published levels?

With respect to the isopleth maps in TSD 24, Appendix B Section 5.1 the SEL and the other parameters of the sound propagation models will have variability. The presented results should include variability in the estimates.

In TSD 24, Appendix B, Section 5.1, E-1 and E-3 sound propagation modelling in a narrow fjord (Milne Port) is challenging. A 3D approach would be more appropriate. DFO suggests that BIM presents a 3D model or discuss the differences in the model results between a 2D and a 3D model.

In TSD 24, Appendix B, Section 5.1, E-26 and E-27 the sound propagation exercise only covers 3 locations on the ship transit. Given that the sound is not linear, modelling along the entire ship route would be required for a proper assessment. For example, in figure E-26 and E-27, the size of the beam of sound will change according to the location of the source of sound. Therefore, a model based on a static sound source does not provide enough information to assess the impact of noise.

Recommendations

- BIM sound exposure modelling consider 100dB – > 180dB.
- BIM compare SEL results using their protocol vs the internationally recognized protocol.
- BIM provide variation in the noise propagation results.
- BIM consider using a 3D sound propagation model along the entire ship route, or at least discuss the impact of using a 2D model.

BIM's position

"*The cumulative sound level ('loudness') is not predicted to increase when multiple vessels are present in the same area*." (TSD27, Section1.4.14.3, p.52).

"*It is anticipated that, should multiple vessels transit through a given area, the cumulative noise field will increase spatially* (TSD27, Section 1.4.14, p.50; TSD24, Golder 2018b). *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* (TSD24)."

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). (TSD27, Section 1.4.14.4, p. 53).

DFO Science's analysis and assessment

While BIM provides some cumulative noise modelling scenarios, none of the scenarios show two transiting carriers in Eclipse Sound or Milne Inlet. Therefore, it is not possible to evaluate the cumulative noise of multiple vessel in the same area. These scenarios are likely to produce louder noise levels BIM is right that sound levels are represented by a logarithmic scale.

However, that means that an increase of 3dB is equivalent to doubling the perceived noise level. Therefore, a small change in noise level can be significant for the animals present.

BIM's position

"*Narwhal are likely to tolerate/habituate to the short-term increased levels of underwater noise and remain in the area*." (TSD27, Section 1.4.14.3, p. 52).

DFO Science's analysis and assessment

It is unclear whether this statement is based on observation, or from a literature search. Is there a reference for this comment?

BIM's position

"*Effects on Narwhal from cumulative underwater noise sources are predicted to be moderate in magnitude (Level II), confined to the LSA (Level I), intermittent (Level II) in frequency, short-term (Level I) for pile driving and medium-term (Level II) for shipping, and fully reversible (Level I). The residual environmental effect is predicted to be not significant.*" (TSD27, Section 1.4.14.3, p. 52-53).

DFO Science's analysis and assessment

DFO is of the opinion that shipping will have impacts outside the LSA, and that the frequency is constant in the open water season. Can BIM provide a reference to support their conclusion that the impacts are fully reversible?

Recommendations

- It is suggested that multiple noise parameters are monitored to indicate change. These should be reported annually in order to determine if a threshold has been met. DFO suggests a comprehensive monitoring plan be developed.
- DFO Science suggests that BIM should include noise propagation modelling for ships anchored at the anchorage and/or drifting locations within the RSA. Tremblay Sound is an important area for Narwhals in the summer and the presence of anchored and/or drifting ships at the entrance of the sound might lead to Narwhal displacement.

3.8.3 Impact of shipping - noise (masking)

BIM's position

Masking is a valid concern for marine mammals at Milne Port, and along the entire Northern Shipping Route. BIM has consistently stated throughout the Addendum that there is minimal impacts to marine mammals. For example, "…*given that most of their calls [Narwhal and Beluga] occur at predominantly higher frequencies than ship noise, and acknowledging the short duration of vessel noise, it was considered unlikely that masking from ship noise would significantly affect Narwhal and Beluga* (TSD24, Section 2.1.4, p. 24). However BIM states that, "*As previously noted, Narwhal are considered MF cetaceans (Southall et al. 2007) with their most sensitive hearing range occurring in the mid-frequency range ranging from 20 to 100 kHz (Richardson et al. 1995a). Narwhal vocalization studies indicate that this species primarily vocalizes in the 300 Hz to 24 kHz range (Ford and Fisher 1978; Marcoux et al. 2011; Marcoux et al. 2012). Ship noise generally dominates ambient noise at low frequencies, with most energy occurring between 20 to 300 Hz and some components extending into the 1 to 5 kHz range (Richardson et al. 1995a)."* (TSD24, Section 2.6.4, p. 48).

DFO Science's analysis and assessment

This is a simplistic assessment of the impact of masking. There is an overlap between Narwhal communication signal and shipping noise (between 300 Hz and 10 kHz). DFO Science suggests a proper simulation of masking should be completed to evaluate the impact of masking on Narwhals. To quantify the masking impact risk the communication space should be assessed under natural (i.e., without anthropogenic sources) and anthropogenized conditions (with additional anthropogenic sources). As natural and anthropogenized environments are both variables in time and space those two conditions should be monitored across the area that will potentially be impacted by anthropogenic activities, and over a sufficient period of time to capture the variability (e.g., annual cycle for natural noise (Kinda et al. 2013, 2015); along the period of activity for anthropogenic noise (Aulanier et al. 2017).

Then, the risk that shipping noise will reduce the communication space can be assessed (Clark et al. 2009, Hatch et al. 2012, Aulanier et al. 2016). As a first approximation, the range reduction factor (Mohl 1981), can be assessed and used as a proxy for the loss of communication space (Aulanier et al. 2017). It is important to note that currently, the acceptable risk threshold for a certain level of communication space loss has not been scientifically demonstrated.

3.8.4 Impact of shipping – mitigation measures

BIM's position

BIM identifies a number of "*mitigation measures [that] will be implemented to reduce or avoid adverse effects on marine mammals as a result of shipping activities for the Phase 2 Proposal:*

> *Vessels will reduce speeds to a maximum of 9 knots when transiting along the established shipping corridor, and 5 knots when operating in Milne Port, thus reducing the overall noise output generated by ship propulsion…;*
>
> *…Vessels will minimize idling when docked at Milne Port;*
>
> *…Idling at the ore dock and moorage will be kept to a minimum in an effort to decrease underwater noise;…*" (TSD24, Section 2.5.2.2, p. 37).

They also state that *"…acknowledging the short duration of vessel noise, it was considered unlikely that masking from ship noise would significantly affect Narwhal or Beluga.*" (TSD24, Section 2.1.4, p. 24).

Based on these measures, BIM maintains that "*With the effective implementation of mitigation, the residual environmental effect of disturbance from ship noise on Narwhal, was predicted to be "Not Significant"* (TSD24, 2.6.2.2, p. 46).

DFO Science's analysis and assessment

DFO is not confident that the sound mitigation measures identified by BIM will be effective, particularly for those large ships that transmit sound from shore to shore in narrow areas of the shipping corridor (Figure 3). In addition, based on the data presented in the 2017 Bruce Head Shore-based Monitoring Program (Report No. 1663724-041-R-Rev0, Table 5-1, p.44), a number of the project-related vessels exceeded 9 knots within the RSA and LSA (Figure 4).

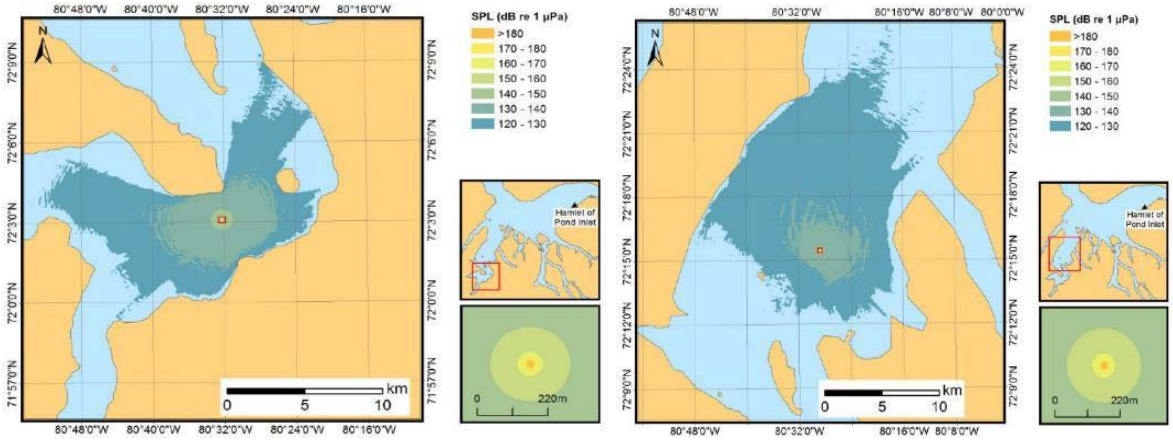

Figure 3. Noise propagation from a Cape sized Carrier travelling at Koluktoo Bay/Bruce Head (left panel) and Milne Inlet (right panel)(Figure 2.2 from TSD24, Section 2.6.2.2, p. 46).

DFO would also like BIM to clarify "*short duration* [of noise]", based on the number of ships entering and departing Milne Inlet and the unspecified time idling and drifting, the noise in the LSA appears to be extensive (i.e., non-stop). How does BIM conclude that vessel noise is short duration? BIM also states that "*Masking effects on Bowhead were predicted to be localized in Milne Port, and short-term along the shipping route relative to the interval between ship transits*." (TSD24, Section 2.1.4, p. 25). DFO Science would like clarification as to what is the interval between ship transits. Understanding the ratio of quiet hours to when vessels are present is useful information for an accurate assessment.

Recommendations

- There are two aspects used to assess the impact of exposure to sound related to shipping: the level and the duration of the sound. BIM report sound pressure levels, however it would be helpful for BIM to provide 24 hour sound exposure levels (SEL) related to shipping, in 10 dB increments. It would also help if BIM were to provide the percentage of time Narwhals will be exposed to different levels of sound.

3.8.5 Impact of shipping – whale strikes

BIM position

In TSD24, Section 2.7, p. 55, BIM states that "*Bowhead whale mortality is not expected to occur as a result of the Phase 2 Proposal activities. All available information suggests that Bowhead will actively avoid vessels transiting in the LSA (Section 2.8.1). With the effective implementation of mitigation, the potential residual effects of Bowhead mortality due to vessel strikes is predicted to be negligible. The residual environmental effect on Bowhead is expected to be 'Not Significant'*".

BIM states that "*The potential for a marine mammal-vessel strike resulting in injury or mortality was evaluated in the previous assessment. Mitigation measures proposed to reduce the potential for a ship strike included reductions in ship speeds (to between 7 and 10 knots) along the Northern Shipping Route, as well as the requirement for vessels to maintain a constant course and speed when in transit. With mitigation measures in place, residual environmental effects to marine mammals was predicted to be "Not Significant" for all marine mammals.*"

BIM suggests that "*With the effective implementation of mitigation, the residual effects of mortality on Bowhead due to vessel strikes are predicted to be low in magnitude (Level I),*

confined to the LSA (Level I), infrequent (Level I) in occurrence, medium-term (Level I) in duration, and fully reversible (Level I) (Table 2.11). The residual environmental effect is predicted to be 'Not Significant'." (from TSD24, 2.8.5.4, p. 60). This was further reiterated in TSD24, Table 10-2, p. 113, "*Collision with marine mammals resulting in harm to marine mammals rated as a minor consequence, rare likelihood and low risk*."

DFO Science's analysis and assessment

DFO does not agree with the current effects assessment summary for Bowhead provided in Table 2.11 of the document titled TSD24 (p. 60). For example, the extent of effects should be evaluated as a Level II (within the RSA and beyond). The reversibility of mortality from ship strike should be ranked as a Level III, since mortality cannot be reversed. This is a general comment for all effects tables within the TSD24. Additionally, with reference to Table 10-2, the consequence of a collision would be fatal (not minor consequence), and the likelihood of a slow moving large cetacean colliding with a vessel is greater due to the significant increase in vessel activity in the region.

Bowhead face some of the same risks as North Atlantic Right Whale in terms of ship strikes. The North Atlantic Right Whale is classified as Endangered under the *Species at Risk Act*, due to persistent lethal and sub-lethal vessel strikes and frequent entanglement in commercial fishing gear. Vessel strike and fishing gear trauma have been documented in Bowhead, but at a much lower rate than in Right Whales (see Reeves et al. 2011) likely due to the lower amount of vessel traffic and fishing activities in the Arctic. However, with the proposed introduction of increased shipping, it is likely that the risk and incidence of Arctic whale injury and mortality from vessel traffic will increase.

BIM evaluates impacts only within the defined marine mammal local and regional study areas which extend to the Nunavut Settlement Area boundary. The ship track continues east into Baffin Bay and at some point crosses the Economic Exclusive Zone (EEZ) as the vessels travel to Europe and make their return voyage. For both the Northern Shipping Route and the alternate route (i.e., Navy Board Inlet), a larger proportion of the ECWG Bowhead population is migrating in both spring and fall along the coast in Baffin Bay and Lancaster Sound to access important nursing, foraging and refugia (i.e., predator avoidance) habitat in the summer (DFO 2009). BIM states that "*a total of 14 Bowhead were recorded near Bruce Head during five consecutive years of shore-based monitoring conducted for Baffinland from 2013 to 2017. Similarly, a total of 14 Bowhead were recorded along the Northern Shipping Route during three consecutive years of aerial surveys conducted between 2013 and 2015*."

