Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

**Canadian Science Advisory Secretariat**
**Central and Arctic Region** **Science Response 2019/031**

# SCIENCE REVIEW OF ADDITIONAL DOCUMENTS SUBMITTED MAY 13–JUNE 17, 2019 FOR THE SECOND TECHNICAL REVIEW OF THE FINAL ENVIRONMENTAL IMPACT STATEMENT ADDENDUM FOR THE BAFFINLAND MARY RIVER PROJECT PHASE 2

## 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 rail and shipping 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. The mine site is connected to Milne Inlet Port via the Milne Inlet Tote Road and ore is transported to Europe via the Northern Shipping Route through Eclipse Sound, Pond Inlet and Baffin Bay. The Southern Transportation Corridor via Steensby Port has not been constructed to date (see Baffinland 2018, DFO 2019a).

Given the financial costs and risks associated with full implementation of the Project at that time, BIM decided to take a phased approach, beginning with a smaller, less-costly option called the Early Revenue Phase (ERP). Since then, BIM has requested two Project amendments to increase the volume of ore shipments, including most recently the Phase 2 Addendum for technical review to the NIRB, which describes the activities associated with the second phase of the Project (an increase to a total of 12 Mtpa road/rail haulage and marine shipping) and provides an updated effects assessment.

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

The objective of the current review is to assess whether the new supporting and supplementary materials (provided between May 13 and June 17) for the Phase 2 FEIS Addendum provides sufficient evidence to support BIM's conclusions regarding potential ecosystem impacts of the expanded Mary River Project on marine aquatic species and habitats (particularly as it relates to marine mammals and shipping). More specifically, the objectives are to:

1. assess the quality and adequacy of information presented, and determine if any relevant information is missing and if there are gaps in the analyses;
2. determine if appropriate methods were used to develop BIM's conclusions, and if the information presented supports those conclusions;
3. determine the appropriateness and adequacy of the proposed mitigation and monitoring measures;

4. if necessary, recommend additional or alternative mitigation and monitoring measures to reduce or avoid impacts to fish and fish habitat, including marine mammals, and;
5. if necessary, recommend additional information, studies, data collection, etc. that is required for DFO to complete its assessment.

This Science Response Report results from the Science Response Process held July 16, 2019 on the Science Review of Additional Supporting and Supplementary Materials for the Final Environmental Impact Statement (FEIS) Addendum for the Baffinland Mary River Project Phase 2.

## 2.0 Background

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

Between April 8–10, 2019, the NIRB held the first Technical Review meeting with interveners to highlight concerns and information gaps contained within the FEIS impact assessment and/or resolve identified technical issues where the methodology, analysis or conclusions presented by BIM are not supported by reviewer. The outcome of the Technical Review meeting was a series of commitments from BIM to provide additional supporting materials to address and resolve outstanding issues. As part of the technical review stage, DFO FFHPP requested that DFO Science review and provide advice on the FEIS Phase 2 Addendum with consideration to the new additional supporting and supplementary materials that were provided. The results of this review were be provided to FFHPP for consideration in the DFO Departmental submission of comments to the NIRB and discussed at the second Technical Review meeting to be held between June 17–19, 2019.

## 3.0 Analysis and Response

The comments presented in this Science Response are related to the supporting and supplementary materials listed in Table 1. They were submitted by BIM to the NIRB between May 13 and June 17, 2019.

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

| Supporting and Supplementary Document | Science Response Sections |
|---|---|
| Assessment of Icebreaking Operations during shipping shoulder seasons on marine biophysical valued ecosystem components (VECs) | 3.1, 3.3, 3.4, 3.5 |
| Draft Shipping and Marine Wildlife Management Plan | 3.1, 3.4, 3.6 |
| Knight Piésold Consulting Memorandum – Supplement to TSD 27 – Cumulative Effects Assessment (May 16, 2019) | 3.1, 3.4, 3.7 |

| Supporting and Supplementary Document | Science Response Sections |
|---|---|
| Socio-economic assessment of Icebreaking operations during shipping shoulder seasons | 3.1, 3.4 |
| Technical Memorandum: Results of Power Analysis for the Marine Environmental Effect Monitoring Sampling Program (MEEMP) (May 13, 2019) | 3.2 |
| Memo Re: Baffinland Vessel Traffic and Anchorage Study Final Report (May 13, 2019) | 3.3 |
| JASCO Applied Sciences Technical Memorandum: Listening Space Reduction Analysis At 1 Khz For 2018 Acoustic Monitoring Data (May 10, 2019) | 3.5.2 |
| JASCO Applied Sciences Technical Memorandum : Additional modelling for one Cape size ore carrier at 13 kts at Eclipse Sound (May 10, 2019) | 3.5.2 |
| JASCO Applied Sciences Technical Memorandum - Sound level (SPL) contours to levels < 120 dB re 1 µPa (May 10, 2019) | 3.5.2 |
| Ballast Water Dispersion Sensitivity Simulations | 3.6 |
| Ballast Water Management Plan | 3.6 |

In addition, two Technical Supporting Documents (TSD), 18 (Ballast Water Dispersion Modelling) and 21 (Risk Assessment for the Introduction of Aquatic Invasive Species from Ballast Water) were also reviewed and comments are provided in Section 3.6.

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 to the extent possible based on the information presented. Many of the comments and recommendations contained in past DFO Science reviews for the Mary River Project remain, or have become more relevant due to the significant increase in vessel traffic and the addition of an icebreaking component (DFO 2014).

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

## 3.1 Vessel traffic and Ice coverage

*BIM's position*

BIM states "*Assumes Start Date of July 20th and Completion Date of October 16th*" (Draft Shipping and Marine Wildlife Management Plan, p. 51).

*DFO Science's analysis and assessment*

DFO Science questions if the dates identified in Tables 3 and 4 within the *Draft Shipping and Marine Wildlife Management Plan* should be amended to July 1 – November 15. DFO Science requests that BIM provides clarification.

*BIM's position*

In the *Assessment of Icebreaking Operations*, *Appendix A*, BIM presents a series of maps showing vessel traffic and ice coverage. For example, BIM presents "*2018 Early Shipping Season Vessel Traffic and Ice Coverage – July 27, 2018 (UTC)*" (p. 139).

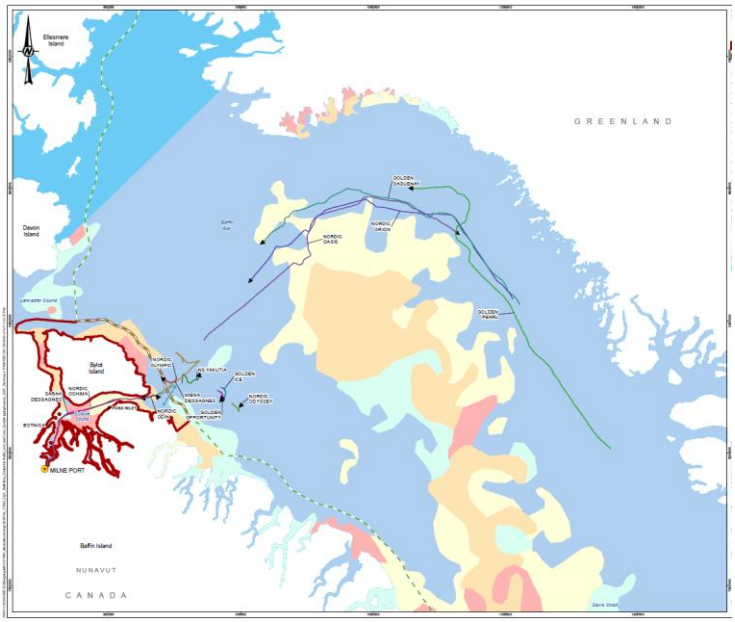


*Figure 1. Example of vessel traffic (colored lines with arrows) and ice coverage (on July 27, 2018) in Baffin Bay and the regional study area of the Mary River Project (from the* Assessment of Icebreaking Operations, *Appendix A, p. 139)*

*DFO Science's analysis and assessment*

The figure for July 27, 2018 vessel traffic and ice coverage (Figure 1; above) is very concerning to DFO Science as it shows vessels transiting/drifting through areas outside the regional study area (RSA) that are ecologically important to narwhal (*Monodon monceros*), beluga (*Delphinapterus leucas)*, bowhead (*Balaena mysticetus*), walrus (*Odobenus rosmarus rosmarus*), seals, and polar bears (Yurkowski et al. 2019a). DFO Science is very concerned that BIM does not provide an assessment of vessel traffic through these ecologically important areas, including the narwhal overwintering area in Baffin Bay and the mouth of Eclipse Sound where vessels and marine mammals will be waiting for ice to recede to enter Eclipse Sound.

*Recommendations*

- DFO Science recommends that mitigation measures be developed and implemented to prevent shipping related impacts to marine mammals in ecologically important areas outside the RSA.

*BIM's position*

BIM states that "*Once the project is fully operational, up to 10 sealifts and 10 tankers could be required each season, although the majority of these would likely transfer to Steensby Inlet as the South Railway is approved to haul freight and fuel*" (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 15).

*DFO Science's analysis and assessment*

DFO Science requires an impact assessment on the increased transit of sealifts and tankers at the southern Steensby Inlet Port to make a proper assessment.

*Recommendations*

- DFO Science requires an updated FEIS for the port at Steensby Inlet and the Southern Shipping Route for future development.

*BIM's position*

BIM contradicts previous statements regarding the length of the shipping season in the updated Cumulative Effects Assessment, stating that "*the 8.5-month shipping season excludes shipping when narwhal may be congregating at the floe edge during the months of April, May and June"* (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 21). This contradiction has been discussed with BIM. BIM clarified that the shipping season will be 4.5 months (July 1 to November 15). This error in shipping season length is also present in the Ringed Seal section on p. 21 of TSD27, that "*The effects of icebreaking to Milne Port can be expected to be comparable, though the temporary disturbance effects will occur over an 8.5-month shipping season at Milne Port, compared to year-round at Steensby Port*" (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 21).

*DFO Science's analysis and assessment*

DFO Science is concerned that BIM states that as mitigation for this issue, shipping will not occur when narwhal are present at the floe edge. However it is known that narwhal are following the floe edge into their summering grounds in July (Watt et al. 2012).

*Recommendations*

- DFO Science requires clarification from BIM that shipping, including icebreaking will not occur in April, May and June. DFO Science understands that the 8.5 month shipping season was a typo error and requires that this be corrected in a resubmitted Cumulative Effects Assessment and any other documents that contain the error.

*BIM's position*

BIM states that "*Based on annual ice conditions (e.g., as described in Enfotec 2016/TSD-16), the level of icebreaking (e.g., duration, frequency, extent) will likely vary annually*" (Assessment of Icebreaking Operations, p. 4). Throughout BIM's *Assessment of Icebreaking Operations and Socio-economic Icebreaking Assessment*, BIM only addresses icebreaking operations during the shoulder seasons (July 1 – August 5 and October 15 – November 15, as noted in both reports). However, within BIM's *Information Request (IR) Response* (Appendix 12, Section 4), BIM states that "*Ice Breaker operations will be performed when prevailing ice conditions require the Ice Class 1A – 1C ore carries to operate under escort. Generally speaking, the Ice Breaker(s) will operate from the time of break-up to freeze-up within the nominal shipping window (July 1 – November 15)*" (Baffinland 2018).

Furthermore, with reference to the *Socio-economic Assessment of Icebreaking Operations*, BIM states that "*Between the period of July 1 and July 30, a maximum of one icebreaker transit (with escorted vessels) will occur per day (24-h period) where ice concentrations of 6/10 or greater cannot be avoided along the shipping route*" (Shipping Mitigation Measures section, p. 13).

*DFO Science's analysis and assessment*

DFO Science requires BIM to provide clarification and description of the minimum and maximum estimates, as well as the amount of variation of ice coverage. Concerns have been raised previously (DFO 2019a) that ecological criteria should also be considered because the ice platform is habitat for ice-dependent pinniped species (e.g., ringed seal [*Pusa hispida]*, bearded seal [*Erignathus barbatus*]).

DFO Science is concerned that BIM's stated potential to use icebreakers as required throughout the shipping season, coupled with the fact that in 2018 they used the icebreaker (*Botnika*) from July 21 – August 10 and September 25 – October 22 (she has also been charted for the 2019 open-water shipping season), clearly indicates that the potential exists for icebreaker use outside of the shoulder season window.

DFO Science is also concerned that BIM did not use the region-specific studies on observed and projected sea-ice change as recommended in Environment and Climate Change Canada's (ECCC) (2019) Technical Submission (3.2: Sea Ice Trends and Projected Changes). DFO Science is concerned that BIM is relying on their existing assumption that pan-Arctic sea ice information applies at the regional scale. ECCC indicates that the assumption made by BIM that earlier ice break-up and later ice freeze-up are expected near Pond Inlet (due to warming temperature and thinner seasonal sea ice) is generally accurate and is also supported by region-specific information. However, ECCC also notes that regional simulations (e.g., Laliberté et al. 2018) indicate that hazardous ice floes will remain in the region for several weeks, if not months, every year. It therefore seems reasonable to conclude that conditions similar to those encountered in 2018 (requiring icebreaker operations outside of the shoulder seasons evaluated in the icebreaking assessment) may be encountered during future shipping seasons of the Phase 2 project. In keeping with the precautionary principle applicable to NIRB assessments, the scope of the assessment should be expanded to evaluate potential effects throughout the entire shipping season.

Note that BIM's commitment PC-02 (as compiled in the final commitment list circulated by the NIRB after the first technical session; Baffinland Commitment List from Mary River Phase 2 project technical meeting April 8-10, 2019; NIRB File # 08MN053), reads " *Baffinland will submit the Icebreaking Assessment, which will address icebreaking activities throughout the entire nominal shipping window of July 1-Nov 15*". It is relevant to assess icebreaking impacts for the entire shipping window as it has been shown that icebreaking is taking place and/or has the potential to take place outside the defined shoulder seasons (e.g., Table 2.2: Timing of Ice Events on the Northern Shipping Route, *Socio-economic Icebreaking Assessment* indicates that drift ice was present along the Northern Shipping Route in 6 of 22 years (1997-2018) during the "open-water season").

*Recommendations*

- DFO Science requires clarification on how many escorted vessels will be permitted. There is a concern regarding their impacts.
- DFO Science requires that BIM provide clarification and a description of the minimum and maximum ice estimates, as well as the amount of variation in ice coverage. DFO Science

recommends that BIM develop monitoring to determine if icebreaking in the fall season will have an impact on ice formation.

- BIM was icebreaking during the open-water season in 2018; mitigations from the icebreaking assessment should apply any time ice conditions are present and should not be constrained by date.
- DFO Science recommends that annual reports be provided to the NIRB to ensure that all components of the Land Use, Vessel Safety, and Environmental criteria for determining opening and closing of the shipping season have been adhered to addressed.

*BIM's position*

BIM states "*Based on a maximum-case icebreaker transit scenario (2 icebreakers escorting 2 capesize carriers)*" (Assessment of Icebreaking Operations, p. 49).

*DFO Science's analysis and assessment*

DFO Science is concerned that BIM is not considering escorting tug boats in their maximum case scenario DFO Science recommends that BIM assess their proposal's maximum case scenario which could include up to 10 escorting tug boats. This information is required for DFO Science to make a proper assessment.

*BIM's position*

BIM states in the updated *Cumulative Effects Assessment* that "*Baffinland is currently investigating the feasibility of using Navy Board Inlet and Lancaster Sound as an alternate route to Eclipse Sound in certain conditions, however, the transits will vary and the potential range has not yet been confirmed. Since the alternative route would still impact the same marine mammal populations, having all project shipping captured under Eclipse Sound is acceptable*" (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 19).

*DFO Science's analysis and assessment*

Although the alternate route will impact the same marine mammal populations, it will also have a greater chance to impact other narwhal stocks (Admiralty Inlet and Somerset Island) and walrus haulout sites on the northwestern tip of Bylot Island. Furthermore, DFO Science is concerned that the transit times will be greater using the alternate route which may have a greater influence/impact on narwhal distribution. As such, DFO Science disagrees with BIM's conclusion.

For example, as identified in the DFO (2019a) review, 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) would impact a larger proportion of the Eastern Canada–West Greenland bowhead population as it is migrating during the 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).

*Recommendations*

- DFO Science recommends BIM considers the change in the proportion of the populations impacted for each species along the alternate route.

## 3.2 Power analysis of monitoring data

At the April Technical Review meeting, DFO indicated that a power analysis of the 2018 Marine Environmental Effects Monitoring Sampling Program (MEEMP) was required for the scientific assessment. The consultant provided the Technical Memorandum entitled: *Results of Power Analysis for MEEMP*.

*DFO Science's analysis and assessment*

DFO Science is concerned that the MEEMP has insufficient sample sizes to detect project impacts for Sediment – Percent Fines (only three comparisons met the 0.8 power threshold) and Sediment – Iron Content (only two transects had sufficient power).

DFO Science noted that no power analysis was conducted for the Epifauna and Macroflora groups. The BIM report indicates that Epifauna was highly patchy and Macroflora had a lack of specimens in one transect (i.e., patchy), and as a result, a power analysis could not be conduct. This rationale is not considered to be sufficient justification. If data are too patchy to support the current monitoring analyses then the Epifauna and Macroflora monitoring programs need to be redesigned.

Similarly, the Benthic Infauna monitoring program requires re-examination to ensure gear, sampling strategy and samples sizes are appropriate in order to make any further conclusions. DFO Science is concerned that no power analyses are being conducted on the basis of a lack of data collection (Benthic Infauna data were only collected in one year). Additionally, BIM recognizes and provides a discussion regarding the inadequacy of the sampling gear used to date to sample Benthic Infauna.

DFO Science is also concerned with how analyses were conducted for some of the taxa. For example, benthic invertebrate community composition is strongly influenced by depth and habitat, yet samples were binned by distance from shore. Consideration of how other community composition studies have been analyzed and reported are critical.

The sample sizes presented for monitoring the three fish species weight-length (i.e., condition) are sufficient.

*Recommendations*

- As previously identified, DFO Science should have the opportunity to review marine (and aquatic) related monitoring plans and reports, independent of the Marine Environment Working Group (MEWG), to ensure that the Proponent's monitoring plans will produce results that are relevant to the monitoring objectives (DFO 2019a). These should be made available in a common, searchable portal.
- In order to improve power and the ability to detect project effects, BIM needs to increase sample size, as well as adapt and enhance sampling designs in the MEEMP program. For example:
    - Increase sample sizes for Sediment – Percent Fines.
    - Increase sample sizes for Sediment – Iron Content.
    - Redesign Epifauna and Macroflora monitoring programs so that power analysis is possible and sufficient power is achieved.
    - Re-examine the Benthic Infauna monitoring program to ensure the gear, sampling strategy, and sample sizes are appropriate.

- When considering benthic marine invertebrates communities, sampling and analyses should account for environmental drivers, including water depth, sediment grain size, bathymetry features, and the influence of riverine sediment and nutrients (Cusson et al. 2007, Conlan et al. 2008, Nephin et al. 2014, Roy et al. 2014), as well as other sources of variability (e.g., seasonal and inter-annual). Controlling for these factors and increasing sample sizes should improve power to detect project-specific impacts.
- BIM to conduct a reanalysis of existing benthic invertebrate community data based on methods used the existing literature (e.g., Roy et al. 2014), including a power analysis (e.g., La Rosa et al. 2012, Kelly et al. 2015).
- Using a reference site approach, such as the Before-After-Control-Impact approach (BACI) will help to control for temporal effects of inter-annual variability, that may confound abilities to detect project impacts.
- Power analyses should be conducted after each monitoring season to ensure all programs are achieving the 0.8 power threshold at the desired effect size. Programs that fall below the power threshold need to be adjusted appropriately to achieve the threshold in the following monitoring season.

## 3.3 Anchorages

Further information with respect to the locations and use of anchorage sites was discussed at the April Technical Review meeting. DFO (2019a) summarized several uncertainties based on the presented information and provided further recommendations on monitoring needs to determine impact and risk. The Proponent prepared and submitted the *Baffinland Vessel Traffic and Anchorage Study Final Report* to DFO in the form of a short memo. Based on this additional information, and information contained in the other submitted reports, DFO Science provided additional comments related to drift zones and anchorages.

*BIM's position*

BIM states "*While ore carriers are standing by for approval to begin their transit to Milne Port through Pond Inlet and Eclipse Sound (either due to prevalent ice conditions or congestion at Milne Port or Ragged Island), they will be instructed to anchor at an established sheltered anchorage location off the west coast of Greenland (Figure 1.3)*" (Assessment of Icebreaking Operations, p. 6).

*DFO Science's analysis and assessment*

DFO Science questions if BIM has conducted an environmental assessment for this anchorage location. In summer, sperm whales (*Physeter macrocephalus*) and northern bottlenose whales (*Hyperoodon ampullatus*) have been approaching fishing and research vessels associated with the expanding turbot (*Reinhardtius hippoglossoides*) fishery in Baffin Bay-Davis Strait region, suggesting an increased occurrence during the open-water season (Davidson 2016). Sperm whales were documented between 60ºN and 69ºN on the east side of Baffin Bay-Davis Strait (Davidson 2016). In autumn 2018, DFO Science collected identification photographs of sperm whales as well as 8 biopsy samples and deployed a satellite tag offshore Baffin Bay-Davis Strait.

*Recommendations*

- Since these whales may be present during both periods of time when boats may be anchored in west Greenland, DFO Science recommends BIM conduct an assessment on

the impacts of the anchorage site on sperm whales and northern bottlenose whales, including transits across Baffin Bay between the anchorage site and Milne Port.

*BIM's position*

BIM states in their findings from the simulation run profiles that (p. 2–3) "*Anchorages Nos. 3 and 5 were determined to be unsuitable"* and that "*Two Capesize vessels cannot anchor safely together at Anchorage No. 4. Another location would need to be identified as an alternate location for Capesize standby, specifically in cases where the operation is delayed, and the Capesize anchorages at Ragged Island are already occupied. Eclipse Sound was noted as the safest alternative.*"

*DFO Science's analysis and assessment*

Based on BIM's assessment, it was concluded that there was a need to find other suitable anchoring locations. It was mentioned at the Technical Review meeting held April 8–10, 2019 in Iqaluit, that BIM decided not to use the anchoring site at Pisikatarfik Island and that this information will be removed from the *Standing Instructions and General Information for Masters of Vessel Loading at Milne Inlet Port* (p. 132). DFO Science would like confirmation from BIM that the Pisikatarfik Island site has been removed as a suitable anchorage location. If not, DFO Science does not have the information to assess the impact of anchoring on marine habitats and species at the Pisikatarfik Island anchorage. BIM should assess any new anchorages as they are identified.

*BIM's position*

BIM also states in their findings from the simulation run profiles that "*Vessel control issues were identified in conditions of northerly winds of 30 knots when the vessel is transiting at operational speed (9 knots). Control was improved by increasing speed to 10-11 knots*" (p. 2).

*DFO Science's analysis and assessment*

Mitigation measures to control vessels when northerly winds exceed 30 knots were not provided.

*Recommendations*

- DFO Science recommends that BIM must reduce speed immediately back to 9 knots as soon as the wind is reduced to below 30.

## 3.4 Marine mammals

### 3.4.1 Residual effects and impacts

*BIM's position*

Within the *Socio-economic Assessment of Icebreaking Operations* (Section 5.6.3, p. 42), there are several statements regarding the residual effects on several marine mammals as "*Not Significant*" (e.g., ringed seals, beluga, bowhead, narwhal habitat loss/fragmentation, ice entrapment and ship strikes).

*DFO Science's analysis and assessment*

As discussed throughout the DFO Science review of past and present Baffinland FEIS documents, the Proponent has not provided information, references, data and/or analyses to support the "*Not Significant*" rating (DFO 2012a,b, DFO 2014, DFO 2019a).

*BIM's position*

BIM states that "*Narwhal is particularly sensitive when congregating at the floe edge in July, as mothers are carrying calves, and narwhal represent a significant proportion of the community's country food harvest. With the implementation of shipping mitigation measures, the local population of narwhal is not expected to abandon the area as a result of icebreaking during the shoulder season (Golder, 2019). Based on the expectation that the local narwhal population will not be reduced or displaced, harvesting of narwhal is not expected to be meaningfully affected*" (Socio-economic Assessment of Icebreaking Operations, p. 50). Furthermore, BIM states that "*Golder (2019) concluded that with application of the mitigation measures summarized in Section 2.8, the local population of narwhal is not expected to abandon the area as a result of icebreaking during the shoulder season, and effects to narwhal will be Not Significant. Based on the expectation that the local narwhal population will not be reduced or displaced, harvesting of narwhal is not expected to be meaningfully affected*" (Socio-economic Assessment of Icebreaking Operations, p. 46–47 and repeated on p. 50).

*DFO Science's analysis and assessment*

DFO Science requires BIM to clarify what data and information BIM has to support the conclusion that the mitigation measures summarized will prevent narwhal from abandoning the area. DFO Science questions if BIM has information from 2018 on narwhal abundance following their icebreaking. Given BIM acknowledges the sensitivities to narwhal when congregating at the floe edge, DFO Science questions if BIM would not expect narwhals to be negatively impacted. If this is a sensitive time for them, would noise pollution and habitat destruction not lead to displacement of narwhals. DFO Science requires this clarification and additional information to make a proper assessment.

*BIM's position*

In order to determine the percentage of individuals within the narwhal population that is impacted by the Project within the study area, BIM provides the following rational, "*For icebreaking operations, if it is assumed that approximately 1,000 to 2,900 narwhal in Milne Inlet and Eclipse Sound will exhibit avoidance of the icebreaking noise source per icebreaker transit, this represents between 5 and 14 % of the Eclipse Sound narwhal summer herd stock (estimated at 20,211 individuals based on NAMMCO 2010) and between 1 and 2% of the Baffin Bay population (estimated at 141,909 individuals based on DFO 2015a). Based on these estimates and in light of proposed mitigation measures during the shoulder seasons, the residual effects of disturbance on narwhal from icebreaking activities is predicted to not be significant (Table 5.7)*" (Assessment of Icebreaking Operations, p. 50).

Similarly, BIM states that they use "…*corrected narwhal density estimates available for July/August and October/November (Baffinland 2012; Elliott et al 2015; Thomas et al. 2015*)" for their estimation of narwhal predicted to occur in the calculated avoidance zones (Assessment of Icebreaking Operations, p. 49).