The impact of vessel strikes on these animals is likely underestimated based on the current level of marine mammal ship based observing effort and assessment. Although there are few Bowhead sighted within the LSA and at the Milne Port site, the proportion of Bowhead within the RSA in Baffin Bay and along the alternate route in Lancaster Sound would be greater. Additionally, the seasonality of when Bowhead would be impacted by the Project does not temporally correlate with when the monitoring took place.

Ship strikes typically go undocumented, largely due to the fact that most whales are negatively buoyant and sink rather than wash ashore or float (Allison et al. 1991 in Lawson and Lesage 2013); in the Arctic there is a lowered capacity to detect whales or collisions from ships or icebreakers as a result of prevailing light and weather conditions (Lawson and Lesage 2013). Lawson and Lesage (2013) also highlight the characteristics that make Bowhead vulnerable to ship strikes (e.g., low degree of escape response). Even though BIM indicates that "*The standing instructions require vessels to reduce speed to a maximum of 9 knots beginning at the entrance to Pond Inlet (at 76° longitude) through Eclipse Sound and Milne Inlet."* (Addendum).

The impacts associated with Bowhead are more likely associated with the shoulder seasons and when the vessels no longer have these speed restrictions imposed on them.

Although Beluga and Narwhal would be expected to be less vulnerable to ship strikes than Bowhead whales, there is still a risk, particularly based on the increases in voyages, ship size and expanding the season into the shoulder seasons when whales have started their migrations.

Lawson and Lesage (2013) developed a ship strike model which includes model assumptions and strike estimates for marine mammals. Risks of mortality or severe injury related to ship strike can be determined using a simple area interaction model. The theoretical and analytical basis of the ore carrier whale strike risk estimation is a mathematical area-interaction model. The model assumes the following:

- The vulnerable parts of the Bowhead whale can be represented as a line of the same length as the whale.
- The whale's orientation relative to the direction of travel of an ore carrier is random.
- The whale does not tend to move into or out of the carrier's path (they may avoid the carriers, but if their mobility is constrained by shallow waters, two vessels passing each other, or available breathing sites in winter this may not be possible).
- The carrier transit route has an overall density of whales that is the same as some larger area from which a survey has given a density estimate. (This is unlikely in winter when both whales and ships will occur more frequently in areas of minimal ice cover.)
- Ore carriers do not avoid whales (it is unlikely they would see them unless in daylight and open water, and their speed and size makes avoidance maneuvering difficult).

The model uses the whale as a horizontal linear target at random orientation to the carrier's line of travel, and which would present an average "target size" of 0.64 x whale's length. Given the size of the vessels, the whale could be viewed as a point and half the "target size" of the whale can then be added to both sides of the "damaging width" of the ore carrier to give a "collision strip width" of W + 1.27L. From the length of the ore carrier transit a "collision area" can then be derived: (W + 1.27L) x D/1000 km^2.

With the number of transits per year and the density of whales at risk, the annual number of vessel/whale collisions in the modelled area would equal (W + 0.64L) x D/1000 x Y x T x P (Table 3). For Bowhead, the model estimates that approximately 8 whales (2-30 95% C.I.) per summer may be struck by an ore carrier, given the aforementioned assumptions. Calculations for Narwhal and Beluga can be found in DFO (2014).

Given the assumptions used in the model, and the generalized nature of the model itself, there are a number of sources of error in these estimates. This process minimizes the estimated risk by selectively biasing the errors in the most favourable (fewer strikes) direction. DFO Science used:

- a body length size which is not the maximum for the species;
- the percentage of time Bowhead whales spend within 8 m of the surface even if vessel draft varies from 13 and 20 m; and,
- assumed ships encounter whales as single individuals rather than groups (or that the loss of an adult does not affect the survival of a dependent offspring or relative).

If whales have an avoidance reaction to approaching carriers – and are able to move away without being constrained by ice or bathymetry, then ore carrier passage would entail lower risks. The whales' flukes and caudal peduncles may present a lower risk of mortality if struck than the body, making the "risk length" shorter than assumed in this exercise although a tail strike could still inflict a lethal swimming disability.

Table 3. Ship strike model assumptions and strike estimates for Bowhead whales within the Mary River Project Northern Shipping Route (based on the equation in Lawson and Lesage 2013).

Population or Stock	Body Length (m)	Fraction of Time at Surface (%)	Damaging width of a capsize vessel (m)	Population/Stock Density (95% C.I. n/km^2)	Distance travelled by carriers (km)	Yearly number of transits	Estimate number of whale struck (95% C.I.)
Eastern Canada-Western Greenland Bowhead	15.00	38 (Watt et al. 2015)	52.5	0.0037 (0.001-0.01; DFO 2015d)	263	368 (TSD22, p. 5)	8 (2-30)

Recommendations

- BIM should re-evaluate the significance of ship strikes related to the project (including inside and outside the RSA), and should consider other marine mammals that would be entering the RSA in summer during the open water shipping season and their risk of ship strikes. As the ice environment continues to change from climate change, the removal of sea-ice choke points means that other whales are venturing farther north into the Canadian Arctic, including Baffin Bay to take advantage of the productive summer months (e.g., Killer Whale, Sperm whale, Fin whale) (Higdon and Ferguson 2009, Higdon et al. 2011, Sheldon et al. 2017). The BIM shipping corridor crosses perpendicularly to the migration corridor for many of these summer migrant species.

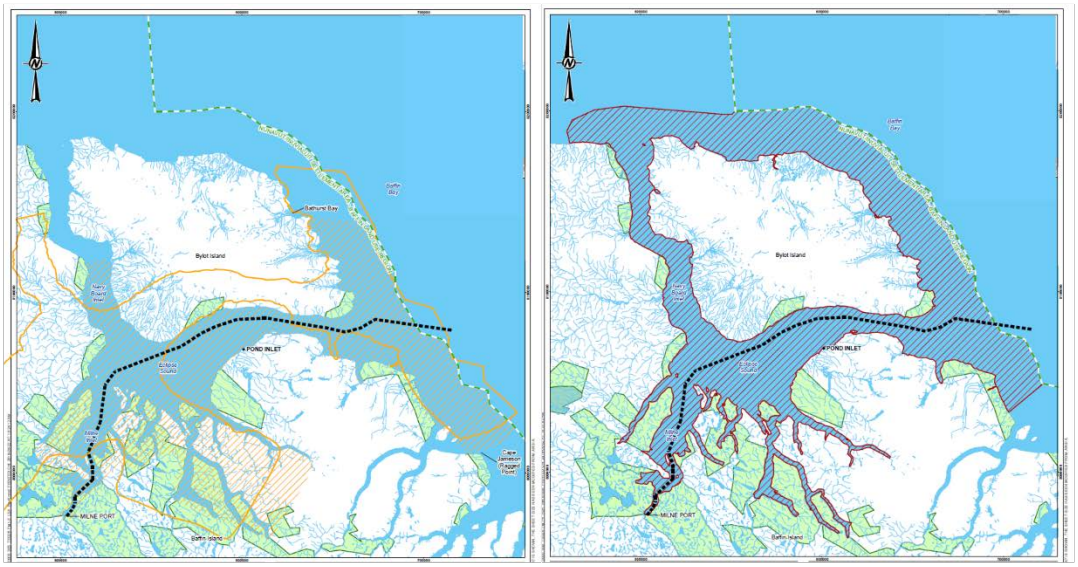

Figure 4. Marine mammal local (left) and regional (right) study areas, as defined by Baffinland in TSD24, Figures 1.3 and 1.4.

3.8.6 Impact of shipping – ice breaking

BIM's position

BIM suggests that "*Although there is no evidence of Ringed Seal injury or mortality due to icebreaker movements in the available literature, seals have been reported to demonstrate fleeing behavior when a ship approached within 0.4 to 0.8 km (Richardson et al. 1995*a)." (TSD24, Section 2.5.3.1, p. 40).

DFO Science's analysis and assessment

BIM should consider recent literature for their assessment of potential impacts of ice breaking on seals during critical life-history periods (including pupping during shoulder periods). Yurkowski et al. (2019) provide rough density estimates and spatial coverage of Eclipse Sound Ringed Seals in spring. The authors also mention concerns with ice breaking at this critical life-history period. Wilson et al. (2017) discuss ice breaking activities and their effect on seals, including an assessment of impacts and potential mitigation for icebreaking vessels transiting pupping areas of an ice-breeding seal.

Indirect effects of ice breaking may include changes to the prey base for seals. Moreover, juvenile seals migrate seasonally and if disturbed during the open-water season they will likely chose to move to other areas which can indirectly affect condition.

BIM's position

"*Potential effects on marine mammals range from subtle changes in behaviour at low received levels to strong disturbance effects or physical injury at high received levels.*" (TSD24, Section 1.3.1, p. 18).

"*Project vessels shall not approach within 300 m of a Walrus or polar bear observed on sea ice.*" (TSD24, Section 2.5.2.2, p. 37).

DFO Science's analysis and assessment

Walrus haulout areas have been identified close to the alternate route. The 300 m buffer zone is not a sufficient distance for Walrus on sea ice. See passage from the Science Response: "Ice breakers have the greatest potential for disturbance given their frequent accelerations, turns, and reversals of direction (Garlich-Miller et al. 2011). Fay et al. (1984) found Pacific Walruses on ice reacted to an icebreaking ship when it was within 2 km. Females with young went into the water when the ship was 500–1000 m away, while males did not enter the water until the ship was 100–300 m away (Fay et al. 1984). Brueggeman et al. (1990) found most groups of Walruses hauled out on ice showed little reaction to ice breaker activities beyond 800 m. McFarland and Aerts (2015) recorded the behavior of Walruses in water and on ice at various distances from their survey vessel. Diving and changing course or speed occurred primarily within 500 m of the vessel." (DFO 2019).

Recommendations

- DFO (2019) 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.

- If the Proponent suggests any approach limitations for Walrus and Polar bear, then seals should also be included "*Project vessels shall not approach within 300 m…observed on sea ice*" (Table 20, p. 32).

BIM's position

"*… shipping at Milne Port will continue to occur during the open water season, and may extend into the shoulder periods when the landfast ice is not being used to support travel and harvesting by Inuit*." (TSD24, Section 1.1, p. 12).

DFO Science's analysis and assessment

DFO has to re-emphasize how critical shipping in the shoulder seasons is whether ice breaking is used or not. In the fall when Narwhal are migrating and exiting the Eclipse Sound area there is the possibility that ship traffic at this time may change Narwhal behaviour and they may try to avoid ships resulting in possible delays that could result in ice entrapments. In addition, shipping during the spring season can result in critical consequences: first, to seals who may experience displacement, separation of mothers and pups, destruction of resting and birth lairs, and vessel–seal collisions for Ringed and Bearded seals (and possibly Walrus) that moult and rely on access to a sea ice platform in spring whom may be adversely affected by protracted moulting resulting from forced re-entry into water prior to new hair formation (Ferguson et al. 2017); and second, to migrating Narwhal making the decision as to whether to enter the Eclipse Sound area or possibly due to noise disturbance deciding to continue on to Admiralty Inlet. DFO science considers sea ice as critical habitat for seals, and that any loss of use of that ice should be reflected in the impact assessment. Since the shoulder season is a critical time for marine mammals, particularly those that are ice-associated, DFO science does not agree with BIM scoring of "1" (Appendix G, Table G4) for interaction between shipping during the ice formation and breakup seasons with marine mammals.

BIM's position

"*For the sake of this assessment, "seals" are lumped together or discussed with Ringed Seals acting as a surrogate for all seals.*" (TSD24, Section 2.1.2, p. 23).

DFO Science's analysis and assessment

Ringed Seals, Bearded Seals, Hooded Seals (*Cystophora cristats*) and Harp Seals (*Pagophilus groenlandicus*) should not be lumped as "seals", or represented by Ringed Seals, as they have quite different life history, behavioural and habitat needs, and fill quite different roles in the arctic marine ecosystem (Schimnowski et al. 2018, Cobb et al. 2019 in press).

BIM's position

"Seals potentially occurring near the Project site during construction were predicted to exhibit temporary and localized avoidance from pile driving activities." (TSD24, Section 2.1.2, p. 23).

DFO Science's analysis and assessment

What was this prediction based on? References should be provided.

BIM's position

In TSD24, Section 2.5, Table 2.3, p. 30.: Summary of Project Interactions and Potential Environmental Effects – Ringed Seal.

DFO Science's analysis and assessment

This interaction matrix should also include "*interaction of ice breakers on seal species hauled out during their moulting season*". Ringed Seals require sea ice during the critical spring period when reproduction and moulting occurs (Ferguson et al. 2017). In Table 2.3, (TSD24), BIM should include the interaction of ice-breakers on seals hauled out during their moult season. Ice-breaking represents a serious threat for pinniped species utilizing the ice for moulting. Their ability to evade vessels is limited on ice compared to in the open water. Concern for pinnipeds on-ice during shoulder season ice-breaking and the potential direct and indirect impacts to these species (e.g., risk of predation, inability to get to haul-out site) should be considered (Yurkowski et al. 2019).