*DFO Science's analysis and assessment*

BIM is estimating that about 5–14% of the Eclipse Sound narwhal stock will exhibit avoidance of the icebreaking noise source. However, BIM is uses an older estimate for the size of the Eclipse Sound narwhal stock (i.e., NAMMCO 2010). The most recent estimate for Eclipse Sound is 10,489 narwhals with an estimated 141,909 in the population (DFO 2015a). Based on this recent estimate, the percentage of the Eclipse Sound narwhal stock that is predicted to exhibit

avoidance is about 10–28% (assuming that 1,000 to 2,900 narwhals will exhibit avoidance of the icebreaker noise).

With respect to the use of corrected narwhal density, DFO Science questions if BIM's analysis is based on an average estimate. Data from Elliott et al. (2015) and Thomas et al. (2015) show considerable variation in both the numbers and distribution of narwhals in the local study area (LSA) over the shipping period, so averages as applied are insufficient. DFO Science requires bracketing estimates with error estimates, or using season and water body specific density estimates in their calculations of numbers of narwhals predicted to occur in avoidance zones.

*Recommendations*

- DFO Science recommends that the Proponent use the most recent stock size estimate for their assessment and should then re-evaluate their conclusions.
- DFO Science recommends that the Proponent provides an estimate of the percentage of narwhal that could exhibit disturbance and avoidance behavior regularly depending on the icebreaking scenarios.

*BIM's position*

BIM states "*For icebreaking operations, if it is assumed that approximately ~70 bowhead in Milne Inlet and Eclipse Sound will exhibit avoidance of the icebreaking noise source per icebreaker transit, this represents ~1 % of the Eastern Canada-West Greenland (EC-WG) population (estimated at 6,446 individuals based on Doniol-Valcroze et al. 2015b). Based on these estimates, the residual effects of disturbance on bowhead from icebreaking activities is predicted to be not significant (Table 5.13)*" (Assessment of Icebreaking Operations, p. 68).

*DFO Science's analysis and assessment*

DFO Science questions what is the estimate for bowhead in Eclipse Sound and requires BIM to estimate the proportion of bowhead that frequent in Eclipse Sound that will be impacted. DFO Science is concerned that a large proportion of the bowhead whales that visit this area, and local disturbance may be significant to the community of Pond Inlet if their subsistence hunt is impacted. This information is needed for DFO Science to make a proper assessment.

*BIM's position*

BIM states "*For icebreaking operations, if it is assumed that approximately 70 to 200 ringed seal in Milne Inlet and Eclipse Sound will exhibit avoidance of the icebreaking noise source per icebreaker transit, this represents <1 % of the population of ringed seals in the Canadian Arctic (estimated at least a few million individuals based on Reeves 1998, NAMMCO 2010). Based on these estimates, the residual effects of disturbance on ringed seal from icebreaking activities is predicted to be not significant (Table 5.16)*" (Assessment of Icebreaking Operations, p. 77).

*DFO Science's analysis and assessment*

DFO Science requires BIM to provide an estimate of how many ringed seals are in Eclipse Sound. It is inappropriate to use a percentage of the entire Canadian Arctic population when region and water-body specific abundance estimates exist. Disturbance of ringed seals by icebreaking operations in Eclipse Sound could have a significant impact on the local population that is hunted by the community of Pond Inlet. DFO Science requires this information to make a proper assessment.

*BIM's position*

BIM states "*A software model estimating zones of impact on beluga whales around icebreakers estimated that masking of beluga communication signals is predicted within 14–71 km range (Erbe and Farmer 2000). However, narwhals have shown avoidance of icebreakers when first detected (LGL and Greeneridge 1986; Finley et al. 1990; Cosens and Dueck 1988), so individuals are unlikely to get close enough for effects such as masking to occur*" (Assessment of Icebreaking Operations, p. 51).

BIM also states that "*Based on acoustic modelling results, it is predicted that narwhal will demonstrate avoidance of the icebreaker at distances ranging from 2.2 to 12.5 km from the source based on a maximum-case icebreaker transit scenario…The estimated range ($R_{95\%}$) for narwhal avoidance (135 dB re 1 µPa SPL) at the floe edge is 0.5 km from the source"* (Assessment of Icebreaking Operations, p. 46).

*DFO Science's analysis and assessment*

DFO Science is concerned that BIM shows that narwhal will get close enough to vessels to experience masking effects. This is supported by BIMs modelling results that showed narwhal demonstrated avoidance of icebreakers at distances ranging from 2.2 and 12 km from the source and 0.5 km at the floe edge. This is much closer than the 14 to 71 km range where masking is predicted to occur.

*Recommendations*

- DFO Science recommends that BIM revaluates the impact of masking on narwhal because BIM has shown that narwhals will get close enough to vessels to experience masking effects.

*BIM's position*

BIM states "*The estimated frequency of shipping during the shoulder season includes a maximum of two icebreaker escorts per day in the regional study area (RSA). For the scenario of two icebreakers escorting two capesize carriers in Pond Inlet, a stationary narwhal in this area could be exposed to a 50% or more reduction in listening space for a period up to ~6 hours per day for transits at 9 knots, and up to ~12 hours per day for vessels travelling at 4.6 knots.*

*There is some overlap in frequency between shipping sounds and narwhal communications, therefore there is potential for masking effects out to an unknown distance from the source. If masking does occur, narwhal may change their call types and call frequency to overcome this effect (e.g., Au et al. 1985; Lesage et al. 1999); although this has not yet been studied in narwhal. Given that sounds important to narwhal are predominantly at much higher frequencies than icebreaker noise, it is considered unlikely that masking would have a significant effect on narwhal. The residual environmental effect of masking on narwhal due to icebreaking noise is therefore predicted to be not significant (Table 5.7)*" (Assessment of Icebreaking Operations, p. 53).

*DFO Science's analysis and assessment*

BIM recognizes that icebreaking might reduce narwhals' communication space by more than 50% for up to 12 hours. Based on two studies of beluga, BIM states that narwhals might change their call frequency to overcome the masking effect. In the same studies, it was also observed that belugas reduced their calling rate in the presence of shipping noise and that a decrease in calling rate is likely to have an impact on the efficiency of beluga communication (Lesage et al.

1999). Therefore, masking from icebreaking is likely to impact narwhals' ability to communicate, for up to 12 hours per day. As a result, DFO Science is concerned that narwhal communication might be masked for 12 hours per day. Given this, DFO Science does not agree with the Proponents conclusion that "*the residual environmental effect of masking on narwhal due to icebreaking noise is therefore predicted to not be significant*".

BIM states "*Monitoring and follow-up are required to examine the effects of masking on narwhal from icebreaking activities in the RSA*" (Assessment of Icebreaking Operations, p. 53). Without this monitoring and follow up there is no support for BIM's "not significant" conclusion. DFO Science requires BIM to provide supporting evidence, justification, and rationale for their conclusions.

*Recommendations*

- DFO Science recommends that BIM re-evaluates the level of the impact of masking from icebreaking on narwhal and provide supporting evidence, justification, and rationale for their conclusions.

*BIM's position*

BIM states "*With the effective implementation of mitigation, it is predicted that the residual effects of disturbance on narwhal from icebreaking activities will be of moderate magnitude (Level II), confined to the RSA (Level II), frequent in occurrence (Level II), medium-term in duration (Level II) in duration, and fully reversible (Level I). The residual environmental effect of disturbance on narwhal is predicted to be not significant (Table 5.7)*" (Assessment of Icebreaking Operations, Section 5.3.6.2 – Acoustic Disturbance, Page 55).

BIM also states "*Based on these estimates and in light of proposed mitigation measures during the shoulder seasons, the residual effects of disturbance on narwhal from icebreaking activities is predicted to be not significant*" (Assessment of Icebreaking Operations, Residual Effects Section, Page 50).

*DFO Science's analysis and assessment*

BIM concludes that the predicted residual environmental effects of disturbance on narwhal from icebreaking activities will be fully reversible (Level I). DFO Science questions what information exists to suggest that disturbance on narwhal is fully reversible. DFO Science is concerned with BIM's conclusion because based on Inuit Qaujimajatuqangit, narwhals were present in very low numbers in the RSA in 2018 and one hypothesis is that they were displaced because of icebreaking in the spring. Many participants stated this at the NIRB's Marine Monitoring and Marine Mitigation Workshop in Pond Inlet for the Mary River Project [NIRB File No. 08MN053, May 1-2, 2019. As a result, it is not clear that the residual effect of disturbance on narwhal are fully reversible and DFO Science recommends that BIM reassess this effect, with references, data, justification, and rationale for their conclusions. Without this information, DFO Science cannot make a proper assessment as BIM does not provide supporting evidence.

DFO Science is also concerned that BIM presents no data to support their conclusion that residual effects from icebreaking is predicted to be not significant. Given the next paragraph, BIM states "*There is uncertainty associated with these estimates, including the avoidance threshold level, density estimates and their correction factors, vessels modelled in the acoustic study, and how narwhal in the RSA may respond to icebreakers during the shoulder season periods - particularly in the narrow inlets of Milne Inlet and Eclipse Sound. There is also uncertainty regarding the duration of the effect and how repeated exposure to icebreaking*

*activities may affect narwhal (e.g., the number of narwhal exposed to noise levels above the 135 dB avoidance criterion over the full duration of the shoulder seasons). With the level of icebreaking proposed during the narwhal staging period (coinciding with ice break-up), it is possible narwhal may be displaced from the RSA to other coastal areas due to repeated icebreaking noise exposure*" (Assessment of Icebreaking Operations, p. 50). It is premature of BIM to assume there will be no significant effect. DFO Science also questions why impacts are confined to the RSA when ships will be transiting Baffin Bay. Furthermore, this conclusion does not agree with the general guidance for the evaluation of overall significance on an effect as described in Volume 2 of the FEIS – Consultation, Regulatory Framework, and Assessment Methodology (p. 55).

*Recommendations*

- DFO Science requires that BIM provide data and literature as well as rationale and justification to support their conclusions. This information is needed for DFO Science to make a proper assessment.

*BIM's position*

BIM states "*With the effective implementation of mitigation, the residual disturbance effects on bowhead from icebreaking noise are predicted to of moderate magnitude (Level II), confined to the RSA (Level III), frequent in occurrence (Level II), medium-term in duration (Level II), and fully reversible (Level I). The residual environmental effect of acoustic disturbance of bowhead whale is predicted to be not significant (Table 5.13)*" (Assessment of Icebreaking Operations, p. 71).

*DFO Science's analysis and assessment*

DFO Science requires BIM to reference the data and literature that supports a "*not significant*" rating and suggests that disturbance to bowhead whales is fully reversible. DFO Science also questions why impacts are confined to the RSA when ships will be transiting Baffin Bay.

*BIM's position*

BIM states "*It is considered plausible that narwhal may habituate to non-threatening icebreaking transits*" (Assessment of Icebreaking Operations, p. 50).

*DFO Science's analysis and assessment*

BIM does not provide any information to support this statement. DFO Science is unaware of any existing studies on narwhal ability to "habituate" to icebreaking transits, noise, etc. As a result, it is unknown if it is plausible that narwhal may habituate to non-threating icebreaking transits. DFO Science requires that BIM provide supporting data and literature to support their statement.

There could be energetic and long-term costs associated with habituation such as stress, and reduced reproductive rates, with subsequent declines in abundance and fitness declines. DFO Science requires that BIM define habituate and be explicit whether associated costs were considered.

*BIM's position*

BIM states that "*Any avoidance behavior* [by narwhal] *is predicted to be temporary*" (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 21).

*DFO Science's analysis and assessment*

DFO Science requires BIM to provide evidence that would support their conclusion that avoidance behavior would be temporary.

### 3.4.2 Entrapment

*BIM's position*

BIM states that "*There is concern that artificially opened water channels can be problematic for marine mammals, who may confuse them for polynyas and can get trapped too far from the ice edge as the channel eventually refreezes*" (Assessment of Icebreaking Operations, p. 53) and that "*Proposed mitigation measures to reduce and/or avoid potential ice entrapment effects from icebreaking activities are identified in Section 5.3.2*" (Assessment of Icebreaking Operations, p. 54). BIM acknowledges that "*Mortality can occur through drowning if open water is no longer accessible or if narwhal fail to leave an area before freeze-up occurs in late autumn and the ice is too thick for them to break through (Laidre et al. 2011)*" (p. 53), and also acknowledges that "*narwhals were also observed using old icebreaking tracks*" (p. 53). However, BIM concludes that "*The residual environmental effect of ice entrapment on narwhal is predicted to be not significant (Table 5.7)*" (Assessment of Icebreaking Operations, p. 54).

BIM states "*With the effective implementation of mitigation, it is predicted that the residual effects of ice entrapment on narwhal due to icebreaking activities will be of low magnitude (Level I), confined to the LSA (Level I), infrequent in occurrence (Level I), medium-term (Level II) in duration, and fully reversible (Level I). The residual environmental effect of ice entrapment on narwhal is predicted to be not significant (Table 5.7)*" (Assessment of Icebreaking Operations, p. 56).

*DFO Science's analysis and assessment*

DFO Science is particularly concerned with icebreaking activities at the beginning and end of the shipping season and the impact on marine mammals. Icebreaking 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. BIM's cited information supports the fact that narwhals might use icebreaker tracks to navigate in late fall, which may increase their chance of getting ice entrapped. 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 icebreaking could result in a change in narwhal migratory patterns and lead to a lack of immigration into the area.

BIM's conclusions that the residual effects of ice entrapment on narwhal due to icebreaking activities will be of low magnitude (Level 1), infrequent in occurrence (Level I) and fully reversible are provided without supporting evidence. Narwhal ice entrapments tend to be large, sometimes numbering more than a thousand individuals, and the residual effects of an entrapment of that magnitude might not be reversible. Therefore, DFO Science does not agree with the Proponents conclusions.

*Recommendations*

- DFO recommends that BIM re-evaluates the significance of the environmental effects of ice entrapment on narwhals since a single entrapment can affect several hundreds to thousands of individuals (Heide-Jørgensen et al. 2013, DFO 2018). In Table 5.7, the magnitude of an ice entrapment should be revised. According to Table 2.3.4 of Volume 2 of

the FEIS – *Consultation, Regulatory Framework, and Assessment Methodology*, BIM defines a Magnitude of Level I as "*An effect of the exposed indicator/VEC that results in a change that is not distinguishable from natural variation and is within regulated values*". However, an ice entrapment could have measurable effect and correspond to a Magnitude of Level II which is defined as "*An effect that results in some exceedance of regulated values and/or results in a change that is measureable but allows recovery within one or two generations*".

- DFO recommends that BIM re-evaluates the extent of the impact of ice entrapment. The effects of an entrapment would be beyond the local study area (LSA) and within the RSA, therefore the extent of an ice entrapment should be set at Level II.
- DFO Science is also concerned that frequency of entrapments will increase over natural levels due to icebreaking in the fall shoulder season. As a result, DFO Science recommends changing the magnitudes to Level II. DFO Science recommends BIM develop mitigation measures to address this concern (e.g., no icebreaking while narwhal migrate into and out of Eclipse Sound).
- DFO Science also requires that BIM provide references and justification for their rationale and conclusions. Without this information, DFO Science cannot make a proper assessment.

*BIM's position*

Within the *Assessment of Icebreaking Operations*, BIM states that "*The passage of an icebreaker in the early summer is not expected to result in an ice entrapment because the ice is breaking up at this time and there are multiple open leads narwhal could use. By mid-October, most narwhal have left the Eclipse Sound complex and the limited number of individuals still present in the RSA are in the Eclipse Sound East and Pond Inlet area and heading east out of the study area (Elliott et al. 2015; Thomas et al. 2015). The residual environmental effect of ice entrapment on narwhal is predicted to be not significant (Table 5.7)*" (p. 54).

*DFO Science's analysis and assessment*

BIM states that most narwhals have left the Eclipse Sound complex by mid-October and that the limited number of individuals still present in the RSA are in the Eclipse Sound East and Pond Inlet area and heading east out of the study area. DFO Science are concerned about the context of the Proponent's assessment and requires clarification on what the Eclipse Sound complex refers to and a justification for not including the Pond Inlet area in this statement.

Matthews et al. (2019) estimated that there were 11,756 and 3,053 narwhals in Pond Inlet on October 17 and 22, 2014, respectively. This represents a large proportion of the Eclipse Sound narwhal stock still present during the proposed icebreaking period based on the two recent stock estimates (10,489, DFO 2015a; 12,039, Marcoux et al. 2019). Given the large proportion of narwhals that may still be present in October, and the uncertainty related to the reaction of narwhals to icebreaking in the fall, DFO Science disagrees with the Proponent's conclusion that the residual environmental effect of ice entrapment on narwhal is predicted to be not significant.

*Recommendation*

- DFO Science is concerned that the Proponents statements and conclusions are based on one year (2014) of aerial survey data (Thomas et al. 2015). As such, DFO Science recommends that these results be interpreted with caution and that BIM conducts aerial surveys during the fall shoulder season.

- DFO Science recommends that BIM's mitigations as noted in the *Assessment of Ice breaking Operations* (p.60), not be constrained by date but, rather be applied whenever the relevant ice conditions are present.

### 3.4.3 Vessel Strikes

*BIM position*

BIM presents in the *Assessment of Icebreaking Operations* a lengthy rationale for why bowhead are susceptible to vessel strikes (p. 70). They go on to say that "*North Atlantic right whales have been found to exhibit no avoidance response when presented with sounds of approaching vessels (either real or play-back recordings) (Nowacek et al. 2004) and have been the subject of numerous vessel strike casualties in the last few years*" but that "*The difference between North Atlantic right whale and bowhead is that bowheads are more prone to exhibit avoidance of vessels*" (p. 70) and that "*All available information indicates that bowhead are likely to avoid vessels under way in the RSA*" (p. 71).

*DFO Science's analysis and assessment*

As stated in the first review (DFO 2019a), DFO does not agree with the current effects assessment summary for bowhead for the open water shipping season. Bowhead face some of the same risks as North Atlantic Right Whale in terms of ship strikes. 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 bowhead whale injury and mortality from vessel traffic will increase.

DFO Science is unaware of any available information on bowhead whale ship avoidance behavior, and questions the validity of BIM's conclusion concerning avoidance of ships by bowhead whales. DFO Science therefore requires BIM to provide supporting information and literature for their statements.

The impact of vessel strikes on these bowhead whales 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.

*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.

*BIM's position*

BIM states that "*The habitat change* [for ringed seal] *was estimated at 4% to 6% of the available landfast ice in Section 1.4.14.2, which is less than the 10% threshold applied in the ringed seal habitat loss assessment in the FEIS (Volume 8, Section 5.6.2.1)*" (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 20-21).

*DFO Science's analysis and assessment*

DFO Science questions if there is good information on ringed seal distribution on ice at this time of year. DFO Science is concerned that if the habitat change only impacts 6% of the ice, but happens to be in an area of high use such as eastern and western Eclipse Sound and Milne Inlet (Yurkowski et al. 2019b), this will likely have a disproportionately larger impact. DFO Science requires clarification from BIM in order to make a proper assessment.

*BIM's position*

BIM states "*Ringed seal that have not fully completed their moult by the time icebreaking operations commence may incur a slight energetic cost as a result of entering the water when their skin temperatures are elevated due to basking, but this would be temporary, and well within their ability to adapt*" (Assessment of Icebreaking Operations, p. 75).

*DFO Science's analysis and assessment*

DFO Science questions what supporting information BIM has with respect to the energetic costs of such a disturbance to ringed seals and their adaptability.

*Recommendations*

- DFO Science requires BIM to provide data or literature to support this statement. DFO Science requires this information to make a proper assessment.

*BIM's position*

BIM provides a sufficient overview of the possible impacts of vessel strikes on ringed seal, *"…serious injury or mortality by means of blunt force trauma from direct impact with the hull of a vessel, or from lacerations due to contact with rotating propellers…*" and "*Observed impacts included displacement, separation of mothers from pups, breakage of birth or nursery sites, and vessel-seal collisions*" (Assessment of Icebreaking Operations, p. 78–80). They also summarize literature on the correlation of vessel strikes with vessel speed in the assessment. "*In general, most lethal and severe injuries are linked to large vessels with bulbous bows travelling at speeds greater than 13 knots (Laist et al. 2001; Jensen and Silber 2003; Dolman et al. 2006). This vessel speed (13 knots) is considered to be the critical threshold above which vessel strikes resulting in severe injury and/or mortality are more likely to occur (Dolman et al. 2006; Jensen and Silber 2003). The probability of a lethal vessel strike is thus positively correlated with vessel speed and gross tonnage of the vessel (Dolman et al. 2006; Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Wilson et al. (2017) presented the first quantitative study of icebreakers transiting ice-breeding habitat of a phocid seal between late January and mid-March*". BIM goes on to provide rationale that this would not occur in their study area and that no occurrences of mortality have been reported, "*Icebreaking activities proposed in support of Phase 2 shipping operations has been planned to avoid important pupping, nursing and mating periods for ringed seal. Icebreaking in the early shoulder season (July/August, October/November) will overlap with the end of the moulting period when ringed seal are engaged in basking behaviour. Seals hauled out on ice floes during this time are likely to show a greater response to vessels than seals in-water. Fleeing behaviour has been observed in seals when approached within 0.4 to 0.8 km by a ship (Richardson et al. 1995b). Only seals occurring in the direct physical path of the vessel (within 10 m of the hull) would be considered at risk of injury or death (Wilson et al. 2017). In a detailed analysis of the potential effects of icebreaking ore carriers on ringed seal off the Labrador coast, Davis and Malme (1997) concluded that adult*

*ringed seal have more than enough mobility under the ice to avoid the close approach of an icebreaker, and that it was considered unlikely that icebreaking vessels would strike adult seals and cause mortality. Since the start of operations at Milne Port in 2015, no vessel strikes on pinnipeds (or near misses) have been reported along the Northern Shipping Route*" (p. 78–80).

*DFO Science's analysis and assessment*

DFO Science would like to note that within the Wilson et al. (2017) reference, of the 13 reported seal collisions, all except one occurred with vessel prior speeds exceeding 4 kn. DFO Science is concerned that this is different than the 13 kn reported by BIM. DFO Science would also like to note that Wilson et al. (2017) reported that seal collisions and mortalities were much more likely at speeds ≥ 4 knots and a recommended speed of ≤ 2.2 knots was suggested.

DFO Science would also like to reiterate that Wilson et al. (2017) reports deaths within 10 m of the vessel on either side, not only seals occurring in the direct physical path of the vessel. In addition, DFO Science is concerned with BIM using distance buffers and justifications from Wilson et al. (2017) as the ice-breakers used in the Caspian Sea are approximately half the size of Arctic ice-breakers. Therefore, the Arctic ice-breakers would have a larger effect on sea ice and in turn cause higher mortality within 10 m of the vessel on either side and at low speeds (i.e., 2.2 knots) than in Wilson et al. (2017).

DFO Science is also concerned that BIM states that no vessel strikes on pinnipeds have been reported in the area, however BIM also reports that local Inuit recount finding dead seals attributed to vessel encounters within the *Inuit Community and Stakeholder Comments* (Section 1.3, p. 13).

DFO Science is also concerned that icebreaking during the ice formation season in autumn will cause ringed and bearded seals to avoid setting up mating territories during landfast ice formation in areas of vessel traffic and icebreaking such as Milne Inlet, thereby reducing overall seal density, shifting distribution, and causing overcrowding in alternative habitat nearby.

*Recommendations*

- DFO Science strongly recommends that BIM continues to refrain from breaking any landfast ice; this would suggest no icebreaking in Milne Inlet through July for a typical season. DFO Science recommends that annual reports be provided to the NIRB to ensure that all components of the Land Use, Vessel Safety, and Environmental criteria for determining opening and closing of the shipping season have been adhered to/addressed.
- DFO Science recommends that BIM monitor icebreaking activity with local Inuit guides (e.g., use of dogs to locate dead seals).

*BIM's position*

BIM presents mitigation measure 10 that "*All icebreaking, ice management and ice escort activities will be conducted outside of the period of ringed [seal] parturition, nursing, and breeding periods*". This is presented in both the Operational Icebreaking Assessment (p. 48) and the Socio-economic Icebreaking Assessment (p. 13). The *Knight Piésold Consulting Memorandum – Supplement to TSD 27 – Cumulative Effects Assessment* also states "*Pups are born in April. Shipping will not be undertaken during the pupping season*" (p. 20), but then contradicts all statements on page 20, "*The potential future development scenario would involve shipping in ice as late as mid-March, which is the time that ringed seals establish their birth lairs".*

*DFO Science's analysis and assessment*

DFO Science is still concerned that seals will be killed due to icebreaking activity. Yurkowski et al. (2019b) provides a summary of key ringed seal behavior and life-history parameters by month during the ice-covered winter and spring seasons (i.e., January to July) (Table 2). DFO Science is concerned how key ringed and bearded seal phenology and life history events will be measured, assessed, and monitored to address seal conflicts with shipping activity, particularly if there is reference to involve shipping in ice as late as mid-March.

Western Eclipse Sound and Milne Inlet is an important pupping area (Yurkowski et al. 2019b) and young seals in July will remain near their birth site. The pups are naïve and susceptible to ship strikes and moving chunks of brash sea ice created from icebreaking activity. In addition, the incidence of displacement, separation of mothers and pups, and destruction of resting and birth lairs will increase. DFO Science is concerned that resting on ice, following the moulting stage will occur as long as sea ice persists. Juveniles and pups moult last and they could be reluctant to go into the water with an icebreaker breaking up the fast ice. All seals on the ice would be at risk (more so the young) as they could easily be crushed by moving ice (less so the actual icebreaker but the movement of ice).

*Table 2. Key ringed seal behavioral and life-history parameters by month during ice-covered periods (adapted from Yurkowski et al. 2019b).*

| Month | Territories | Parturition | Nursing | Mating | Basking |
|---|---|---|---|---|---|
| **January** | X | - | - | - | - |
| **February** | X | - | - | - | - |
| **March** | X | X | X | - | - |
| **April** | X | X | X | X | - |
| **May** | X | - | X | X | X |
| **June** | - | - | - | - | X |
| **July** | - | - | - | - | X |

*Recommendations*

- DFO Science recommends no icebreaking where and when seal density is relatively high. These areas occur in closed embayments and inlets where landfast ice exists (e.g., Yurkowski et al. 2019b). Western Eclipse Sound and Milne Inlet are important areas for ringed seals, such as those locations described in the reference and numbers appear to be high during vulnerable and critical life-history stages.
- If icebreaking does occur, DFO Science recommends that BIM be required to document and report mortalities with an appropriate survey methodology (e.g., Wilson et al. 2017).
- DFO Science would like clarification of the statement that suggests icebreaking would occur in late March.