BIM's position

"Ringed Seal, and 298 unidentified seals were observed "opportunistically", and seals were more difficult to observe during rough seas" during the Bruce Head shore-based monitoring program for Narwhal and vessel traffic during August of 2017 (2017 Bruce Head Shore-based Monitoring Program (Feb 2018), Table 5.5.3, p. 84).

DFO Science's analysis and assessment

Seal observations were not the prime purpose of the Bruce Head shore-based monitoring program. It is therefore highly probable that the number of seals using the Bruce Head waters were more than presented in Table 5.5.3. The unidentified seals are most likely Ringed Seals. A full assessment of Ringed Seals would include the shoulder months when seals are most likely to aggregate for pupping and moulting. For example, Yurkowski et al. (2019) showed that spring use by Ringed Seals in the waters off Bruce Head (identified by Yurkowski et al. (2019) as southern Milne Inlet northward of Kuluktoo Bay) was very high. Clearly, the combination of high abundance of seals and Narwhal (including calves) suggests that the narrow waterway at Bruce Head could be an important habitat for marine mammals; more studies are needed to assess factors contributing to this hotspot (e.g., oceanography, presence of forage species). Other Ringed Seal hot spots identified by Yurkowski et al. (2019) that occur along the proposed shipping route for Baffinland included Eastern Eclipse Sound near the entrance to Baffin Bay and western Eclipse Sound near the southern point of Bylot Island. For these reasons, DFO science recommends that Ringed Seals be a VEC for the marine environmental effects assessment monitoring program.

Recommendations

- To minimize the negative impacts of ice-breaking traffic on marine mammals in the LSA, and beyond the current proposed RSA, mitigation strategies need to be developed and integrated prior to these activities occurring.
- No ice-breaking activities during the Ringed Seal parturition, nursing, and breeding period would greatly reduce negative impacts on the Ringed Seal population. Such mitigation would require supply logistics to already be in place prior to this critical time period. In addition, the ice-breaking route should avoid Ringed Seal hotspots and pupping grounds in western Eclipse Sound.

- Although ice-breaking would be unavoidable in Ringed Seal hotspots in southern Milne Inlet, restricting speeds could likely allow successful maneuverability of ships around hauled out seals while also maintaining a “safe distance” of at least 250 m.
- More precaution in speed and a farther “safe distance” would likely be needed for larger Arctic ice-breaking vessels.
- MMO on the ship for the entire ship track, this would include report of any marine mammal collisions.
- Impact assessment for use of alternate route.
- Impact assessment of pinnipeds during the ice-breaking seasons.
- Spring survey/floe edge survey for shoulder season in Baffin Bay (Walrus, seals, whales).
- Establish mechanisms to ensure that speed restrictions are adhered to for all vessels within the RSA and the MMO should remain on the ship for the entire ship track, this would include reporting of any marine mammal collisions.
- Speed restrictions across the migratory pathway in Baffin Bay.

3.8.7 Impact of shipping – avoidance and displacement

BIM’s position

BIM suggests that animals do not demonstrate avoidance behavior or displacement from activities within the RSA and LSA. “*Narwhal are expected to exhibit temporary and localized avoidance behaviour when encountering Project vessels along the shipping route and in Milne Port. No abandonment or long-term displacement behavior is anticipated*.” (TSD24, Section 2.6.2.2, p. 46). BIM also suggests that “*No changes in yearly relative abundance or distribution were observed, nor any evidence of long-term displacement or avoidance behavior (Moulton et al. 2016)*.” (TSD24, Section 2.6.2.2, p. 44).

BIM asserts that “Based on behavioral observations collected to date from the various monitoring programs and information provided in the available literature, 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 (TSD27, Section 1.4.14.3, p. 52). For this reason BIM suggests that the impact of noise on Narwhal would be ‘not significant’ (Section 10-5, Table 10-5, p. 131).

DFO Science’s analysis and assessment

DFO has documented a change in abundance of Narwhal in Eclipse Sound, 2018 in particular marked a decrease in Narwhal sightings compared to 2017 in the Tremblay Sound area (M. Marcoux, DFO, Pers. Comm.). Similar patterns where detected by observers during the Bruce Head Vessel-Based monitoring program (BIM 2019). However, if BIM is stating they have not observed avoidance behaviour, this does not necessarily mean Narwhal are not negatively impacted by their interactions with Project vessels. Noise disturbance can cause avoidance behaviour of marine mammals from the Eclipse Sound area which would reduce availability of animals for hunting. Shipping might have been implicated with an entrapment in 2015 in Pond Inlet, which can have negative impacts on stock abundance (Watt et al. 2018).

BIM's position

TSD24, Section 2.6, p. 42, Table 2.6 summary of project interactions and potential environmental effects – Narwhal - Change in habitat caused by construction of new ore dock and freight dock = change (decrease) in suitable foraging habitat in Milne Inlet.

DFO Science's analysis and assessment

BIM should assess change in habitat as a result of ice breaking, and potential change in Narwhal migratory patterns which may lead to lack of immigration into the area, or ice entrapments. BIM should also consider changes in habitat at the anchorage sites, displacement of Narwhal prey, and sound disturbance which can affect foraging ability.

With reference to TSD24, Appendix A 4.1.7.1, p. 178, and the reaction of Narwhals to Killer Whales in the area, DFO suggests that more recent literature is available on this topic, including Breed et al. (2017) that presented information suggesting that Killer Whale presence had drastic impacts on Narwhal swimming behavior and habitat use for the duration of time both species co-occurred in Admiralty Inlet.

BIM's position

BIM states that "*While elevated underwater noise could startle or displace animals, behavioural responses are not necessarily predictable from the sound source level (loudness) and may vary depending on factors such as age and status of the animal, type of activity it is engaged in, and social context (McCauley et al. 2003)*." (TSD24, Section 1.3, p.10).

"*There is some uncertainty in terms of how Narwhal will respond to more frequent ore carrier traffic in the narrow waterways of Milne Inlet. There exists similar uncertainty concerning masking effects on Narwhal communication from increased ship traffic in these areas. Although no significant residual effects are predicted for Narwhal, Baffinland will continue to conduct tailored environmental effects monitoring programs to evaluate Narwhal responses to ore carrier traffic along the shipping corridor*." (TSD24, Section 3.0, p. 64).

Community engagement meetings: "*Concern is that acoustic disturbance may lead to changes in animal distribution, abundance, migration patterns and subsequent availability of these animals for harvesting.*" (TSD24, Section 1.4, p. 11).

TSD24, Section 2.6, p. 42, Table 2.6 provides a summary of project interactions and potential environmental effects. Regarding Narwhal BIM states the Project Interaction will include "*Disturbance caused by underwater noise from pile driving and shipping*" while the Environmental Effects will include "*Disturbance effects - avoidance response leading to seasonal abandonment of suitable habitat areas*".

DFO Science's analysis and assessment

Narwhal are relatively naïve to any shipping traffic and their interactions with shipping could be different from other species that are found in areas where shipping occur. For example, Narwhals showed very different reactions to the same ice breaking activity (Finley et al. 1990). Williams et al. (2017) have shown that Narwhal exhibit extreme flight response to a stress. Along with concerns previously identified with shipping in the shoulder seasons, and a low abundance of Narwhal in 2018 in the Eclipse Sound region, there may be other indirect consequences to Narwhal behaviour. For instance, Narwhal may become more susceptible to Killer Whale predation if they are prevented from moving into the lower Milne Inlet waters where Killer Whales are less prevalent.

Another behaviour change that may be correlated with shipping is displacement of Narwhals from preferred feeding or nursery habitat. For example, the narrow waters adjacent to Bruce Head is a hotspot for Narwhal (and Ringed Seal) in summer (BIM 2016), and the daily transit of Cape-sized vessels to and from Milne port could affect foraging ability of marine mammals and cause them to search elsewhere for food. This could have fitness consequences.

BIM's position

"*The effect of mechanical disturbance by helicopters, fixed wing aircraft, and small zodiac vessels with outboard motors on Atlantic Walrus hauled out on shore was studied in summer (24 July – 23 August 1997) at Bathurst Island, Nunavut (Salter 1979). Disturbances occurred on average once every three hours. Helicopter disturbances were audible to human observers for an average of 2.8 minutes, fixed-wing aircraft for 3.6 minutes, and zodiac disturbances were intermittent and highly variable in length (Salter 1979). Walruses responded to 27% of 71 flights by helicopters, 35% of 31 flights by fixed wing aircraft, and none of the 6 approaches by boat by either head lifting, orienting themselves toward the sea, or retreating to the sea altogether. Head-lifting occurred when a helicopter was as much as 8 km distant; orientation changed at a maximum distance of 1.3 km, and in one case the Walrus group escaped into the sea when the helicopter was at a distance of 1.3 because a sudden veering in the helicopter's flight path resulted in a sharp change in pitch of the engine. On the two occasions when largescale escape into the sea occurred, pre-disturbance numbers on land were regained only six and nine hours later, respectively. Noise produced by Single Otters appeared to be much more disturbing to Walrus than any other fixed wing aircraft observed, but consisted of direct overflights at altitudes of 1000-1500 m which resulted in a mix of head raising, orientation and escape responses. There were no detectable responses to zodiac engines which approached at distances of 1.8-7.7 km.*" (TSD 24 Appendix A 3.1.5.1, p. 121).

DFO Science's analysis and assessment

While the literature on Walrus disturbance by vessels and aircraft is admittedly sparse, there are numerous references that BIM did not consider in their assessment. As written, the assessment leaves the impression that Walruses do not respond to boat-based disturbances, which is not true. DFO (2019) provides a much more comprehensive review of the literature, with detailed summaries of disturbance events characterized by type (e.g., vessel, fixed-wing aircraft, etc.), and summarized overall that:

"Observations at Round Island, Alaska indicate vessels that remain outside the 3 mile (4.8 km) restricted zone do not cause disturbances at terrestrial Walrus haul-outs. A larger body of research on small vessel (e.g., zodiac or skiff) disturbance indicates that Walruses disperse and enter water when boats are within 800 m, with the bulk of dispersals occurring when boats are within 400 m (including landings). Responses to aircraft are variable, and dispersal into water is not uncommon even for jet overflights at 9000+ mAGL. Excluding jets, propeller planes and helicopters flying at ~1370 to 6100 mAGL at horizontal distances of up to 2.8 km have caused dispersal of Walruses at haul-outs. Disturbance is more severe as distances decrease (including helicopter landings)."

BIM's position

"*All Project vessels will not be operated in such a way as to separate an individual member(s) of a group of marine mammals from other members of the group*" (TSD24, Section 2.5.2.2, p. 35).

DFO Science's analysis and assessment

DFO Science would like clarification on what is meant by the above mitigation measure. How will BIM operate vessels when groups of animals are encountered, how will they define groups, and how will monitoring of vessel operations be conducted?

BIM's position

"Three potential trans-shipping locations for Baffinland's Phase 2 (Figure 1) were reviewed with workshop participants." (TSD24, Appendix A, p. 223).

DFO Science's analysis and assessment

DFO has not reviewed the community IQ workshops that were conducted as part of establishing a monitoring program. Assessment on the impact of the trans-shipping locations where vessels are waiting is needed. Are these vessels engines running the whole time or are they turned on and off? Is there monitoring at these sites? And if not, there should be an observation program at the trans-shipping locations much like there is at Bruce Head. If vessels are continuously waiting there this may result in permanent displacement of the animals and permanent loss of habitat for calving, nursing, and foraging.

BIM's position

"*The reaction of the Narwhals to the vessel was not recorded*." (TSD24 Appendix A 4.1.2.1.3, p. 165). "*During another observation made from Bruce Head on 26 August 2013, the vessel approached within approximately 1 km of the Narwhals before the end of the observation of this group."* (Figure 4.21). *No information was provided on the response of the Narwhals to the ship*". (TSD24, Appendix A 4.1.2.1.3, p. 167).

DFO Science's analysis and assessment

DFO Science questions why observations on the responses of Narwhals to vessels was not recorded. This is an important aspect of the research and highlights the need for a MMO on board at all times.

BIM's position

"*Logbook comments may represent previous observer experience or knowledge of Narwhal behaviour when vessels were present, but do not appear to be specific to what was recorded during the study (observations are inconsistent with reported survey data)*." (TSD24, Appendix A 4.1.2.1.3, p. 168).

DFO Science's analysis and assessment

DFO Science questions which information is more reliable, and would like to know how BIM plans to correct this inconsistency in the future.

BIM's position

"*7 September 2014: Bruce Head observations had concluded by this date, and it was midway between two aerial survey periods. High densities of Narwhals were observed in Milne Inlet South in the 1 to 2 September aerial survey, but Narwhals were absent by the next survey on 14 to 15 September through the last survey on 21 to 22 October. No Narwhals were observed in Koluktoo Bay after 30 to 31 August. Thus the low number of Narwhal calls on 7 September may have simply reflected the seasonal migration of Narwhals out of the Milne Inlet area*." (TSD24, Appendix A 4.1.2.1.3., p. 163).

DFO Science's analysis and assessment

They may have moved out of Milne Inlet, but this is a relatively early migration out of Eclipse Sound based on previous tagging data. In addition, From Sept 7-Oct 21, 2014 Narwhal were hunted by Pond Inlet hunters and almost 40% of their hunt that year happened from Sept-Oct (Watt and Hall 2018). Thus, Narwhal had not migrated out of Eclipse Sound for the season, but may have migrated out of the Milne Inlet area. An assessment of within season distribution would be needed.