*BIM's position*

BIM states "*Based on available evidence, ringed seals seem tolerant of industrial activity, and disturbance effects are expected to be localized and temporary. Based on the above, effects of icebreaking on ringed seal from icebreaking associated with the potential future development scenario are predicted to be not significant*" (Knight Piésold Consulting Memorandum: Supplement to TSD27 – Cumulative Effects Assessment, Section 4.3.1, p. 21).

*DFO Science's analysis and assessment*

BIM concludes that the effects of icebreaking on ringed seals will not be significant is made without supporting information. DFO Science requires that BIM consider recent literature for their assessment of potential impacts of icebreaking on seals during critical life-history periods (including pupping during shoulder periods). For example, Wilson et al. (2017) discuss icebreaking activities and their effect on seals including an assessment of impacts and potential mitigation for icebreaking vessels transiting areas of an ice-breeding seal.

*Recommendations*

- To make a proper assessment, DFO Science requires the Proponent to consider recent literature and reassess the potential impacts of icebreaking on seals during critical life-history periods, including pupping during shoulder periods.

### 3.4.4 Mitigation Measures

*BIM's position*

BIM states in the Acoustic Disturbance Mitigation Measures section of the *Assessment of Icebreaking Operations*, that "*mitigation measures…will be implemented to reduce or avoid adverse effects on all species of marine mammal in the RSA as a result of icebreaking activities for the Phase 2 Proposal:*

> *1) Between the period of 01 July and 30 July, a maximum of one icebreaker transit (with escorted vessels) will occur per day (24-h period) where ice concentrations of 6/10 or greater cannot be avoided along the shipping route.*
>
> *2) Between the period of 01 July and 30 July, a maximum of two icebreaker transits (with escorted vessels) will occur per day (24-h period) where ice concentrations less than 6/10 but greater than 3/10 cannot be avoided along the shipping route*" (Assessment of Icebreaking Operations, p. 48).

BIM also presents the same Mitigation Measures 1 and 2 in the *Socio-economic Icebreaking Assessment* (p. 13).

*DFO Science's analysis and assessment*

BIM provides two mitigation measures to minimize adverse effects on all species of marine mammals for the period of July 1 to July 30.

The 2018 Ship-based Observer (SBO) program (conducted from July 28 – August 7 and September 28 – October 17) observed ice concentrations ranging from between ice-free to 8–10/10 range (81–100%: 32% total survey effort to 1–10%: 19% survey effort).

Table 2.2 (Timing and Ice Events on the Northern Shipping Route) of the *Socio-Economic Icebreaking Assessment* indicates that drift ice was present along the Northern Shipping Route in 6 of 22 years (1997–2018) during the "open water season".

DFO Science is concerned that the Proponent has indicated in their proposal that icebreaking might still occur after July 30th which was substantiated in 2018 when BIM conducted icebreaking activities until August 10.

*Recommendations*

- DFO Science recommends that annual reports be provided to the NIRB to ensure that all components of the Land Use, Vessel Safety, and Environmental criteria for determining opening and closing of the shipping season have been adhered to/addressed.

*BIM's position*

BIM recognizes that the "*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). In the "*Assessment of Icebreaking Operations during shipping shoulder seasons on Marine Biophysical Valued Ecosystem Components (VECs)*" BIM states that "*All 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; Socio-economic Assessment of Icebreaking Operations, p. 14; Draft Shipping and Marine Wildlife Management Plan, p. 72). They also state 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*

DFO Science re-iterates that there are serious concerns about the omission of seals within the above stated mitigation measure (DFO 2019a). BIM should consider recent literature for their assessment of potential impacts of icebreaking on seals during critical life-history periods (including pupping during shoulder periods). Yurkowski et al. (2019b) provide rough density estimates and spatial coverage of Eclipse Sound ringed seals in spring. The authors also mention concerns with icebreaking during critical life-history period(s). Wilson et al. (2017) discuss icebreaking 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. The impacts documented in Wilson et al. (2017) were from much smaller icebreaking vessels than those proposed by BIM which would be much larger.

Indirect effects of icebreaking 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.

Additionally, the 300 m buffer zone is not a sufficient distance for walrus on sea ice, as previously stated in detail in DFO (2019a,b).

*Recommendations*

- 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).
- DFO (2019a,b) 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.

*BIM's position*

In the Shipping Mitigation Measures section BIM states "*When marine mammals appear to be trapped or disturbed by Project vessel movements, the vessel will implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife move away from the immediate area (as safe navigation allows)*" (Socio-economic Assessment of Icebreaking Operations, p. 14).

*DFO Science's analysis and assessment*

DFO Science requires clarification from the Proponent as to who will observe and identify marine mammals, and which criteria and thresholds will be used to assess further disturbance. Further clarification as to whether additional measures beyond stoppage of movement will be taken to mitigate disturbance is required. Clarification regarding wildlife distance and behavior criteria that will dictate when normal shipping activities are allowed to resume is also required.

*BIM's position*

In the Shipping Mitigation Measures section BIM states "*All Project vessels will be provided with standard instructions to operate their vessel in a manner that avoids separating an individual member(s) of a group of marine mammals from other members of the group*" (Socio-economic Assessment of Icebreaking Operations, p. 14).

*DFO Science's analysis and assessment*

DFO Science is concerned that BIM does not describe these instructions.

*Recommendations*

- DFO Science requires BIM to supply these instructions to make a proper assessment and determine if there will be an impact.

*BIM's position*

BIM states that "*Data indicates that a dedicated observer could be effective in reducing the risk of colliding with a whale*" (Assessment of Icebreaking Operations, p. 70). BIM also states in the Shipping Mitigation Measures section that "*Baffinland will place Marine Wildlife Observers (MWOs) on icebreaking vessels during the shoulder seasons that will be responsible for recording relative abundance, group composition and behaviour of marine mammals relative to icebreaker transits along the Northern Shipping Route. MWOs will also be responsible for recording any incidences of marine mammal strikes or near misses with Project vessels, including icebreaker vessels*" (Socio-economic Assessment of Icebreaking Operations, p. 14).

*DFO Science's analysis and assessment*

BIM's statement supports DFO Science's repeated recommendation that a Marine Wildlife Observer (MWO) should be on board on every vessel related to the project and its activities, even outside of the shoulder seasons (DFO 2019a).

DFO Science requires clarification from BIM if there will be Marine Wildlife Observers (MWOs) on every icebreaking vessel including their escort vessels as it was stated previously that (MMO) Marine wildlife officers would be on "*select vessels*" (TSD28, Appendix V, Section 5.3, Table 2, p. 166; Draft Shipping and Marine Wildlife Management Plan, p. 72).

*Recommendations*

- DFO Science recommends all project related vessels (e.g., icebreakers, escort vessels, ore carriers) have MWOs present for the entire shipping season (e.g., port to port). If this not logistically possible we recommend an alternative plan be developed by BIM to monitor presence and behavior of marine mammals.

## 3.5 Noise Assessments

### 3.5.1 General comments on noise assessments

*BIM's position*

In the *Assessment of Icebreaking Operations*, BIM presents scenario 31 and 38 maps of SPL isopleths in 10dB steps corresponding to an Icebreaker and two Cape size ore carriers transiting at 2 kn at the floe edge (Figure D-31, Figure D-38).

*DFO Science's analysis and assessment*

The scale of the map does not allow DFO to properly assess the extent of noise.

*Recommendations*

DFO recommends that the maps are zoomed out so the full extent of the noise can be assessed.

*BIM's position*

With respect to Section 5.1.11, p. 27–30 in the *Assessment of Icebreaking Operations*.

*DFO Science's analysis and assessment*

BIM provides information on how noise might impact marine mammals in the RSA including injury, disturbance, and communication masking. DFO Science is concerned that BIM does not consider the effect of project related noise on marine mammal habitat and other ecosystem components. For example, BIM does not consider the impact of noise on fishes (e.g., Radford et al. 2014) which are the prey of marine mammals. A significant change on marine mammal prey abundance and availability in addition to the other project related impacts could adversely impact marine mammal stocks.

*Recommendations*

- DFO Science recommends that BIM assess the impact of noise on fishes as this is a significant gap in BIM's assessment, as stated previously in DFO (2019a).

*BIM's position*

BIM states "*Distances to the disturbance onset threshold are considered conservative estimates as this threshold does not account for the overall duration of noise exposure to the animal, nor does it account for the frequency of the noise source relative to narwhal hearing sensitivity*" (Assessment of Icebreaking Operations, p. 46).

*DFO Science's analysis and assessment*

In addition to the uncertainty about the overall duration of noise exposure and the sensitivity to the frequency of noise, DFO Science also points out that there will be a cumulative effects of noise disturbance from multiple vessel sources in addition to the icebreaking (this is discussed further in Section 3.7). It is generally accepted that when scientific knowledge is lacking to inform decisions where there is a possibility of harm, a precautionary approach should be used.

*Recommendations*

DFO Science recommends that BIM should be considering the "worst case scenario" and a precautionary approach should be used to ensure the distances to disturbance onset threshold be set at the maximum.

*BIM's position*

BIM states "*Given the degree of frequency overlap between icebreaker noise and narwhal hearing, animals that do occur within the modelled disturbance zones are predicted to experience masking caused by icebreakers on a local and short-term scale*" (Assessment of Icebreaking Operations, p. 51).

*DFO Science's analysis and assessment*

DFO Science requires BIM to define "*short-term*". DFO Science is concerned that BIM states that the whales have the "potential to be in the disturbance zone for a period of up to 3 h (for transits at 9 knots in 0/10 ice), 5 h (for transits at 9 knots in 3/10 ice), and 10 h (for transits at 4.6 knots in 10/10 ice) per icebreaker transit" (Assessment of Icebreaking Operations, p. 45). A total of 10 daily over a period of 4.5 months represents a considerable proportion of time the Eclipse Sound narwhal stock resides in the LSA.

*BIM's position*

BIM states "*Sounds from two icebreakers escorting two Capesize carriers near Pond Inlet travelling at 4.6 knots in 10/10 ice generated the largest LSR area for narwhal whistles (centered at 5 kHz band) (Figure 5.3;* see Figure 2 below*). For this scenario, the listening space for whistles was reduced by >99% over an area extending shore to shore between Bylot Island and Pond Inlet, and by >50% over an area extending ~30 km east and west of the source*" and "*Proposed mitigation measures to reduce and/or avoid potential acoustic masking effects on narwhal from icebreaking activities are identified in Section 5.3.2*" (Assessment of Icebreaking Operations, p. 51).

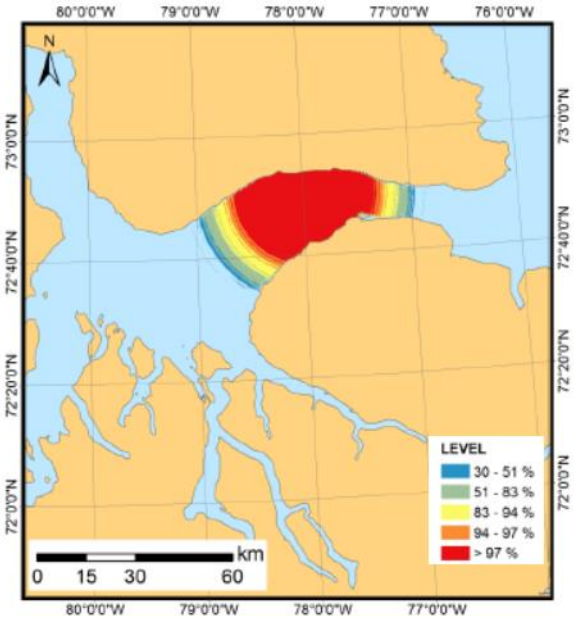


*Figure 2. Example of modelled listening space reduction (LSR) for two icebreakers and two capsize carriers transiting in compact ice (10/10) at 4.6 knots near Pond Inlet (from Assessment of Icebreaking Operations, Figure 5.3).*

*DFO Science's analysis and assessment*

Given there is essentially no listening space from shore to shore across Pond Inlet and that this disturbance could last for 10 hours per transit, DFO Science requires that BIM develop mitigation measures to address this serious concern.

*BIM's position*

BIM states that "*Based on the available literature, bowheads 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*" (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 22). Similarly, "*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*" (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 21).

*DFO Science's analysis and assessment*

DFO Science does not agree with BIM's conclusions, and requires that BIM reference the literature and monitoring results supporting their conclusions that bowheads and narwhal will tolerate and habituate to noise disturbance. DFO Science cannot make a proper assessment without this information.

*BIM's position*

BIM states "*With the effective implementation of mitigation, the residual disturbance effects on narwhal from cumulative underwater noise effects 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*" (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 21-22) with the same assessment for ringed seal (p 20), beluga (p. 22) and bowhead (p. 23).

*DFO Science's analysis and assessment*

DFO Science requires that BIM provide reference to the data and literature that supports a "*not significant*" rating as DFO does not agree with BIM's assessment as stated previously (DFO 2019a). DFO Science questions what information exists to suggest noise effects are fully reversible and why are the impacts confined to the LSA when ships will be transiting Baffin Bay. DFO Science requires this information to make a proper assessment.

*Recommendations*

- DFO Science requires that BIM justify their conclusions with supporting evidence for each species assessed.
- DFO Science also requires an assessment of the percentage (%) of time that narwhals will be exposed to noise under the Phase 2 proposal shipping scenario.

*BIM's position*

BIM states "*Baffinland will implement the outlined mitigation measures based on the current assessment and conduct additional acoustic monitoring in the 2019 season. The results of this monitoring will be used to refine the underwater sound model. The refined model will be used to confirm the results of this assessment and verify needs for ongoing mitigation and monitoring*" (Assessment of Icebreaking Operations, p. i–ii).

*DFO Science's analysis and assessment*

DFO Science is concerned that acoustic monitoring is only going to be conducted in 2019, given the long-term nature of the Project.

*Recommendations*

- DFO Science recommends that BIM commits to additional acoustic monitoring related to icebreaking beyond 2019 regardless of if Phase 2 is approved or not, to verify predictions and better inform/refine ongoing monitoring, mitigation, and adaptive management.

### 3.5.2 JASCO Technical Memorandums for Acoustic Modelling

DFO Science requested three additional supplementary analyses regarding the Baffinland Phase 2 acoustic modelling. For this review, DFO Science did not have any additional review comments for the *Memorandum: Sound Level (SPL) Contours to Levels <120 DB RE 1 µPA*.

*BIM's position*

With reference to the *Memorandum: Listening Space Reduction Analysis at 1kHz for 2018 Acoustic Monitoring Data*, the following *Equation 1* and *Figure 1* are presented (p. 1–2):

$$LRR = 100 \times \left(1 - 10^{\frac{NL_2 - NL_1}{N}}\right) \qquad \text{Equation 1}$$

In addition the document states that "*The LSR was then computed following Equation 1 (Equation 7 from Pine et al. (2018), modified to remove the factor of 2)*" (p. 1).

*DFO Science's analysis and assessment*

BIM provides calculations for Listening Space Reduction (LSR) in Milne Inlet for ambient noise. In the calculation for LSR provided by BIM, $NL_2$ is the sound pressure level with the masking noise present, $NL_1$ is the sound pressure level without the masking present. DFO assumes that $NL_1$ is equal to ambient noise and therefore, by definition, LRS for ambient noise should be 0.

Secondly, in the description of Equation 1, the memo specifies that the equation used here is a modification of Equation 7 from Pine et al. (2018). BIM does not provide justification for any of the modifications; therefore it is not clear why the factor 2, or the negative sign in front of it, was removed from the original equation (Pine et al. 2018).

DFO Science also requires an example of how LSR is calculated, and would like confirmation that Listening Range Reduction (LRR; instead of LSR) is a mistake in Equation 1. Specifically, it is not clear if BIM calculated the LSR or the LRR.

As an overarching comment, Equation 1 assumes an isotropic noise propagation and that noise propagation is not constrained (NRC 2003, Gervaise et al. 2012). DFO Science is concerned that the location of the two listening stations (AMAR-1 and AMAR-3) for which the LSR was calculated is in Koluktoo Bay. Sound propagation is likely to be non-isotropic and limited by land in Koluktoo Bay. DFO Science requires clarification that sounds propagation in Koluktoo Bay is isotropic and non-limited by land. If it is not the case, DFO Science recommends that BIM comments on the impact of the violation of the assumptions of the equation. DFO Science is concerned that the violation of the assumptions might result in an underestimate of the listening space reduction.

*Recommendation*

- DFO Science requires clarification on how $NL_1$ was calculated and on how LSR was calculated for ambient noise.
- DFO Science is concerned that there is an error in the modified equation from Pine et al. (2018), and requires rationale for the modifications. DFO Science also requires an example of how LSR is calculated.
- DFO Science is concerned that there was a violation of the assumptions for this Equation and requests the Equation be reviewed and corrected.

*BIM's position*

With reference to the *Memorandum: Listening Space Reduction Analysis at 1kHz for 2018 Acoustic Monitoring Data* BIM states that "*N is the geometric spreading coefficient for the acoustic propagation environment, here set to the nominal value of N=15*" (p. 1).

*DFO Science's analysis and assessment*

BIM does not provide justification or reference as to why N = 15 was chosen. This value will ultimately influence the calculation of the LSR. DFO Science cannot make a proper assessment without this information.

*Recommendations*

- DFO requires that BIM provide justification or reference as to why N = 15 was used.

*BIM's position*

BIM states that LSR *"was computed for underwater sound levels recorded during the 2018 shipping season (Frouin-Mouy and Maxner, 2018) at a typical recording location (AMAR−1) as well as the quietest location (AMAR−3)"* in Koluktoo Bay (Memorandum: Listening Space Reduction Analysis at 1kHz for 2018 Acoustic Monitoring Data, p. 1).

*DFO Science's analysis and assessment*

In order to properly assess the LSR, DFO requires the Proponent to conduct similar modelling in other parts of the Regional Study Area including Milne Inlet and Eclipse Sound. DFO Science requires this additional information to make a proper assessment.

*Recommendations*

- DFO Science requires the Proponent conduct listening space reduction modelling in other parts of the Regional Study Area including Milne Inlet and Eclipse Sound.

*BIM's position*

LSR performed by JASCO is based on the current noise from the shipping traffic recorded in 2018 (Memorandum: Listening Space Reduction Analysis at 1kHz for 2018 Acoustic Monitoring Data, p.1).

*DFO Science's analysis and assessment*

BIM is proposing to increase shipping to 420 annual transits in Milne Inlet (Baffinland Information Response, Appendix 12, p. 4-5). As a result, DFO Science is concerned that the Proponent is using current noise levels from shipping traffic recorded in 2018. Given the significant increase in shipping traffic expected with Phase 2, DFO Science requires the Proponent to conduct a modelling exercise to calculate the LSR associated with the proposed 392 transits in all the areas of the Regional Study Area (e.g., Aulanier et al. 2017, Pine et al. 2018).

*Recommendations*

- In order to make a proper assessment, DFO Science requires the Proponent to conduct a modelling exercise to calculate the LSR associated with the proposed 392 transits in all the areas of the Regional Study Area.

*BIM's position*

With reference to the *Memorandum: Additional Modelling for one Cape Size Ore Carrier at 13KTS at Eclipse Sound*, calculations of sound exposure level ($SEL_{24}$) and thresholds for auditory injury are presented (p. 3). Similarly, in the *Assessment of Icebreaking Operations*, BIM presents Figures D-39 to D-76.

*DFO Science's analysis and assessment*

References used for these calculations were based on NMFS (2018) and Southall et al. (2007); however, Southall et al. (2019) have published new guidelines for the calculation of $SEL_{24}$ and thresholds for auditory injury.

*Recommendations*

- DFO recommends that the authors of the Memo either provide new calculations based on the new guidelines (Southall et al. 2019) or provide comments on the difference in methods and results between the older and newer methods. In light of the new guidelines, DFO also

recommends that BIM also considers temporary threshold shift (TTS) and not just permanent threshold shift (PTS), if relevant.

*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).

*Recommendations*

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

## 3.6 Environmental effects of ballast water and vessel biofouling

Aquatic invasive species (AIS) is a priority area for DFO Science. DFO Science has responsibilities under the Canadian Action Plan for AIS, which highlights the need for a strategic plan to address pathways of introduction and prioritizes prevention of new invasions. The Plan considers the shipping pathway as the largest single source of new aquatic invasive species and, as a high priority area, highlights the need for research on control methods for priority AIS and the need for increased capacity for inspections and enforcement for import vectors. DFO and Transport Canada have maintained an effective science-policy partnership for more than a decade. Transport Canada develops, implements, and enforces shipping regulations with a strong commitment to science-based decision-making. DFO conducts research to identify risks, mitigation strategies, and effective compliance-monitoring and environmental monitoring/early detection tools, with a strong focus on prevention and early detection of non-indigenous species (NIS).

DFO Science is concerned that ballast water discharges could result in the release and survival of NIS, some of which could be invasive. The effect of any such introductions will likely be non-reversible and could negatively impact the structure and function of the marine ecosystem (beyond the LSA and RSA). Regular monitoring is essential to determine the efficacy of management strategies, as well as to support early detection and response activities. DFO Science reiterates its prior recommendation that biological monitoring of ballast and hull fouling is essential. This concern and recommendation has repeatedly been stated in both MEWG meetings and DFO Science reviews of BIM project proposal (e.g., DFO 2019a).

DFO Science understands that the Proponent has not been conducting ballast sampling for biological data collection (i.e., on types and/or densities of organisms) from arriving ships. DFO Science has recommended numerous times that this information should be collected to inform future risk assessments (DFO 2019a) and potentially respond to a new introduction.

DFO Science also has substantial concerns related to the potential effect that large quantities of discharged ballast water will have on the physical/chemical characteristics of the marine environment and associated impacts to fish and fish habitat. DFO science continues to emphasize the need for accurate models of ballast dispersion and of inclusion/collection of appropriate data for informing these models.

### 3.6.1 Monitoring and modelling

*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). BIM states in the document titled: *Risk Assessment for the Introduction of Aquatic Invasive Species from Ballast Water* (TSD21) that "*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*." (Table 3.1, p. 8-16).

*"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 Exclusive Economic Zone (EEZ). Depending upon the location of mid-ocean exchange, the temperature and salinity can be quite different than the assumed values provided by BIM (see Chan et al. 2014). BIM should provide data (coordinates, dates) of ballast water exchanges conducted by vessels during 2015–2018. These data could be mapped along with information on average monthly water temperature and salinity, as this data is readily available. With this information, BIM could model temperature for the mass of water in the tanks at a given time of the year. This information is required for DFO Science to conduct a proper assessment of impacts of ballast release on the physical marine environment.

The amount of ballast water that has been estimated is significant – making Milne Inlet the 3rd largest port in terms of ballast water discharge volume in the Atlantic/Great Lakes (following Sept Iles and Port Cartier) and the 4th largest port in Canada. Given the number of vessel trips per open water season, ships will be almost 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. This could result in long-lasting alteration to fish habitat over 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) and less mobile species may be more vulnerable to change if they are unable to compensate behaviorally by moving elsewhere. While some of these marine fish and invertebrates may be physiologically 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, others may not be able to tolerate these changes, potentially resulting in 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.

DFO Science would like to re-iterate the on-going concern that the physio-chemical characteristics within the water column will be altered with the high levels of discharge of ballast water to this environment (DFO 2019a, see benthic invertebrates and fishes section). For this reason, DFO Science would like to have a better understanding, and be provided with the prediction of effects of ballast water discharge on the vertical structure of the inlet waters. For example, how does the discharge of “open ocean” water change or affect the water mass layers present in Milne Inlet? Temperature, salinity, nutrient concentration and mixing between various water masses, along with light conditions drive primary production which in turn influences secondary productivity (zooplankton, fish, and marine mammals). As a result, BIM needs to assess if the release of ballast is changing the physical/chemical environment which in turn will impact ecosystem structure and function within the LSA. Are nutrient concentrations lower as a result of dilution with open ocean waters? Will this result in less productivity during the summer/open water season? By how much is water temperature and salinity changing in the different vertical water masses and how much are bottom waters temperature changing, if at all, and what is the effect on productivity?

DFO Science is concerned that temperatures of exchanged water could be much higher than that of recipient water depending on when and where exchange is conducted. Previous research has shown ships coming to the Arctic from Europe conduct exchange in waters having temperatures from 9–22°C to much greater temperatures than the 6°C value used by BIM (see Chan et al. 2014). Large masses of warm water in ballast tanks would take time to cool and may not reach ambient temperature at the time of discharge.

Current predictions produced by the hydrodynamic model do not appear to be very accurate or precise (Sections B-2.3.3 to B-2.3.5, p. 45–56) and it is not clear what Tables B-2.3 to B-2.5 refer to. Are these root mean square error and correlation, or measured vs modelled speeds? If the table is presenting measured vs. modelled currents, there is an order of magnitude difference between modelled and actual values, which raises issues with reliability of models. The last four bullets in Section B-3.0 – Calibration Summary (p. 56) clearly indicate limitations of the model, some of which could likely be remedied by further field observation/data collection and improvement of the model.

Ballast water is discharged more or less continuously at the Port dockside and/or at anchorages in the Milne Inlet Port vicinity. Based on the hydrodynamic modelling and the volume of ballast water discharged, and given the physical-chemical properties of the discharged water (open ocean source with different temperature, salinity, and low nutrient and metal concentrations), DFO Science questions how effects of other project discharges (from drainage and operational discharge) can be detected when the water in the Port area where the monitoring is taking place is potentially highly impacted by ballast water discharge. Given this confounding effect, DFO Science has concern that BIM's results to date (e.g., no increase in metal concentrations, etc.) are not completely accurate and do not account for these confounding effects.