BIM's position

"12 September 2014: The cessation of Narwhal calls is most likely due to seasonal migration." (TSD24, Appendix A 4.1.2.1.3, p. 163).

DFO Science's analysis and assessment

This is not likely seasonal migration out of the LSA, rather may indicate seasonal movements within the RSA. Based on catch statistics, Narwhal are hunted in Eclipse Sound suggesting seasonal movements throughout the RSA at this time, and should not necessarily be interpreted as a migration out of the area (Matthews et al. 2019).

Recommendations

- DFO recommends BIM provide what proportion of their time Narwhal will be exposed to level from 100 to 180 dB, in 10 dB increments.
- DFO Science recommends that no shipping occur in the shoulder seasons but if it is needed then extensive monitoring would be required and specific methodology developed prior to operations, and employed on all vessels to assess the likely negative consequences of disturbance during these critical periods.
- A number of monitoring programs were conducted by BIM for marine mammals and marine species (marine mammal monitoring programs at Bruce Head). DFO Science has not reviewed all of the reports from these programs, however based on what we have had a chance to review, we recommend that all studies be peer reviewed so that BIM can have full confidence in using findings of these studies in future assessments of the project environmental effects.

3.9 Ballast water exchange and discharge

BIM's position

BIM states "*There will be an increase in both the number of ship voyages and ship sizes to accommodate the volume of ore shipped. An estimated maximum of 176 shipping trips, mostly Panamax and Capesize vessels, is expected to occur during the open water season from mid-July to November. This represents approximately a three-fold increase from the ERP level of shipping. Ore carriers will discharge ballast water prior to loading ore. The volume of discharged water will range from 14,000 m^3 for Supramax vessels to 63,000 m^3 for Capesize vessels. Ships may begin ballast water discharge when they enter Eclipse Sound and Milne Inlet. Ballast water discharged while the ship is in transit will rapidly mix with the ocean water and, therefore, will have no effect on water quality. Ballast water discharged at a single point while the ship is berthed at the ore dock may cause an effect on the surrounding marine water quality due to differences between the discharged and receiving water in levels of water quality constituents, such as temperature, salinity, and concentrations of metals and nutrients.*

Shipping operators will manage ballast water discharge to comply with the applicable regulations and guidelines as per the Baffinland Ballast Water Management Plan, which includes sampling and measurements of ballast water prior to discharge. According to the Ballast Water Control and Management Regulations under the Canada Shipping Act (SOR/2011-237) all ships entering the Canadian Exclusive Economic Zone (EEZ) must exchange their ballast water in open seas, away from coastal waters (i.e., 200 nautical miles from land and in water at least 2,000 metres deep)." (TSD17, Section 2.6.4).

DFO Science's analysis and assessment

It is unclear where the discharge and exchange of ballast water will be carried out as the Proponent has not indicated whether it will only occur outside the Canadian Exclusive Economic Zone (EEZ).

The Proponent refers to temperatures, salinity, and other water quality characteristics in the Labrador Sea as well as Baffin Bay being higher than those in Eclipse Sound when discussing potential effects of ballast discharge. DFO Science does not understand why the Proponent is comparing to water quality in Baffin Bay. DFO Science questions if the Proponent is expecting that vessels will be exchanging (taking up water) in this location as well. Regulations state that exchange should only be conducted outside the EEZ except in case of emergencies in which case designated alternate exchange zones within the EEZ may be used. Currently there is one in Hudson Strait and one in Lancaster Sound, however, DFO has recommended these be changed (DFO 2015e, Goldsmit et al. 2019). DFO Science recommends that the Proponent specify where exchange will be carried out and explain why they are including an analysis of Baffin Bay waters. DFO Science is concerned Baffin Bay waters are included because these waters will be used in case of emergency exchange. If so, the Proponent should specify this and be aware that this is not in line with current Transport Canada regulations.

The locations where ballast discharge will take place is also unclear. In this section there is reference not only to discharging at the port, but also to discharging upon entry into Eclipse Sound and Milne Inlet. As a member of the MEWG, DFO Science has repeatedly tried to verify this and have been told that all ballast is released while vessels are docked at the port, yet the document seems to suggest this is not the case. Typically vessels anchor at Ragged Island upon entry into Milne Inlet (Baffinland had 3 anchorage sites here) and remain there for a period of typically 24 hours according to the Proponent (Marine Environment Working Group meeting minutes for Dec 10, 2018; see NIRB website). If vessels are indeed releasing ballast at this location it is likely being done when vessels are stationary for both practical and safety reasons. DFO Science recommends the Proponent specify whether vessels discharging at this location only do so while in transit or if they also discharge while anchored at Ragged Island. If the latter is occurring, then there is the potential for effects on local water quality and an assessment of local effects on water quality should be provided for the Ragged Island anchorage site.

Recommendations

- DFO Science recommends that the Proponent specify where discharge is to be carried out as it is may affect local water quality and biota as well as increase risks for release of non-indigenous (and potentially invasive) species. This way the proper assessment can take place.
- Furthermore DFO recommends that the Proponent specify whether vessels are discharging at other anchorage sites as well as the drifting sites as these could potentially have an effect on local water quality and release of non-native aquatic species in ballast or from the hulls of vessels. DFO Science requires this additional information to make a proper assessment.

- DFO Science recommends that Transport Canada consider implementing these recommendations given the large amount of shipping traffic now occurring in the eastern Arctic to Milne Inlet. DFO Science notes that there is ongoing confusion within the Marine Environment Working Group (MEWG) and in the community of Pond Inlet regarding where vessels conduct exchange so this should be clearly specified and outlined in the Proponents plans.

BIM's position

BIM states "*Shipping operators will manage ballast water discharge to comply with the applicable regulations and guidelines as per the Baffinland Ballast Water Management Plan, which includes sampling and measurements of ballast water prior to discharge. According to the Ballast Water Control and Management Regulations under the Canada Shipping Act (SOR/2011-237) all ships entering the Canadian Exclusive Economic Zone (EEZ) must exchange their ballast water in open seas, away from coastal waters (i.e., 200 nautical miles from land and in water at least 2,000 metres deep). Baffinland monitors salinity of ore carriers' ballast water prior to discharge to verify that it meets the regulation for salinity (at least 30 parts per thousand [ppt])*." (TSD17, Section 2.6.4).

DFO Science's analysis and assessment

Baffinland monitors salinity of ore carriers' ballast water prior to discharge to verify that it meets the regulation for salinity (at least 30 parts per thousand [ppt]).

Although the use of ballast exchange and salinity testing was something designed to reduce introduction into freshwater ports and has been effective in these environments (Bailey et al. 2011), a number of studies have demonstrated that it is not necessarily always effective for vessels transiting to marine ports such as the one in Milne Inlet (Simard et al. 2011, Cordell et al. 2009, Lawrence and Cordell 2010) and may in some cases inadvertently increase risk (Roy et al. 2012). While salinity testing may help to verify if exchange has been carried out, it doesn't necessarily provide any assurance that risk has been mitigated. It also does not provide any information on the efficacy of current measures or the risk associated with ballast discharge.

Recommendations

- As part of their monitoring program, DFO Science recommends the Proponent should be including ballast sampling to evaluate the number and types of organisms being discharged. This would allow the Proponent to evaluate level of risk and develop appropriate mitigation strategies.

BIM's position

In TSD17, Section 2.6.4, and Section 3.7.3, BIM states "*Shipping operators will manage ballast water discharge to comply with the applicable regulations and guidelines as per the Baffinland Ballast Water Management Plan, which includes sampling and measurements of ballast water prior to discharge. According to the Ballast Water Control and Management Regulations under the Canada Shipping Act (SOR/2011-237) all ships entering the Canadian Exclusive Economic Zone (EEZ) must exchange their ballast water in open seas, away from coastal waters (i.e., 200 nautical miles from land and in water at least 2,000 metres deep). Baffinland monitors salinity of ore carriers' ballast water prior to discharge to verify that it meets the regulation for salinity (at least 30 parts per thousand [ppt]). With the implementation of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Convention; IMO 2017), all ships must install a ballast water treatment system to meet D-2 performance standards and eliminate potential invasive species. As the result of the mitigation measures implemented by*

Baffinland, the residual effect from AIS introduced with ballast water will be negligible (Table 3-12)."

DFO Science's analysis and assessment

DFO Science disagrees with the wording presented by the Proponent. The D-2 standards are designed to minimize introductions, but will not necessarily eliminate them as the standards allow for a minimum number of organisms to be transported (the number is not zero) and treatment may not be effective for all species (Casas-Monroy et al. 2015). Furthermore, the treatment systems sometimes fail and very little testing has been done in colder waters, particularly in full-scale shipboard operational conditions, so it is unclear how effective they will be for vessels transiting to the Arctic (Jing et al. 2012, Casas-Monroy et al. 2015, 2018, Casas-Monroy et al. in press). Salinity testing currently used by BIM will not verify if treatment has worked.

Recommendations

- DFO Science recommends that BIM should indicate how they plan to test if vessels meet D-2 standards and what procedures will be in place to deal with vessels that do not meet the standard upon arrival. Additionally, DFO Science recommends that BIM should indicate where/when ballast testing will be conducted on vessels.
- It is DFO Science's understanding that any testing is currently done once ships arrive at the ore dock (only salinity testing is done currently). However, if ballast discharge occurs prior to arrival then DFO Science recommends testing should be done before or during discharge (depending on the type of treatment system in place on a given vessel) to allow for mitigation if vessels fail to meet the standard.
- It should be noted that DFO Science cannot properly review and provide recommendations as the Proponent fails to identify and describe how they plan to conduct testing on vessels that discharge while still in transit. Furthermore, the Proponent fails to identify what treatment systems will be used which will impact DFO Science recommendations. Finally, the Proponent does not describe mitigation measures if vessels fail to meet standards. DFO Science requires this information to properly assess any potential concerns. If ballast water discharge results in the release and survival of non-native species, this effect will be non-reversible.

BIM's position

In TSD17, Section 3.6.4, BIM states "*The AIS risk assessment approach (Casas-Monroy et al. 2014) involves a three-step process that consists of (i) calculating the probability of introduction based on the probability of arrival and probability of survival of non-native species to Milne Inlet; (ii) defining the consequence of invasion; and (iii) determining the overall risk of invasion.*"

DFO Science's analysis and assessment

It is unclear what data is being used to calculate the probability of arrival. The approach the Proponent cites relies on information regarding density of non-indigenous species in ballast water. It is DFO Science's understanding that the Proponent has not been conducting ballast sampling to collect this information from arriving ships. DFO Science has recommended numerous times that this information should be collected as it would be useful in future risk assessments. DFO Science developed protocols specific to their program and offered to provide training. DFO Science is concerned about the data used to conduct this risk assessment. Ideally the risk assessment should be based on real data. While this may not be currently available.

Recommendation

- DFO Science recommends that this data be collected moving forward to support future revised assessments.

BIM's position

In TSD17, Section 3.6.4, BIM states "*The Shipping and Wildlife Management Plan will be revised, and will include reference to the D-2 standard of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (Convention; IMO 2017) ratified by Canada. The Convention came into force in 2017 and requires that all ships implement a Ballast Water Management Plan and comply with the D-2 performance standard that specifies the maximum amount of organisms and indicator microbes allowed to be discharged to the receiving marine environment. According to the Convention, ships entering Canadian waters from abroad will need to install an on-board system to treat ballast water and eliminate unwanted organisms to meet the D-2 performance standard according to the schedule set by the IMO (MEPC 2017). The requirements of the reference to the D-2 standard will reduce the risk of AIS introduction in the Milne Inlet ecosystem*."

DFO Science's analysis and assessment

The Proponent does not specify how they will test if vessels meet this requirement and how will they determine if risk has been reduced over current management standards given that they do not currently do any biological sampling of ballast.

Recommendations

- DFO Science recommends that the Proponent conducts sampling of ballast for overall diversity and abundance of organisms as well as to determine proportion of non-indigenous species. This information can then be use to revise the risk assessment and determine if the measures put in place are appropriate.

BIM's position

BIM states "*A ballast water treatment system (BWTS) will be installed on the ore carriers to prevent non-native organisms from being accidentally introduced into Canadian waters. The BWTS will be selected based on various parameters such as system type, size and cost. The BWTS selected will also be IMO and North American (Canadian) Coast Guard Approved. Baffinland is committed to meeting the Phase 2 discharge standards as described by the IMO.*" (TSD28, Appendix V, Appendix F Section F.1).

DFO Science's analysis and assessment

DFO Science does not agree with the above statement as Canadian Coast Guard does not approve BWTS. DFO Science questions whether the Proponent meant United States Coast Guard approval.

BIM's position

BIM states "*Shipping in Milne Inlet during the operational phase of the ERP occurs during the open-water period. Ore carriers accessing Milne Inlet exchange ballast in the North Atlantic or Labrador Sea as per the Ballast Water Control and Management Regulations administered under the Canada Shipping Act and identified in the Shipping and Marine Wildlife Management Plan. The potential effect on water and sediment quality was assessed due to the difference in water characteristics between the Labrador Sea or Baffin Bay and Milne Inlet. The waters in the*

Labrador Sea and Baffin Bay have higher temperature and salinity, and lower concentrations of nitrate, silicate, and metals, such as cadmium and iron, compared to water in Milne Inlet.

If ships begin to discharge ballast water upon entry into Eclipse Sound and Milne Inlet, while still in transit, the ballast will be rapidly mixed with the surface water and will therefore have little or no effect on local water quality.

Ballast water dispersion, if discharged at the ore dock, was modeled to estimate potential effects on water quality at the port site. Due to density differences between the ballast water and the receiving waters, as well as the overall volume of the receiving water, it was predicted that water quality guideline thresholds would not be exceeded with exception to a slight increase in temperature (i.e., by more than 1ºC) within the immediate vicinity of the dock site. A ballast water eddy of lower nutrient (silicate and nitrate) concentrations could also occur at Milne Port moving along the bottom of the inlet to a point about 900 m offshore before dissipating at a depth of 100 m. As a result, the effects of ballast water discharges at Milne Port were determined to be of low magnitude." (TSD17, Section 2.1.3).

DFO Science's analysis and assessment

In this section the Proponent refers to locations of ballast exchange and discharge. The Proponent then discusses potential water quality differences between exchange and release location and how this may influence marine water and sediment quality at different locations. The Proponent states that low magnitude effects on water quality may occur at the ore dock, but that no effects are expected near the entrance to Milne Inlet and Eclipse sound because ships will discharge while in transit at this location: If ships begin to discharge ballast water upon entry into Eclipse Sound and Milne Inlet, while still in transit, the ballast will be rapidly mixed with the surface water and will therefore have little or no effect on local water quality.

It is unclear where exchange will be carried out as the Proponent has not indicated whether it will only occur outside the Canadian EEZ. They refer to temperatures, salinity and other water quality characteristics in the Labrador Sea as well as Baffin Bay being higher than those in Eclipse Sound when discussing potential effects of ballast discharge. DFO Science questions why the Proponent is comparing to water quality in Baffin Bay. DFO Science is concerned that the Proponent is expecting that vessels will be exchanging (taking up water) in this location as well. Regulations state that exchange should only be conducted outside the EEZ except in case of emergencies in which case designated alternate exchange zones within the EEZ may be used. Currently there is one in Hudson Strait and one in Lancaster Sound, although DFO has recommended these be changed (DFO 2015, Goldsmit et al. 2019). DFO Science recommends the Proponent specify where exchange will be carried out and explain why they are including an analysis of Baffin Bay waters here. DFO Science questions whether it is because these waters will be used in case of emergency exchange. If so, DFO Science recommends the Proponent specify this and be aware that this is not in line with current Transport Canada regulations, although it is consistent with DFO recommendations which have yet to be implemented by Transport Canada. There has been ongoing confusion within the MEWG and in the community of Pond Inlet regarding where vessels conduct exchange so this should be clearly outlined in the document.

Likewise the locations where ballast discharge takes place are unclear. In this section there is reference not only to discharging at the port, but also to discharging upon entry into Eclipse Sound and Milne Inlet. As member of the MEWG, DFO Science has tried numerous times to verify this and have been told that all ballast is released while vessels are docked at the port, yet the document seems to suggest this is not the case. The Proponent needs to be clear about where discharge is to be carried out as it is may affect local water quality and may increase

risks for release of non-indigenous (and potentially invasive) species. Typically vessels anchor at Ragged Island upon entry into Milne Inlet (Baffinland had 3 anchorage sites here) and remain there for a period of typically 24 hours according to the Proponent (MEWG meeting minutes for Dec 10, 2018). If the Proponent is indeed releasing ballast at this location it is likely being done when vessels are stationary for both practical and safety reasons.

Recommendation

- DFO recommends that the Proponent should specify whether vessels discharging at this location only do so while in transit or if they also discharge while anchored at Ragged Island. If the latter is occurring then there is the potential for effects on local water quality and an assessment of local effects on water quality should be provided for the Ragged Island anchorage site.

BIM's position

In TSD17, Section 2.1.3 and Section 3.1.4, BIM states the following: "*Ballast water dispersion, if discharged at the ore dock, was modeled to estimate potential effects on water quality at the port site. Due to density differences between the ballast water and the receiving waters, as well as the overall volume of the receiving water, it was predicted that water quality guideline thresholds would not be exceeded with exception to a slight increase in temperature (i.e., by more than 1°C) within the immediate vicinity of the dock site. A ballast water eddy of lower nutrient (silicate and nitrate) concentrations could also occur at Milne Port moving along the bottom of the inlet to a point about 900 m offshore before dissipating at a depth of 100 m. As a result, the effects of ballast water discharges at Milne Port were determined to be of low magnitude.*

Modeling of ballast water dispersal in Milne Inlet predicted that there would be a low magnitude effect on water quality from ballast water discharges and no effect on sediment (Section 2.1.3). Ballast water would contribute less than 0.1 % of the changes in water properties that occur naturally in Milne Inlet on an annual basis. Pelagic and benthic biota would be exposed to a small increase in temperature (by more than 1°C) and decrease in nutrient concentrations from ballast water over a small spatial extent. Overall, the magnitude of ballast water effect on marine habitat and biota through water and sediment quality change was determined to be low."

DFO Science's analysis and assessment

The Proponent indicates that "*it was predicted that water quality guideline thresholds would not be exceeded with exception to a slight increase in temperature (i.e., by more than 1°C) within the immediate vicinity of the dock site... As a result, the effects of ballast water discharges at Milne Port were determined to be of low magnitude*". While this may seem like a small temperature difference, a difference of 1 degree Celsius could affect whether habitat is suitable for released non-indigenous species. Non-indigenous or invasive species have established in other unexpected locations where localized warming has occurred (e.g., below thermal station; Simard et al. 2012).

Recommendation

- DFO Science recommends that the Proponent conduct habitat suitability modelling of high risk species known to be transported in vessels or that are known to be established in source ports of vessels transiting to Milne Inlet to properly assess this (e.g., see approach used in Goldsmit et al. 2018). If ballast water discharge results in the release and survival of non-native species, this effect will be non-reversible.

BIM's position

In TSD17, Section 3.2, BIM states "*Components of the Phase 2 Proposal that have potential to result in adverse effects on marine habitat and biota but were not assessed as part of the Approved Project include the following:*

- *Change in habitat (habitat loss) caused by Milne Port expansion;*
- *Habitat alteration (changes in water and sediment quality) related to:*
- *Construction activities associated with the proposed port expansion;*
- *Increase in shipping traffic (propeller wash effect);*
- *Increase in ballast water exchange;*
- *Increase in wastewater and site drainage;*
- *Increase in levels of dust from the secondary ore crusher and stockpile; and*
- *Underwater noise disturbance related to construction activities (pile driving) and increased shipping."*

DFO Science's analysis and assessment

The Proponent indicates that components of the Phase 2 Proposal have potential to result in adverse effects on marine habitat and biota but were not assessed as part of the Approved Project include the increase in ballast water exchange. However, the Proponent fails to recognize ballast discharge. The Proponents statement and assessment should include ballast discharge. Ballast exchange should be conducted outside the Canadian EEZ, so the major impacts and issue of local concern would be associated with increased ballast discharge.

BIM's position

In TSD28, Appendix V, Section 5.5.1, BIM states "*The ballast water exchange will occur as per IMO Ballast Water Convention Regulation D-1 and as described in Section 6(1) of the Canadian Ballast Water Control and Management Regulations. The exchanged ballast water will then be treated by the BWTS onboard the vessel during the remainder of the voyage. While the specific BWTS has yet to be chosen, typical system involves a combination of the following techniques:*

- *Filtration (e.g., wedge wire, weave wire, membranes, hydro cyclones, flocculation and disc filter),*
- *Mechanical/Physical Mechanism (e.g., cavitation, vacuum, ultraviolet (UV) light, heat, oxygen stripping, and acoustic treatment); and*
- *Active Substance (e.g., ozone, sea water electrolysis, sea water electrodialysis, electro-dialysis, additives, and catalyst)."*

DFO Science's analysis and assessment

Preferred locations for ballast water exchange should be contained in ballast water management plans of individual ships, taking into account advice contained in Stewart et al. (2015).

The Proponent should note that treatment systems must be in use between 2020-2024 (or earlier) as per IMO timeline. The selection/installation of treatment systems should already be in progress by individual shipping companies. Treatment technologies should be selected with Arctic environments in mind, noting that decay rates for any biocides will be much slower in

colder waters. Neutralization requirement must be assumed and appropriate neutralization monitored.

BIM's position

In TSD28, Appendix V, Section 5.5.1.1, BIM states "*As a component of the Project Environmental Impact Statement and Addendum, Baffinland completed a risk analysis regarding ballast water discharge (See FEIS Addendum Vol 8 Appendix 8B-4). The risk analysis followed a methodology as developed and applied by Fisheries and Oceans Canada. The conclusion of the analysis ranked Milne Inlet (Early Revenue Phase) as "lower" compared to other Arctic and Northern ports. A revised assessment will be completed once additional data have been collected and a newly developed methodology has been finalized by research personnel at Fisheries and Oceans Canada.*"

DFO Science's analysis and assessment

The Proponent's statement is incorrect. The risk outcome was 'high' under the conditions in this Addendum. If vessel activity results in the release and survival of non-native species, this effect will be non-reversible.

Recommendations

- DFO recommends a re-evaluation of the risk assessment based on recent information about the potential new taxa that were found in samples.

3.9.1 Impact of shipping – hull fouling

BIM's position

BIM states "*In addition to environmental effects monitoring for marine water and sediment quality as discussed in Section 2.3, the MEEMP also included effects monitoring for biological components of the marine environment. These also included an Aquatic Invasive Species (AIS) monitoring program implemented as a part of the MEEMP to fulfil Baffinland's commitment to reduce the risk of impact through introduction of invasive species during the Project's shipping operations, mostly via ballast water exchange. The AIS monitoring program is aimed to monitor for presence of alien species in the vicinity of Milne Port.*" (TSD17, Section 3.3).

DFO Science's analysis and assessment

Hull fouling is also a major vector of concern for arriving vessels and should be noted here.

BIM's position

In TSD28, Appendix V, Section 5.5.2, BIM states "*Baffinland is committed to meeting the IMO International Convention on the Control of Harmful Antifouling Systems on Ships. As per Annex I of the convention (and Schedule 6 of the Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals (2007-86)), the anti-fouling system will:*

- *Not bear organotin compounds on their hulls or external parts or surfaces; or*
- *Bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems."*

Recommendation

- DFO Science recommends the Proponent require vessels follow the IMO's 2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species.

BIM's position

In TSD28, Appendix V, Section 5.5.2, BIM states "*In order to reduce or eliminate the risk of aquatic invasive species and pathogens being introduced into Canadian waters as a result of fouling of vessels, an anti-fouling system will be in place on all vessels that will arrive and depart from Milne Port and Steensby Port. The anti-fouling systems used have yet to be determined but will comply with the anti-fouling convention as well as be approved under the Pest Management Regulatory Agency of Canada and Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals (2007-86). This convention prohibits the use of dangerous organotin chemicals in anti-fouling systems. Any anti-fouling system that has a component listed under Annex I of the convention will not be used. The potential anti -fouling systems include:*

- *Organotin-free polishing type paint*
- *Organotin-free ablative type paint*
- *Organotin free conventional type paint*
- *Biocide-free silicon type paint; and*
- *Other biocide-free paints.*

As the iron ore carriers to be constructed for the Project will exceed 400 gross tonnage, and undertake international voyages, the vessels will require an International Anti-fouling System Certification. Surveys will be conducted on new vessels to verify that the anti-fouling system complies with the IMO convention."

DFO Science's analysis and assessment

DFO Science is concerned that this section only focuses on new builds in the future and uses future tense when vessels are already operating under this project. Procedures must be put in place now for the vessels currently operating. The Proponent does not specify what procedures are currently in place. Furthermore, the Proponent highlights Steensby Port, which also highlights the importance of preventing the introduction and spread of aquatic invasive species related to Phase 2 of Baffinland as well as any other future shipping activities.

Recommendation

- DFO recommends immediate procedures be put in place, especially since some shipping is already occurring for the project; committing to act in the future is not sufficient.

BIM's position

In TSD28, Appendix V, Section 5.5.2.1, BIM states "*Sampling of the anti-fouling system will follow the Guidelines for Brief Sampling of Anti -fouling Systems on Ships (MEPC.104 (49)). The number of samples taken will be representative of the ship's hull and occur at areas where the anti-fouling system is intact. A minimum of four (4) sample points, equally spaced down the length of the hull will be taken.*"

DFO Science's analysis and assessment

It is DFO Science's understanding that MEPC.104(49) pertains to sampling only to confirm that the anti-fouling system does not use organotins and is compliant with Annex 1 of the International Convention on the Control of Harmful Anti-fouling Systems on Ships. It is not clear to DFO Science what is the purpose of this sampling as vessels should have records of the anti-fouling system currently in use.

Recommendations

- DFO Science recommends the Proponent specify the purpose of this sampling. Should it be related to compliance with the International Convention on the Control of Harmful Anti-fouling Systems on Ships, the Proponent should specify what action will be taken in instances of non-compliance.
- DFO Science also recommends the Proponent specify what action will be taken in instances where the anti-fouling system is not in good condition. Areas of damage to the anti-fouling system will be vulnerable to fouling by native and non-native species and can be spread through the vessels movement. DFO Science recommends the Proponent require vessels follow the IMO's 2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of aquatic invasive species.