*Recommendation*

- The ballast water dispersion model needs to be updated using temperature and salinity data associated with ballast water exchange coordinates and where possible, actual water quality values measured from ballast of arriving vessels just prior to discharge (e.g., DFO is aware that the Proponent measures salinity in ballast of arriving vessels) as well as from Milne Port/Inlet itself, to accurately understand project effects on the physical and chemical environments of the Port and Inlet's water, sediment, and vertical stratification dynamics. In addition, the modelling also needs to be conducted using predicted volumes for newer cape size vessels proposed for Phase 2.
- The Marine Environmental Effects Monitoring Program (MEEMP) needs to be developed so as to account for the confounding effect of impacts from ballast water discharge on water quality parameters in the study area.
- DFO Science recommends that seasonal water sampling be conducted in Milne Inlet 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). Further, sampling of water quality parameters beyond just salinity (e.g., temperature) in ballast discharged by arriving vessels is recommended to provide information of the difference between ambient and discharged water.
- 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 more intensive seasonal sampling for marine fish and invertebrates, and recommends the employment of temperature, salinity, and depth instruments on/or beside the nets/sampling gear to better reflect oceanographic conditions at exact locations where fishing/organism collection occurred in relation to the port.
- DFO recommends a more detailed study of the freshwater inputs and budget to port/Milne Inlet (accurate flushing rate, nutrient content and carbon budgets), to better model and understand the effects of ballast water discharge. Freshwater inputs play an important role in primary productivity dynamics in the area, with cascading effects on fish and fish habitat.

*BIM's position*

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

*DFO Science's analysis and assessment*

Histories of ballast tanks can differ and there can be variability among ballast tanks since exchange occurs over hours (e.g., Goldsmit et al. 2019b). As a result, DFO Science is concerned that sampling only a single tank is thus not likely to be fully representative of the ballast on a vessel.

As noted above, BIM states ballast sampling will be conducted by the ship's crew, which DFO commendted that such samples should be taken under the supervision of an authorized

authority. As such, BIM could sample all or a subset of randomly selected ballast tanks to verify that the self-reported values are correct.

*Recommendations*

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

*BIM's position*

BIM states that: *"In the unlikely scenario of a non-compliance event, Baffinland will initiate adaptive management measures (see Section 4.0).*

*If the average salinity reading is less than 30 ppt or greater than 40 ppt, the following steps will be taken:*

- *Recalibration of YSI to determine if there is an error with the instrument.*
- *Review vessel Ballast Water Records to verify ballast water exchange occurred*
- *Using secondary YSI instrument if needed to retest ballast water tanks.*

*If after the above steps have been followed and the average salinity reading remains less than 30 ppt or greater than 40 ppt, the Port Captain will notify Baffinland's Head of Shipping of the situation. The Head of Shipping will then, in consultation with the vessel Master and vessel owner/operator, defer to Transport Canada on what the appropriate next steps for the vessel would be.*

*Baffinland will continue to consult with Transport Guidance on guidance regarding best practices for testing and adaptive management in relation to the D-2 standard"* (Ballast Water Management Plan, Section 4, p. 13–14).

*DFO Science's analysis and assessment*

DFO Science is concerned that adaptive management measures outlined by the Proponent appear to only concern vessels that do not comply with D-1 standards. However, some vessels already have treatment systems and need to adhere to the D-2 standard as per the BWM convention.

*Recommendations*

- DFO Science recommends that BIM's adaptive management needs to also include a plan with steps that will be taken if there is a known failure of a treatment system or in cases of non-compliance with D2 standards.
- DFO Science reiterates our earlier recommendation that all project vessels use a treatment plus exchange strategy. This will help ameliorate some of the risks associated with failed treatments and reduce the risk of introducing NIS/AIS.

- DFO Science recommends that the Proponent implements a program to sample and monitor the type and number of viable organisms.

*BIM's position*

BIM states in Section B.4.3 – Salinity Measurement Procedure section that "*To determine the actual depth of the ballast tank, lower a weighted line to the bottom of the tank…*" (Ballast Water Management Plan, p. 26).

*DFO Science's analysis and assessment*

DFO Science notes that many ships have horizontal structures, so the lowest accessible depth may be 3 or 4 meters, rather than being able to measure the actual depth of the tank.

*Recommendations*

- The Ballast Water Monitor should always reference ship structural diagrams or consult with the ship crew to verify the depth of each ballast tank.

*BIM's position*

BIM states in Section B.4.3 – Salinity Measurement Procedure section that "*Using the YSI, take a reading at the surface, approximately 1 m from bottom…*" (Ballast Water Management Plan, p. 26).

*DFO Science's analysis and assessment*

As above, the depth at which a salinity measurement can be taken may be limited by internal tank structure.

*Recommendations*

- As saline water tends to stratify by depth, the lowest salinity reading is expected near the surface. Thus, taking a measurement only at the top when depth accessibility is limited should be acceptable (and precautionary).

*BIM's position*

BIM states in Section B.4.3 – Salinity Measurement Procedure section to "*Turn the instrument on*" (Ballast Water Management Plan, p. 26).

*DFO Science's analysis and assessment*

Air temperature can affect accuracy of salinity measurements.

*Recommendations*

- DFO Science recommends that BIM should verify the air temperature range at which the YSI can operate. DFO Science also recommends that BIM should keep a portable refractometer available as a backup (and sample bottles) so that a surface sample of ballast water could be collected and taken to the ship's deck office to conduct the measurement in a warmer location, when necessary.

*BIM's position*

BIM states that "*Monitoring results will be recorded in the salinity measurement logbook*…" (Ballast Water Management Plan, p. 13).

*DFO Science's analysis and assessment*

Results in a logbook format are not easily accessible for later sharing or analysis.

*Recommendations*

- DFO Science recommends that monitoring results should also be transcribed into an excel spreadsheet such that results can be easily made accessible for analysis at a later date. DFO Science notes that Transport Canada has an existing Ballast Tank Exam form that could be used, and it would provide consistency of data collected across regions.

*BIM's position*

In Section 6.6 (Environmental Monitoring – Marine Environment), p.76 of the *Draft Shipping and Marine Wildlife Management Plan*), BIM states that "*Baffinland is committed to implementing marine-based monitoring programs for the Mary River Project to monitor for possible Project-related impacts to the marine environment as identified in the FEIS (Baffinland 2012) and Addendums (Baffinland 2013; 2018) and to meet monitoring requirements outlined in Terms and Conditions of Project Certificate No. 005. The main objectives of the monitoring programs are to:*

- *Verify effects predictions described in the Approved Project;*
- *Evaluate the effectiveness of Project mitigation measures;*
- *Identify unforeseen environmental effects;*
- *Provide an early warning of an adverse change in the environment; and*
- *Improve the understanding of cause-and-effect relationships".*

*DFO Science's analysis and assessment*

DFO Science is concerned about the lack of monitoring by BIM to test and assess the mitigation for release of NIS/AIS into the aquatic environment.

*Recommendations*

- DFO Science reiterates its repeated recommendation that biological monitoring of ballast water and hull fouling is essential to assessing if the Proponents management of these vectors is successfully mitigating for the release of NIS/AIS into the marine environment of Milne Inlet and surrounding region. This concern and recommendation has repeatedly been stated in both MEWG meetings and DFO Science reviews of BIM project proposal (e.g., DFO 2019a).

*BIM's position*

With respect to the *Ballast Water Dispersion Modelling* (TSD 18), BIM states "*For the current model, we have assumed that ballast water dispersion modelling assumes that ballast water discharge will be 30% of the deadweight tonnage of the vessel. The ballast water is assumed to be discharged at the same rate as the ore is loaded*" (p. 6).

BIM presents Table 3.1 which "*summarizes the ballast water content and discharge rates for the respective vessel classes*". For example, a 65,000 metric tonne Panamax vessel, BIM indicates that 30% of deadweight tonnage is equivalent to 19,000 meters cubed of ballast water (p. 6).

*DFO Science's analysis and assessment*

DFO Science re-calculated this example and calculated that 30% of deadweight tonnage should be equivalent to 19,500 $m^3$; not BIM's reported 19,000 $m^3$ of ballast water content. In addition to errors in the calculation, DFO is aware that data exists on the actual volumes of ballast water discharged by vessels and calculated ballast discharged at Milne Inlet during the 2018 shipping season to be closer to 32% of the deadweight tonnage, suggesting discharge volumes used in their modelling may be underestimates. The use of actual empirical data instead of an assumed percentage will be more accurate and informative.

*Recommendations*

- DFO Science would like BIM to provide clarification on the accuracy and sensitivity of results/assessments of using the 30% DW in their models to date. For future models and reports, DFO recommends using actual data, or where it is not yet available providing a sensitivity analysis on the effects of their assumptions around ballast water volumes.

*BIM's position*

BIM states that "*The minimum dilution is calculated as the integration of model results through time and space (vertical)*" (Ballast Water Dispersion Sensitivity Simulations Technical Memorandum, p. 7).

BIM Figures 4.1–4.6 show the results of the ballast water discharge simulations (Ballast Water Dispersion Sensitivity Simulations Technical Memorandum, p. 8–13).

*DFO Science's analysis and assessment*

The model results are integrated through time and space (vertical space), so it is difficult to understand to what degree the ballast water discharge is affecting the vertical structure of the water masses in the area. Based on the information that BIM provides, the effects of adding ballast water, which has different temperature and salinity from Inlet water, on the three distinct water masses as described in Appendix A2.3.1–CTD Profiles of TSD–18 (*Ballast Water Dispersion Modelling*) cannot be assessed. For example, is the pycnocline affected – or does the dilution happen only in the surface layers? Furthermore, Figures 4.1–4.6 report a dilution factor only over a horizontal distance. BIM does not assess what potential biological and ecological effects may occur. BIM also does not address how the risk of AIS establishment could be affected. DFO Science cannot make a proper assessment without this information

*Recommendations*

- DFO Science recommends the Proponent show results for changes in temperature and salinity over the three water masses (vertical) and over distance (horizontal) so that DFO Science can properly assess what is happening to the physical and chemical properties of the Inlet. For example, is the freshwater layer getting more saline? What about the other two distinct water masses? Does the addition of ballast change or influence the structure of the water masses? This information is crucial as temperature and salinity are the drivers of ecosystem functioning (e.g., productivity).
- DFO Science recommends BIM provide an assessment of potential biological and ecological effects of ballast discharge including how the risk of AIS establishment could be affected by changes in water mass characteristics.

*BIM's position*

BIM states that "*Simulations of the observed onboard ballast water salinity and temperature during the 2018 shipping season are currently in progress and will be reported at a later data*" (Ballast Water Dispersion Sensitivity Simulations Technical Memorandum, p. 2)

BIM presents "*Table 2: Prescribed salinity and temperature and resulting density for each ballast water discharge simulation developed*" (Ballast Water Dispersion Sensitivity Simulations Technical Memorandum, p. 6).

*DFO Science's analysis and assessment*

DFO Science is concerned that simulations are not conducted with actual salinity and temperature measurements of the ballast water. Without this information, DFO Science cannot properly assess the impacts of ballast water discharge.

DFO science questions why BIM did not conduct a scenario using the full range of salinity and temperature measurements from the 2018 shipping season? Temperatures ranged from -1.5 to 16.2 °C but scenarios only varied from 2 to 13 °C.

*Recommendations*

- DFO Science recommends that BIM conducts scenarios using the full range of salinity and temperature measurements based on actual salinity and temperature measurements of the ballast water.

### 3.6.2 Risk and mitigation measures

*BIM's position*

In TSD21 – *Risk Assessment for Introduction of Aquatic Invasive Species from Ballast Water*, BIM states that "*As recommended by DFO (2014), ship ballast water management will be undertaken with due diligence*" (Section 4.0, p. 12).

*DFO Science's analysis and assessment*

The Proponent should not overlook the fact that the risks of AIS arrival are high (TSD21, Section 4). Given that prevention (open ocean ballast water exchange) is already included in the risk assessment, and the effectiveness of treatment is not yet known (and likely not 100% effective), the risks associated with AIS will likely remain high throughout Phase 2.

*Recommendations*

- DFO Science strongly recommends that BIM require all vessels to conduct exchange plus treatment of ballast water.
- DFO Science recommends that BIM develops a coordinated early detection and rapid response framework and program for invasive species in Milne Inlet/Eclipse Sound with communities and other potential partners. This work could include the development of watch lists, reporting, monitoring protocols, and response strategies.
- An early response plan (similar to an oil spill response plan) should be developed with applicable regulators and local communities so that, should an NIS/AIS be detected, significant environmental effects or major change to species composition could be avoided. DFO Science recommends the Proponent examine the early response framework developed by Locke et al. (2011) as a basis for developing this type of plan.

- DFO Science also recommends the Proponent, based on their risk assessment, identify the high risk species or groupings of species (e.g., benthic invertebrates, macroalgae) of concern and assess the risk those NIS pose. These should include any NIS/AIS that have been detected in the course of past AIS/MEEMP monitoring, and be updated in the event that new NIS/AIS are detected in future monitoring. With this information, the Proponent could then develop rapid response plans for these high risk species/groups of concern which would be based on species-specific information such as life cycle and what management actions, if any, could be undertaken (e.g., application of deleterious substance) in consultation with the communities and appropriate government authorities. Some examples of response plans are the United States Parks Service and the Grand Portage Band of Lake Superior Chippewa's Emergency Prevention and Response Plan for Viral Hemorrhagic Septicemia and the International Joint Commission's Aquatic Invasive Species Rapid Response Policy Framework Work Group's policy framework.