BIM's position

BIM states "*Sampling of the anti-fouling system will occur quarterly each year, as well as when the vessels are drydocked. Sampling will not occur where the anti-fouling coating is visibly damaged or on block mark areas on the flat bottom of the ship (where intact anti -fouling system is not applied). Sampling adjacent to or below areas of damaged anti-fouling coating should also be avoided. When an appropriate sample point on the hull has been selected, any fouling present should be removed with water and a soft sponge or cloth. Any organisms collected will be delivered to an accredited laboratory for species identification. If the sampling is occurring during dry-dock, sampling should occur after the hull has been water washed*." (TSD28, Appendix V, Section 5.5.2.1, p. 172).

DFO Science's analysis and assessment

DFO Science questions the likelihood of this sampling occurring as this sampling would require divers to be conducted properly. DFO Science is also concerned about damaged areas of the anti-fouling system which can biofouled by native and non-native species and result in their spread through the vessels movement.

Recommendations

- DFO Science recommends the Proponent require vessels follow the IMO's 2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of aquatic invasive species.

3.10 Cumulative Effects

BIM's position

BIM briefly identifies all the activities that are taking place by Baffinland, for example, "*During the four photographic surveys, there was never more than one ore carrier actively transiting Milne Inlet at any given time, but there were two days when two to three large vessels were active in Milne Inlet on the same day (30 August and 4 September). Small vessels were active in Milne Inlet during all surveys and on some dates Narwhal hunts were underway. Other large vessels, including cruise ships and ore carriers were present in Eclipse Sound during the surveys*." (TSD24, Appendix A, p. 156).

DFO Science's analysis and assessment

The assessment does not consider activities that will have a cumulative effect on marine mammal behavior. For example, evaluating the cumulative impact of shipping and hunting in the LSA on Narwhal behaviour is needed. In isolation either of these activities may have little impact

on distribution, but they will often occur simultaneously and together may elicit a stronger behaviour response of Narwhal.

BIM position

"*It is understood that development activities will directly and indirectly affect marine habitat, and behaviour /movement of marine wildlife species; however, long-term monitoring studies documenting the resilience of marine animals to development and the time required to reverse adverse effects are lacking.*

Forecasting a future that may be outside the range of observable baseline environmental conditions is clearly challenging (because of climate change for example (Walther et al. 2002)). Quantifying changes to habitat provides a static assessment of a species' environment, ignoring change that may occur over time as a result of ecological succession and natural disturbances such as climatic events. Thus, there is less certainty in long-term predictions of reversibility (e.g., over periods extending beyond 100 years). However, there is a high level of confidence that the regional landscape will be different with or without the Project in future decades." (TSD24, Section 3, p. 64).

DFO Science's analysis and assessment

DFO reaffirms this statement and reiterates that cumulative effects from multiple stressors should be considered. This will impact marine mammals, such as Narwhal, which are shown to be one of the most sensitive Arctic cetaceans to change (Laidre et al. 2008).

BIM's position

"*The effects of the Phase 2 Proposal to these species are low magnitude and are not predicted to have serious implications for the regional populations."* (TSD27, Section 2.3.5, p. 69). *"Marine mammals and transboundary cumulative effect will likely not be measurable at the population level, and hence will be not significant."* (TSD27, Section 2.3.5, p. 69).

DFO Science's analysis and assessment

Shipping to European markets will result in interactions with other Narwhal stocks in northern Canada (e.g., east Baffin Island), and off the coast of Greenland which may have implications for these regional populations. Just because cumulative effects are not measureable does not mean they will not be significant. Given the proposed shipping schedule, it is probable that a single pod of Narwhal could interact with ships transiting to and from the port every single day during the open water season. This interaction will occur within the RSA, but also beyond, and should be considered in the FEIS.

3.11 Climate Change Impacts

In the Addendum FEIS for the Phase 2, BIM states that "*The Phase 2 Proposal builds on the extensive baseline studies and assessment carried out since 2011 for the larger Approved Project and is thus closely linked to the FEIS and previous addendums*." However, there are several examples of when the data is not 'extensive' and many gaps in data collection are present (e.g., benthic invertebrate sampling-reference location in the text). This has implications on the ability to determine cause of change, if any exist from either climate change or impacts from the Project.

BIM's position

In TSD6, BIM does not assess climate change impacts on freshwater ecosystems.

DFO Science's analysis and assessment

The Proponent does not assess the impact of climate change on freshwater ecosystems. DFO Science cannot assess the potential impacts of climate change on freshwater ecosystems which is a significant gap in the Proponents analysis.

Recommendation

- DFO Science recommends that the Proponent assess the impact of climate change on freshwater ecosystems.

BIM's position

In TSD6, Section 2.3.4, BIM states "*Currently, routine measurements of ambient temperatures are performed with an accuracy of about 0.1°C. Given environmental noise and natural variability in temperature time series, the warming associated with the Project's cumulative GHG emissions will be undetectable. Likewise, the other climate impacts shown in Table 2.16 would be undetectable. Given the Project's individual contribution to climate change is not detectable, the effect of the Project on climate change is not significant*."

DFO Science's analysis and assessment

DFO Science is concerned that if other global emissions are increasing over the life of the project (2013 to 2038) then what additive role will the project have in terms of climate change and potential impact to freshwater and marine biota and ecosystems.

BIM's position

In TSD6, Section 3.2.1, BIM states "*Peer-reviewed publications are usually focused on small regions, specific parameters or environments, or compound environmental parameters. They usually contain substantial technical detail. Examples could be a publication on global sea-level rise using improved glacier models or a publication on the climate feedback of black carbon deposition in the Arctic. Given the current interest in climate change and its broad relevance, this body of literature is vast, growing quickly, and in constant flux. It is beyond the scope of this research to review original research papers, but the reader is occasionally referred to research papers of particular relevance.*"

DFO Science's analysis and assessment

The Proponent's lack of a literature review and deeming this step as "*beyond the scope of their research to review original research papers*" makes it impossible for DFO science to assess the adequacy of information and the veracity of any predictions that there will be no environmental effects on marine ecosystems. The Proponent also does not assess the impacts of climate change on freshwater ecosystems. These are significant gaps in the analysis.

Recommendation

- DFO Science recommends that the Proponent conducts a comprehensive assessment (including literature review) of impacts of climate change to freshwater and marine ecosystems.

BIM's position

BIM states "*Rising temperatures, leading to the future thawing of permafrost, and changing precipitation patterns have the potential to change infrastructure and related services in the Arctic (IPCC 2014b, Chapter 28). Shifts in timing and magnitude of seasonal biomass*

production could disrupt matched phenologies (periodic plant and animal cycles) in the food webs, leading to decreased survival of dependent species." (TSD6, Section 3.3).

DFO Science's analysis and assessment

The Proponent identifies potential mismatched phenologies in the food webs leading to decreased survival of dependent species but fails to describe in any detail. This makes it impossible for DFO science to assess the adequacy of information and determine potential impacts to marine and freshwater ecosystems. Impacts to freshwater ecosystems is also not considered within the climate change technical document. These are significant gaps in the Proponent's analysis.

Recommendation

- DFO Science recommends that the Proponent comprehensively assesses and describes how the timing and magnitude of mismatched phenologies will have on marine and freshwater food webs.
- DFO Science also recommends that the Proponent assess the potential impacts of climate change on freshwater ecosystems.

BIM's position

In TSD6, Section 3.4.4, BIM states "*River flows taken in isolation are likely insufficient indicators of precipitation changes, particularly in the High Arctic. River flows in Pond Inlet and other communities in the Project region are likely affected by reduced snow accumulation in the winter, earlier snowmelt, increased glacial melt, deeper thawing of permafrost, increased surface runoff of precipitation on drier soil, and changes in the frequency and amount of rain*."

DFO Science's analysis and assessment

The Proponent identifies potential impacts including reduced snow accumulation in the winter, earlier snowmelt, increased glacial melt, deeper thawing of permafrost, increased surface runoff of precipitation on drier soil, and changes in frequency and amount of rain. The Proponent fails to describe how these potential impacts will negatively impact freshwater and marine ecosystems. As a result, DFO science is unable to assess the adequacy of information and determine potential impacts to marine and freshwater ecosystems. This is a significant gap in the Proponent's analysis.

Recommendation

- DFO Science recommends that the Proponent provides a comprehensive analysis and assessment of the potential negative impacts listed above will have on both freshwater and marine ecosystems.

BIM's position

BIM states "*Climate change information on key physical parameters were examined for water temperature, salinity, and pH. IQ on the marine environment did not provide specifics on the key physical parameters. The scientific review provides some specific information on the key physical parameters but remains mostly high level covering more generic characteristics of the Arctic marine environment.*

A supplemental review of observed and expected climate change impacts in the Canadian eastern Arctic as they relate to marine environment and marine mammals is provided below.

*The literature review summarized below indicates that the predicted changes in ice cover that may occur as a result of global climate change have the potential to affect, directly or indirectly, all aspects of the marine ecosystem in the Project ar*ea." (TSD6, Section 3.5).

DFO Science's analysis and assessment

The Proponent identifies that global climate change will have the potential to affect, directly, or indirectly, all aspects of the marine ecosystem in the Project area. The Proponent fails to provide an adequate literature review and comprehensive evaluation of impacts to marine ecosystems including biota as a result of climate change. Furthermore, the Proponent does not consider the potential impacts to freshwater ecosystems. These are significant gaps in the Proponent's analysis.

Recommendation

- DFO Science recommends the Proponent conducts a comprehensive analysis and assessment of global climate change potential to affect, directly, or indirectly, all aspects of both freshwater and marine ecosystems in the Project area.

BIM's position

In TSD6, Section 3.5.2, BIM states "*Surface water temperatures of large water bodies has warmed, particularly in high latitudes. Increased water temperatures affect planktonic and benthic biomass and lead to changes in species composition (IPCC 2014b). During the period of 1997 to 2009, a trend toward earlier phytoplankton blooms was detected in approximately 11% of the Arctic Ocean*."

DFO Science's analysis and assessment

The Proponent does not assess whether increased water temperatures and earlier phytoplankton blooms will impact marine biota. This relates to the Proponents statement that shifts in timing and magnitude of seasonal biomass production could disrupt matched phenologies (periodic plant and animal cycles) in the food webs, leading to decreased survival of dependent species. There is a lack of comprehensive evaluation of impacts to marine ecosystems. The Proponent also does not consider impacts to freshwater ecosystems. As a result, DFO Science is unable to assess the adequacy of information and determine potential impacts to marine and freshwater ecosystems.

Recommendation

- DFO Science recommends that the Proponent conducts a comprehensive analysis and assessment of potential impacts to both marine and freshwater ecosystems.

BIM's position

In TSD6, Section 3.6.6, BIM states "*On the downside of these opportunities, the future status of marine, terrestrial, and freshwater biota may be negatively affected as a result of increased coastal infrastructure. Moreover, the frequency of marine transportation is at its highest during the most productive and vulnerable season for fish and marine mammals, which is the late spring/summer.*"

DFO Science's analysis and assessment

The Proponent provides an inadequate analysis and assessment of potential impacts to marine and freshwater biota as a result of climate change, increased coastal infrastructure, and marine transportation. The Proponent states the potential impacts as a result of the Project activity, however, do not describe expected impacts. Freshwater impacts are also not considered

despite the Proponent acknowledging freshwater biota may be negatively affected. These are significant gaps in Proponent's analysis.

Recommendations

- DFO Science recommends the Proponent conducts a comprehensive analysis and assessment of potential impacts to both marine and freshwater ecosystems.

3.12 Monitoring and mitigation

BIM's position

In TSD17, Section 3.3, p. 37-38 and TSD17, Appendix A, p. 35, BIM states "*In addition to environmental effects monitoring for marine water and sediment quality as discussed in Section 2.3, the MEEMP also included effects monitoring for biological components of the marine environment. These also included an Aquatic Invasive Species (AIS) monitoring program implemented as a part of the MEEMP to fulfil Baffinland's commitment to reduce the risk of impact through introduction of invasive species during the Project's shipping operations, mostly via ballast water exchange. The AIS monitoring program is aimed to monitor for presence of alien species in the vicinity of Milne Port.*

The scope of biological components of the MEEMP and AIS studies included monitoring of the following marine biological components:

- *Benthic habitat, including benthic substrate, macroflora[1] and epifauna[2];*
- *Fish population and health;*
- *Zooplankton;*
- *Benthic infauna[3]; and*
- *Encrusting epifauna.*

[1] Large, visible vegetation, e.g. seaweeds or seagrasses.
[2] Animals, e.g. invertebrates and fish, living on the surface of the seabed.
[3] Animals, mostly invertebrate, living in the seabed sediment. "

DFO Science's analysis and assessment

The Proponent does not include phytoplankton sampling within their Aquatic Invasive Species monitoring program. DFO Science notes that the Proponent has not been doing phytoplankton sampling as part of monitoring so far (see TSD17, Appendix A, Section 8.0, p. 35).

Recommendations

- DFO Science recommends the Proponent conduct species level composition monitoring for phytoplankton in both ballast water and the marine environment given that vessels can transport harmful algae (Smayda 2007). Species level monitoring is required to identify harmful taxa that could be a risk as well as determine the effectiveness of the treatment systems. Harmful algal blooms (HABs) can cause shell fish poisoning with potential impacts to marine mammals and humans (Landsberg 2002, Berdalet et al. 2016, Berdalet et al. 2017, Starr et al. 2017).

BIM's position

In TSD17, Section 3.3, p. 41 and Section 3.4, p. 43, BIM states "*Zooplankton samples were collected at four locations in the vicinity of the Milne Port area (Figure 3-1) by four vertical and four oblique tows during each open-water season (August to September). In addition, four*

under-ice vertical samples were collected in June 2015. Vertical samples were collected using an 80-µm-mesh plankton net and oblique tows using a 250-µm-mesh plankton net. Both nets had a diameter of 30 cm."

DFO Science's analysis and assessment

Using the same methods described by BIM, recent DFO studies involving collection of plankton for aquatic invasive species port surveys indicate that a minimum of 6 composite samples (3 tows per sample) is required within a given area (they sampled within a 5 km radius of a given port) and time period to adequately characterize zooplankton species richness. This evaluation was based on species accumulation curves (including for Milne Inlet) (Dispas in press).

Recommendations

- DFO Science recommends that the Proponent conducts zooplankton monitoring with at least this level of effort.

BIM's position

In TSD17, Section 3.3, p. 38, 41 and Section 3.4, p. 43, BIM states the following "*From 2014 to 2016, two replicate video surveys were conducted along each transect described above and identified as replicate 1 (R1) and replicate 2 (R2). Three segments (referred to as S1, S2 and S3) along each transect replicate of recorded video were analyzed amounting to approximately 25% of the total video. Video was analyzed in 5-m increments along each transect and were summarized on a per-transect basis, as well as on a per-segment basis within each transect. Parameters documented included length and area of each survey, video time, substrate type (% coverage, predominant substrate group), macroflora (% coverage, predominant macrofloral class) and macrofauna (abundance and relative abundance of each taxon where it was possible)…"*

"Benthic epiflora, epifauna, fish and mobile benthic invertebrate data collected as a part of MEEMP are also used for the purpose of the AIS monitoring program. Taxonomic identification of fish and mobile benthic invertebrates is used to detect potential non-native species in the vicinity of Project facilities."

DFO Science's analysis and assessment

The methods described for monitoring epifauna appear to mainly be based on video which DFO Science does not deem suitable for identifying many organisms to the species level. Species level identifications is required to identify the majority of non-indigenous species which can, in some cases, be similar in appearance to native congeners.

Recommendations

- DFO Science recommends that the Proponent improves their monitoring efforts to allow species level identification of marine biota including non-indigenous species.

BIM's position

In TSD17, Section 3.3 and Section 3.4, BIM states "*Data collected during each survey is used to update the inventory list of taxa, which is examined for evidence of new taxa not previously identified and to determine if any of these new taxa may potentially be invasive. Numbers of samples collected during each survey were considered sufficient to capture species diversity for each ecological component studied. No invasive species have been detected as a result of the AIS monitoring studies conducted up to the 2016 field season (T. Macdonald, pers. com.)*."

DFO Science's analysis and assessment

DFO Science questions how the Proponent came to the conclusion that the number of samples collected during each survey were considered sufficient to capture species diversity for each ecological component studied.

Recommendations

- DFO Science recommends the Proponent provide evidence of this including their methodology.
- DFO Science recommends the Proponent construct species accumulation curves to test if sampling effort was sufficient.

BIM's position

"*Data collected during each survey is used to update the inventory list of taxa, which is examined for evidence of new taxa not previously identified and to determine if any of these new taxa may potentially be invasive. Numbers of samples collected during each survey were considered sufficient to capture species diversity for each ecological component studied. No invasive species have been detected as a result of the AIS monitoring studies conducted up to the 2016 field season (T. Macdonald, pers. com.).*"

"Baffinland has developed and implemented an AIS monitoring program that includes collection of data on taxonomic composition of zooplankton, benthic infauna, epibenthos, macroflora, fish and encrusting epifauna and constant updates of taxa inventory lists. The lists are examined for evidence of new taxa for early warning of a potential case of any new taxa being invasive. To-date, no indication of presence of any invasive species in the Milne Inlet ecosystem has been detected (Section 3.3; Golder 2018d)." (TSD17, Section 3.3, Section 3.4 and Section 3.6.4).

DFO Science's analysis and assessment

DFO Science questions the Proponents conclusion that no invasive species have been detected in the Milne Inlet ecosystem. At least 4 species not previously known to the area have either been identified, confirmed, or tentatively identified in surveys in Milne Inlet area. One of these species (*Monocorophium insidiosum*) is a known invader in ports and associated with shipping activity (Golder 2018, Goldsmit et al. 2019). *Monocorophium insidosium*, a tube-dwelling crustacean, is a well-known invasive fouling species and non-indigenous in the Canadian Arctic. *Polycarpa pomaria*, a tunicate, native to the northeastern Atlantic Ocean and therefore non-indigenous in the Canadian Arctic. *Mya arenaria*, a bivalve, was also reported and is a well-known invasive in other locations including Iceland, was well outside its known range but could have been a specimen of the indigenous *Mya truncata* that was misidentified. If not, this too is likely non-indigenous. There was also a fish (Apodichthys *sp.*, F. Pholidae) that was well outside its known range. Again this could have been a specimen of the indigenous *Pholis fasciata* that was misidentified. If not, this too is likely non-indigenous.

BIM's position

In TSD17 Section 4.0 (pdf page 80), BIM states "*Four of Baffinland's existing environmental management plans and three of Baffinland's ongoing monitoring programs are relevant to the marine environment. Proposed updates or revisions to management plans to address the outcome of the marine environmental effects assessment for the Phase 2 Proposal are presented in Table 4-1.*"

Recommendations

- DFO Science recommends that the Proponent develop a mitigation and management plan to address the events when a harmful invasive species is introduced and/or establishes in the area.

BIM's position

In TSD17, Section 3.6.4, p. 56, BIM states "*Baffinland has developed and implemented an AIS monitoring program that includes collection of data on taxonomic composition of zooplankton, benthic infauna, epibenthos, macroflora, fish and encrusting epifauna and constant updates of taxa inventory lists. The lists are examined for evidence of new taxa for early warning of a potential case of any new taxa being invasive. To-date, no indication of presence of any invasive species in the Milne Inlet ecosystem has been detected (Section 3.3; Golder 2018d).*

Implementation of mitigation plans and continuing AIS monitoring will minimize the potential for AIS introduction with ballast water. The residual effect is, therefore, determined as negligible."

DFO Science's analysis and assessment

DFO Science disagrees with the Proponent as the effect is not negligible. The increase in shipping activity, number of ballast discharges, and size of vessels will increase the risk of species introductions. Even with the use of ballast water exchange, DFO Science expects some number of new species to be introduced by ballast water. Although the Proponents are planning to manage risk, their determination of effect as negligible could be interpreted as zero or no risk, while DFO Science expects invasions to occur which would result in negative impacts.

Recommendation

- DFO Science recommends that the Proponent revisit their assessment to acknowledge the likelihood of an invasion.

BIM's position

In TSD17, Section 3.7.3, p. 65, BIM states "*There is a potential of introduction of invasive species and harmful bacteria and parasites that may negatively affect Arctic char health and conditions. The AIS risk assessment and mitigation measures are discussed in Section 3.6.4. As the result of the mitigation measures implemented by Baffinland, the residual effect from AIS introduced with ballast water will be negligible (Table 3-12).*"

DFO Science's analysis and assessment

DFO Science does not agree with the Proponents conclusion that the residual effect from AIS introduced with ballast water will be negligible. DFO Science expects invasions will occur and some percentage of those invasions are expected to have a negative impact.

Recommendation

- DFO Science recommends that the Proponent revisit their assessment to acknowledge the likelihood of an invasion.

BIM's position

In TSD28, Appendix V, Section 5.5.1.2 (page 40 of 60), BIM states "*The ballast water monitoring plan will be incorporated into the Environmental Monitoring Program. The goals of the ballast water monitoring plan are to ensure that ballast water management procedures are working properly and to identify any non-native organisms that may be present within the*

discharged ballast water and waters surrounding the ports. Water chemistry data collected through a separate monitoring program will be incorporated into the results where applicable."

DFO Science's analysis and assessment

Identification of non-indigenous species will require experts and as a result DFO Science questions how the Proponents plan to accomplish this task.

Recommendations

- DFO Science recommends the Proponents also include indicator variables like salinity (for ballast water exchange) and ATP (for treated ballast water) within their monitoring program. The benefit of indicator measurements is that they can be collected and assessed in real time (or within a few hours at least). DFO Science questions whether the Proponent plans on conducting these analyses for the more than 176 ship trips planned. DFO Science also questions what measures the Proponent will take when ballast water results indicate a problem.

BIM's position

In TSD28, Appendix V, Section 5.5.1.2, BIM states "*Monitoring and sampling procedures for treated ballast water discharge are to follow IMO Guidelines for Ballast Water Sampling (G2) MEPC.173 (58) and will be integrated into the Project AEEM Program. Monitoring and sampling of ballast water will occur onboard the vessel itself as well as dockside. Sampling onboard the vessel will occur in order to verify that a mid-ocean transfer has occurred. Onboard sampling will also serve to ensure that, once in place, any ballast water treatment systems are fully functional and in compliance. Onboard sampling will occur along the ballast water discharge line in order to capture an accurate representation of the treated ballast water that will be discharged. The sampling locations will be taken into consideration during the design of the vessel and selection of ballast water treatment system.*"

DFO Science's analysis and assessment

Monitoring and sampling should already be occurring for those vessels currently operating. The Proponent does not provide methods identified to address the monitoring and sampling for the vessels currently operating.

Recommendations

- DFO Science recommends the Proponent provides the methods currently employed for monitoring and sampling so DFO Science can assess their appropriateness.

BIM's position

BIM states "*Sampling protocols are to be strictly followed and in conformance with quality control and assurance standards. To date the IMO does not recommend a specific sampling or analysis protocol. As more information becomes available and testing regimes are developed by manufacturers and nation members of the IMO, the sampling and analysis protocols will be updated to reflect these changes. Due to the fact that concentrations of organisms vary throughout the ballast water, it is recommended that, if possible, sampling should occur at various locations during the ballast water discharge process (Gollasch, 2006). At least two random samples will be conducted during sampling events.*" (TSD28, Appendix V, Section 5.5.1.2).

Recommendations

- DFO Science recommends the Proponent review the recommended inline sampling methods for ships with ballast water treatment systems. These methods were produced by an International Council for the Exploration of the Sea (ICES) working group on Ballast and other Ship Vectors (WGBOSV) expert group and are in the process of being formally recognized at the IMO.

BIM's position

In TSD28, Appendix V, Section 5.5.1.2, BIM states "*Monitoring and sampling protocols will be designed in consultation with appropriate territorial and federal agencies. In addition to the onboard sampling, control sites within Milne Inlet and Steensby Inlet and impact sites that are anticipated to interact with discharged treated ballast water within each port will be sampled. This program will be implemented as part of AEMP for the Project*."

DFO Science's analysis and assessment

DFO Science is concerned about the Proponents use of future tense to describe the monitoring and sampling protocols that will be designed and implemented as part of the AEMP (Aquatic Effects Monitoring Plan) for the Project. These statements are vague and inadequate for DFO Science to conduct a proper assessment. Furthermore, DFO Science questions what procedures have been developed and currently in use for the sampling that should be already in use.

Recommendations

- DFO Science recommends the Proponent provides current monitoring and sampling protocols, as well as, develop other protocols for the proposed Project for DFO Science to review.

BIM's position

In TSD28, Appendix V, Section 5.5.1.2, BIM states "*Samples will be analyzed at an accredited laboratory to determine whether the ballast water treatment system is functioning properly. Results will be reported annually.*"

DFO Science's analysis and assessment

The Proponent should expect there to be problems with the treatment systems, especially during the first few years as vessels optimize the operation and maintenance of the treatment systems. DFO Science is concerned about the failure of treatment systems as well as the effectiveness in marine-marine port ballast transfers.

Recommendations

- DFO Science recommends that Proponent take a more pro-active approach by including the use of indicators.
- DFO Science recommends the monitoring of the toxicity (TRO) of treated ballast water in real time in case the neutralization step is not working. In these instances, vessels should stop the discharge and fix the system to avoid discharge of highly chlorinated water (may not apply if the vessel operates a UV-based system).

BIM's position

In TSD21, Summary, BIM states, "*Given the increased capacity and operation of the Mary River Project, and anticipated increases in shipping traffic, it is expected that the volume of shipping*

ballast water discharge will increase. Using the Phase 2 Proposal shipping schedule and vessel information, it was determined that ore carriers will discharge exchanged ballast water 132 times per year to allow for loading of ore upon arrival at Milne Port. A total of approximately 3,586,000 tonnes of ballast water is anticipated to be discharged into Milne Port during the shipping season each year, however mid-ocean exchanges will drastically reduce the potential that any water from a vessel's port of origin will be discharged into Milne Inlet.

The study determined that, with the large volume of ballast water discharged, the probability of AIS being introduced at Milne Port is very high. However, the risk assessment does not take into account potential mitigation measures against the introduction of AIS. Ship ballast water management will be undertaken with due diligence. Conditions and effectiveness of different treatment options can be considered, quantified, and assessed to provide more accurate information for the risk assessment of aquatic invasive species. The best treatment options will be considered as one of the potential mitigation measures. In addition, Baffinland's Shipping and Wildlife Management Plan, and Aquatic Invasive Species Monitoring Programs will be updated to address the increase in ballast water discharge volume as well as ballast water treatment options and monitoring. A new, more strict standard for ballast water management has come into force which will mean the installation of an on-board system to treat ballast water for most ships, which will also greatly reduce the risk of introduction of AIS."

DFO Science's analysis and assessment

DFO Science disagrees with the Proponents statement that the risk assessment does not take into account potential migration measures against the introduction of AIS. This is not accurate as the risk assessment model does appear to apply a correction factor to account for ballast water exchange. As a result, the risk is high despite all reasonable/prescribed management actions being taken.

The Proponent determined that ore carriers will discharge exchanged ballast water 132 times per year to allow for loading of ore upon arrival at Milne Port. DFO Science questions the accuracy of the Proponents determination of 132 exchanges per year when in other parts of the Project documents they cite 176 discharges by ore carriers (e.g., TSD21, Section 3.1, pdf page 16 - Using the Phase 2 Proposal shipping schedule and vessel information, it was determined that ore carriers will discharge exchanged ballast water 176 times per year to allow for loading of ore upon arrival at Milne Port). DFO Science questions the accuracy of the Proponents estimate of a total of 3,586,000 tonnes of ballast water to be discharged into Milne Port during the shipping season each year.

Recommendation

- DFO Science recommends that the Proponent verify the number of discharges per year as well as the total estimated tonnes of ballast water to be discharged into Milne Port per year. DFO Science also notes that the discharge estimates do not include other vessels visiting Milne Port including wet/dry supply vessels.

BIM's position

In TSD21, Section 2.0, BIM states "*For the purpose of the present risk assessment, the following assumptions were made:*

- *Ports of origin' were assumed to be the same as the 'ports of destination', as listed in Baffinland's ore shipping schedule (Phase 2 Proposal);*
- *Vessels discharging ballast water will be required to undergo a mid-ocean exchange as required by Transport Canada (the Ballast Water Control and Management Regulations*

under the Canada Shipping Act, 2001; Stewart et al. 2015). To date, the ballast water to be discharged is not expected to have been treated with biocides (Baffinland 2017a);

- *Ballast water originating from the North Atlantic and the Labrador Sea is assumed to have a temperature of 6°C and salinity of 34 PSU (Baffinland 2017b);*
- *Each ship will discharge on average 25% of the vessels Dry Weight Tonnage (DWT) in ballast water volume (David et al. 2012). This is equivalent to the following volumes:*
- *Supramax (ice class 1C) vessels: 12,500 tonnes of ballast water;*
- *Panamax: 16,250 tonnes of ballast water;*
- *Post Panamax: 23,000 tonnes of ballast water;*
- *Cape Size vessels: 37,500 tonnes of ballast water; and*
- *Ballast water estimates were calculated using the maximum ship traffic for a given month in Milne Port."*

DFO Science's analysis and assessment

There are currently no requirements for ships moving ballast water between Canadian ports to conduct mid-ocean exchange. Given that multiple domestic ports were listed as ballast water source ports, the Proponent needs to specify if ballast water is being managed on domestic trips and that the risk assessment reflects the actual conditions. DFO Science recommends the Proponent specify if domestic ballast water is managed or not managed. There are concerns that domestic ballast water release could result in the spread of species to non-native areas as well as the secondary spread of non-native species across Canada.

Recommendation

- DFO Science recommends the Proponent have management plans for both domestic and international vessel movement and ballast water release.

BIM's position

In TSD21, Section 2.1, p. 6, BIM states "*Two aspects related to probability were examined – Probability of Arrival and Probability of Survival. These two factors combine to create a Probability of Introduction.*

Probability of Arrival is based on the corrected ballast water volume that will be discharged. A correction factor was applied to the total annual volume of ballast water to be discharged due to the fact that the Project will implement mandatory management activities (mid-ocean exchange). This correction factor is employed in order to determine the discharged volume of water that may contain founding individuals of aquatic nonindigenous species, also known as propagules, after a mid-ocean exchange. This correction factor is based on exchange efficiency rates, as determined by total zooplankton abundance, which was defined as 90% for saline water (Ruiz and Smith 2005; Chan et al. 2012). Based on this efficiency rate, a correction factor of 0.1 was applied by Chan et al. (2012) where mid-ocean exchange could be assumed."

DFO Science's analysis and assessment

DFO Science requests confirmation from the Proponent that all vessels will conduct mid-ocean exchange as this is not currently required for domestic trips. DFO Science has concerns with domestic ballast water discharge as a vector of spread and recommends the Proponent require all vessels (international and domestic) conduct mid-ocean exchanges and use Ballast Water Management Systems (BWMS) to meet D-2 standards. Although the IMO does not require

domestic ships to currently use BWMS, Transport Canada has signaled its intent to include domestic ships in the next round of regulatory updates to the *Canada Shipping Act*.

Recommendation

- DFO Science recommends the Proponent have management plans for both domestic and international vessel movement and ballast water release.

BIM's position

In TSD21, Section 3.1, p. 8, BIM states "*Using the Phase 2 Proposal shipping schedule and vessel information, it was determined that ore carriers will discharge exchanged ballast water 176 times per year to allow for loading of ore upon arrival at Milne Port. This is approximately a 3-fold increase compared to the 2012 estimate (SEM 2013). At the berth, vessels will discharge approximately 12,500 to 37,500 tonnes of ballast water. Other vessels such as tugs, fuel tankers, and cargo vessels are not anticipated to discharge ballast water at Milne Port. Hence, these ships were excluded from the risk assessment. A total of approximately 3,023,750 tonnes of ballast water is anticipated to be discharged into Milne Port during the shipping season each year (Table 3.1)*.

Ballast water exchange is considered 90% effective for salt-water source water and 99% effective for freshwater sources (Gray et al. 2007; Chan et al. 2012; SEM 2013). Therefore, the volume of ballast water discharged by vessels was corrected to account for the reduction in propagule pressure, using a correction factor of 0.1 (Chan et al. 2012; SEM 2013; Chan et al. 2013).

The calculated ballast water discharge estimate for Milne Port was higher than the range of values considered in Chan et al. (2012) and SEM (2013), so the scale of rankings was modified (Table 3.2). The modified range was applied to the top three ports for international merchant vessels – Churchill, Deception Bay, and Milne Port (Chan et al. 2012; SEM 2013)."

DFO Science's analysis and assessment

DFO Science notes the amount of ballast water that has been estimated will be the third largest port in terms of ballast water discharges in the Atlantic/Great Lakes, following Sept Iles and Port Cartier. Given the number of vessel trips per open water season, ships will be continuously discharging ballast at the port, and the likelihood is high that physical/chemical water properties will not exactly match the surrounding environment at all times. As a result, the ballast water will sink to the bottom and spread along the seabed slope resulting in a long lasting alteration to fish and other marine biota habitat. Some sessile species of marine fish and invertebrates may not be able to tolerate these changes and this has the potential to result in a harmful alteration or destruction of fish and fish habitat well beyond the immediate vicinity of the loading dock (Carmack and Macdonald 2002, Conlan et al. 2008, Roy et al. 2014).

Recommendation

- DFO Science recommends that water sampling be conducted in order to gather necessary information to allow an assessment of long term changes to the marine environment surrounding the port resulting from ballast water discharge.
- As mentioned in previous comments, DFO Science requires confirmation from the Proponent that exchange is being applied on all voyages (both international and domestic) as this correction factor is applied to all trips.

BIM's position

In TSD28, Appendix V (Appendix H, Table 1.1), BIM states the significance rating for "Marine Biota: Aquatic Invasive Species" as "*Lower*":

DFO Science's analysis and assessment

DFO Science does not agree with the Proponents significance rating of "lower" for Marine Biota: Aquatic Invasive Species. DFO Science indicates that the risk assessment identified "high" risk. It appears the Proponent has now ranked it "lower" when compared with other Arctic ports (footnote by BIM). DFO Science questions the validity of this and how this statement is relevant to the assessment. DFO Science reiterates that the risk assessment was identified as being high risk.

4.0 Conclusions

The proposed extended shipping season through the Northern Shipping Route associated with the Mary River Project is unprecedented in scale for the Canadian Arctic. This area is important to several marine mammal species with special conservation status, including Narwhal, Bowhead and Walrus, as well as the marine communities and habitats that support them (e.g., DFO 2015a). Bearded and Ringed Seals are also known to be abundant and considered to be important components of the arctic marine ecosystem (Cobb et al. 2019, Yurkowski et al. 2019).

Based on the material presented in the FEIS and supporting documents, DFO Science disagrees with the Proponent's overall conclusion that the proposed project operations will inflict no significant impacts on the marine ecosystem within the LSA and RSA. The overall conclusion of no significant impact on any marine mammal, and no long term impacts, is difficult to accept, especially since the Proponent admitted that "*It is understood that development activities will directly and indirectly affect marine habitat, and behaviour /movement of marine wildlife species; however, long-term monitoring studies documenting the resilience of marine animals to development and the time required to reverse adverse effects are lacking*".

DFO Science's response to each the objectives of the request for science advice can be summarized as follows:

1. ***assess the quality and adequacy of information presented in the FEIS, and determine if any relevant information is missing and if there are gaps in the analyses;***

Many of the concerns identified during the review of the Addendum to the FEIS for the Early Review Phase (ERP) would also apply to the Project proposed for the Phase 2 (DFO 2014).

DFO Science disagrees with BIM's overall conclusion that the proposed project operations will cause no significant impacts on the marine environment. Many of the conclusions are based on subjective expert opinion, and are not based on empirical data. For example, the literature review for some sections is not as current as it should be. Information from recent publications could lead to different conclusions of effects (direct and indirect). Climate Change in particular (TSD 6) has a vast body of literature and BIM notes it is beyond their scope to review original research papers, and only refers to papers they consider to be of particular relevance.

For some sections, the Proponent did a reasonable job of reviewing literature up to 2012 when they submitted their original project EIS. However, there appears to have been very little effort to consider more recent literature, some of which is directly relevant to the geographic area, and some of the new information could have led the Proponent to different conclusions about the impact of proposed activities on the marine environment (e.g., recent dramatic declines in Narwhal abundance in Eclipse Sound, AIS studies, impact of noise on fish).

There were instances where not enough information is provided, or information was vague or inconsistent to assess the FEIS conclusions. (e.g., sea ice analysis, number of transits, amount of ballast discharge, definition of shoulder season and shipping).

DFO Science believes the scope of the Regional Study Area (RSA) is too restrictive (Figure 4). It should include Baffin Bay, where ships heading to Europe will transit. Marine mammals such as Bowhead and Narwhal are known to overwinter in Baffin Bay, and transit from the high arctic via the Baffin Island coastline.

2. ***determine if appropriate methods were used in the FEIS to develop conclusions, and if the information presented supports those conclusions;***

There were instances where methods were not considered appropriate to adequately assess the potential impact of the project and develop conclusions for the FEIS (e.g., sound modelling, ship strike assessment, marine fishing effort, benthic invertebrate sampling, AIS sampling).

Shipping season effects on ice species does not adequately consider shoulder seasons, often during critical life cycle stages. Shoulder season ice breaking could in fact affect sea ice extent and duration and extend the shipping season at both ends.

DFO Science also notes that many key components of the ecosystem received little consideration in the FEIS (e.g., benthic invertebrates, fishes). 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 to allow for a thorough environmental impact assessment of the Project. This also includes the assessment of impacts from climate change.

3. ***determine the appropriateness and adequacy of the proposed mitigation and monitoring measures in the FEIS,***

DFO Science is concerned by the lack of a scientifically rigorous approach to baseline data collection and monitoring. Use of surveillance monitoring for identifying impacts of some Project components and as a trigger for more focussed monitoring is problematic. Surveillance monitoring does not provide sufficient precision for the statistical power needed to identify potential project effects at or above biologically-appropriate thresholds.

DFO Science is concerned with the project design and methods associated with a number of the past and existing monitoring projects and baseline monitoring for marine species (e.g., Bruce Head shore-based monitoring, marine fish monitoring) and the conclusions that the Proponent makes in the FEIS based on the results of these studies.

The resulting monitoring information presented and proposed thresholds are, in some cases, either not fully developed (e.g., clear thresholds for determining if negative impacts as a result of vessel noise) or inadequate to assess potential Project effects on the marine environment either to make predictions or to monitor and, as necessary, mitigate them.

DFO Science also questions the feasibility of some of the proposed mitigation measures, particularly those related to shipping and ballast water.

4. ***if necessary, recommend additional or alternative mitigation and monitoring measures (that may be more appropriate) to reduce or avoid impacts to fish and fish habitat, including marine mammals.***

Given gaps in current knowledge, inclement weather, remoteness, and the potential for unexpected accidents and malfunctions, DFO Science recommends that the Proponent develop realistic and appropriate mitigation measures as a precautionary approach before the Project

gets underway. Currently there is insufficient detail presented on alternative means of carrying out the Project to mitigate impacts and to support the development of adaptive management strategies.

This and future review processes would benefit from DFO conducting regular reviews of the design and results of monitoring program.

Marine Mammal observers should be included on all vessels and be present throughout the shipping season.

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(March 20, 2019)

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