*BIM's position*

BIM states that "*it is noted that ballast water management is first and foremost the responsibility of vessels, Transport Canada and the International Maritime Organization (IMO)*." (Ballast Water Management Plan, p. 5)

*DFO Science's analysis and assessment*

While the identified parties have responsibilities for ballast management, BIM has the ability to put additional ballast management measures in place that exceed existing requirements (e.g., as outlined in PC Term and Condition No. 89, p. 9, referenced below), particularly if such measures are operationally feasible and expected to confer greater protection against adverse impacts to the marine environment that could result from the accidental NIS/AIS by ballast water discharges. There is already a precedent for this with other mining companies. For example, ballasted domestic vessels destined for Vale's Voisey's Bay Mine have a requirement to conduct coastal ballast exchange in the Labrador Sea within a designated geographic zone, even though Transport Canada currently exempts domestic vessels from conducting ballast management.

*Recommendations*

- DFO Science recommends that as part of their ballast management plan, the Proponent should acknowledge what shortcomings exist in required management measures associated with Canadian regulations and explain how, as a matter of due diligence, BIM's ballast management measures will exceed regulations to address these shortcomings. For example, these shortcomings include (but may not be limited to):
    - Transport Canada Inspectors are not obliged to conduct compliance testing on all vessels and current compliance testing procedures (for Regulation D-1 and D-2) are indicative tests that can identify gross non-compliance but do not inform research or risk assessment. Further, compliance testing does not evaluate the efficacy of ballast water exchange or treatment.
    - On-board ballast water treatment systems are a relatively new technology and ships using their technologies have relatively high rates of failure to attain D-2 standards (DFO 2019c).

*BIM's position*

BIM states that "*At this point in time, sampling and analysis methodologies to test for compliance with the D-2 standard have not been fully developed*" (Ballast Water Management Plan, p. 7).

*DFO Science's analysis and assessment*

DFO Science agrees that methods for sampling and analysis of ballast water to verify compliance with the D-2 standard are still under development. However, BIM should note that IMO does have Guidelines for Port State Control related to the Convention [resolution MEPC.252(67)] of which sampling and analysis are only one small part. Documentation checks and instrument self-monitoring logs are used to check for proper operation of Ballast Water Management Systems. As Transport Canada will not be able to physically inspect the equipment on most ships, DFO Science recommends that BIM Ballast Water Monitors should conduct such 'inspections' as part of their due diligence.

*Recommendations*

- DFO Science previously recommended (DFO 2019a) that BIM should require all vessels to conduct exchange and treatment as a combination method to reduce the risk of introduction and spread of AIS. DFO Science is concerned that this previous recommendation has not been incorporated into the Ballast Water Management Plan. DFO Science also recommends that BIM preferentially use vessels with treatment systems as they become available and provide evidence of doing so. DFO Science reiterates its recommendation that BIM should require all ships to utilize both management measures (exchange and treatment).

*BIM's position*

BIM states that "*the Proponent shall develop and implement an effective ballast water management program that may include the treatment and monitoring of ballast water discharges in a manner consistent with applicable regulations and/or exceed those regulations if they are determined to be ineffective for providing the desired and predicted results. The ballast water management program shall include, without limitation, a provision that requires ship owners to test their ballast water to confirm that it meets the salinity requirements of the applicable regulations prior to discharge at the Milne Port."* (Ballast Water Management Plan, p. 8)

*DFO Science's analysis and assessment*

The current wording for this project condition, in particular the use of the word "may", is ambiguous and does not hold the Proponent accountable for ensuring that ballast water is managed effectively. While the Proponent has indicated they will make testing of salinity a requirement of all ship owners, thus allowing for assessment of non-compliance with D-1 standards (but not necessarily efficacy of exchange in mitigating AIS risk, DFO 2019c, p. 38), there is no mention of any requirements of ship owners to test for D-2 compliance and efficacy of treatment.

*Recommendations*

- DFO Science recommends wording in the first part of this paragraph be changed to "The Proponent shall develop and implement an effective ballast water management program that will include monitoring all ballast water discharges for non-compliance with Regulations

D-1 and D-2. The ballast water management program shall include, without limitation, a provision that requires ship owners or the Proponent to test ballast water of each ship to confirm that it meets Canadian requirements for salinity (at least 30 ppt) and number of viable organisms (Regulation D-2) of the applicable regulations prior to discharging.

- DFO Science recommends the Proponent develop a program for sampling and monitoring ballast from all arriving ships to evaluate the number and types of organisms being discharged as part of their monitoring program. This would allow the ship owners as well as the Proponent to evaluate the level of risk for species introductions, develop appropriate mitigation strategies to reduce risk, and inform DFO if a potential introduction occurred.

*BIM's position*

BIM states that *"The Proponent shall incorporate into its Shipping and Marine Mammals Management Plan provisions to achieve compliance with the requirements under the International Convention for the Control and Management of Ship's Ballast Water and Sediment (2004) or its replacement and as implemented by the Canadian Ballast Water and Control Regulations as may be amended from time to time."* (Ballast Water Management Plan, p. 9)

They also state that "*As a matter of due diligence, Baffinland has elected to conduct regular inspections of the chartered foreign flag vessels and conduct on-board ballast water testing to verify vessel compliance with the applicable ballast water regulation, the BWM Convention and Baffinland's BWMP"* (Ballast Water Management Plan, Section 3, p. 12) and "*As a matter of due diligence, Baffinland has elected to conduct ballast water sampling in one randomly selected ballast water tank on all foreign flag vessels arriving directly to Milne Port from international waters to confirm that effective exchange has occurred in accordance with the Regulations and the BMW Convention. Specifically, ballast water salinity will be measured prior to discharge to verify that it meets the D-1 threshold (at least 30 parts per thousand [ppt])"* (Ballast Water Management Plan, Section 3.2, p. 13).

*DFO Science's analysis and assessment*

DFO Science commends the Proponent on exercising due diligence and agrees with these statements which imply that they will be regularly testing ballast for D-1 compliance in vessels that conduct exchange and for D-2 compliance in cases where vessels are using treatment (for example, ships built after Sept 8, 2017 since BWM convention came into force). However, the follow-on Section 3.2 (page 13) only specifies that the proponent will conduct salinity testing for D-1 compliance. Although the Proponent's ballast management plan provides a great amount of detail surrounding how the Proponent will achieve and test for compliance with Regulation D-1 (ballast water exchange) with respect to salinity requirements, they do not provide any indication as to how they will test for compliance for ships that opt to use treatment systems to meet Regulation D-2. Under the current Transport Canada regulations, ships that use treatment systems must demonstrate that they meet, at a minimum, the D-1 standard which would simply require achieving salinities above the D-1 threshold. However, as stated above and in previous reviews (DFO 2019a, p. 38), this will not provide information needed for the Proponent to assess whether or not ballast management measures and procedures are achieving the objective to "*prevent and/or minimize potential adverse impacts to the marine environment that could result from the accidental introduction of non-native aquatic invasive species (AIS) via Project vessel ballast water discharges*" or the purpose of "*protecting the marine environment from potential introduction of AIS via project vessel ballast water discharge*" as outlined on page 5 (Introduction section) of BIM's Ballast Water Management Plan. Furthermore, salinity

sampling will not allow testing for compliance with D-2 standards regarding concentration of viable organisms.

*Recommendations*

- As stated above, DFO Science recommends the Proponent include be including biological sampling of ballast water for all arriving ships (not just foreign flagged vessels – see comments below with regards to this topic) to evaluate the number and types of organisms being discharged as part of their monitoring program. This would allow the proponent to evaluate efficacy of DFO Science's recommended ballast management strategy (require all vessels to conduct exchange and treatment as a combination method) for preventing or minimizing species introductions and developing appropriate mitigation strategies to reduce risk. DFO Science previously provided an example of a potential ballast sampling protocol to the Proponent at their request (emailed June 9, 2017), which could be adapted as needed. There are also a variety of examples of different sampling methods (along with pros and cons) for sampling ballast in the scientific literature which the Proponent should consider.
- While DFO Science acknowledges that methods for compliance testing are not yet fully developed, this does not preclude the Proponent from utilizing existing approaches to test for relative differences among vessels utilizing different management strategies and treatment systems. DFO Science notes that the International Maritime Organization does have Guidelines for Port State Control related to the BWM Convention [resolution MEPC.252(67)] of which sampling and analysis are a part. Given the size of the proposed Phase 2 expansion, with unprecedented levels of shipping for the Canadian Arctic it is important that the Proponent strive to prevent the introduction of NIS/AIS. This development provides the ideal opportunity for the Proponent to assess the risks and efficacy of their ballast water management measures in mitigating risk as well as contributing to research designed to test efficacy of different strategies and treatment systems in cold water environments.
- As commented on  in further detail below, DFO Science recommends that the use of the term "foreign flag vessel" should be changed to ensure accuracy and consistency with terminology in the regulations.

*BIM's position*

BIM states that "*To minimize the risk of introduction of AIS through ballast water discharge, Baffinland will ensure the following management measures are implemented for foreign flag vessels arriving directly to Milne Port from international waters:*

*• Ensure that all foreign flag vessels chartered to perform Baffinland trade comply with the Regulations and the BWM Convention.*

*• Ensure that all foreign flag vessels chartered to perform Baffinland trade that are not yet required to meet the D-2 standard of the BWM Convention meet the D-1 standard of the BWM Convention, which requires all ships to exchange ballast water in open seas, away from coastal areas (>200 nautical miles from land and in water at least 2,000 metres deep).*

*• Provide all foreign flag vessels chartered to perform Baffinland trade with a copy of Baffinland's Ballast Water Management Plan.*

*• Verify by inspection that all foreign flag vessels chartered to perform Baffinland trade have a record of their Ballast Water Exchange and sampling results according to the Regulations.*

• *Verify by inspection that all foreign flag vessels chartered to perform Baffinland trade maintain and carry on-board an up-to-date International Ballast Water Management Certificate*" (Ballast Water Management Plan, Section 2, p. 9).

*DFO Science's analysis and assessment*

Here and throughout the Ballast Water Management Plan, the Proponent makes reference to foreign flagged vessels. However, the flag of a vessel does not correspond to ballast source (relevant to level of risk) or last port of call (relevant for regulatory requirements). What is important from the point of view of NIS/AIS prevention and ballast water management is the last port of call and the origin of ballast water to be discharged (known as ballast history).

Further to this, research has demonstrated that vessels moving ballast water between ports within Canadian waters (foreign or Canadian flagged), particularly between different regions (e.g., Atlantic and Arctic) can pose a significant risk for introduction of AIS (Chan et al. 2012, Casas-Monroy et al. 2014, Laget 2017, Tremblay 2017). Risk for these vessels can be reduced substantially by implementing DFO Science's recommendation that all vessels be required to conduct exchange and treatment as a combination method. Risk can be reduced further though vessels conducting exchange in appropriate locations such as proposed alternate ballast exchange zones for the eastern Arctic that were identified through science-based risk assessment (DFO 2015b, Stewart et al. 2015, Goldsmit et al. 2019a).

*Recommendations*

- DFO Science recommends all references to foreign flagged vessels be changed to terminology consistent with regulations which simply refers to jurisdictions from which vessels (and ballast) originate. Given that some vessels may originate from Canada but travel outside the EEZ and re-enter Canada at a later time or that foreign vessels may move between Canadian ports after entering the EEZ, it would be simplest and most inclusive if the proponent simply state that they will ensure all applicable vessels entering Milne Inlet Port comply with the Transport Canada regulations and BWM convention, regardless of flagship. Any vessel exemptions and special situations are contained within the regulations and will be captured through referencing them.
- Further to this, DFO Science recommends that BIM should require all vessels (including those from southern Canadian ports) to conduct exchange and treatment as a combination method to reduce the risk of introduction and spread of NIS/AIS. Furthermore, DFO Science recommends that vessels treat their ballast or conduct exchange in an appropriate low risk location identified through a risk-based analysis, prior to discharging in Milne Inlet. Zones within Baffin Bay-Davis Strait identified through the DFO (2015b) assessment would be appropriate if operationally feasible. Areas off the Labrador Shelf, currently utilized for exchange by the MV Umiak on transits to Vale's Voisey's Bay Mine may also be appropriate. However, dispersion modelling and assessment of risks associated with discharge in this location (e.g., using methods consistent with Brickman et al. 2006, Goldsmit et al. 2019a, and Stewart et al. 2015) are needed.

*BIM's position*

BIM states that "*The Ice Navigator will witness the safe and reliable operation of the machinery and familiarize themselves with the manoeuvrability of the vessel, the change out of ballast, and will report any apparent deficiencies to Fednav International. The Ice Navigator shall provide the Master with advice on safe navigation in ice covered Canadian waters, coastal navigation and*

*environment protection procedures in Canadian Arctic Waters & loading at Milne Inlet*" (Draft Shipping and Marine Wildlife Management Plan, Page 65).

*DFO Science's analysis and assessment*

BIM's reference to change out of ballast water suggests that ballast exchange may be carried out in Canadian waters. DFO Science requires clarification from BIM what they mean in this statement. Is BIM referring to ballast discharge in Milne Port or to ballast exchange in other Canadian waters? If the latter, DFO Science requires the Proponent to identify where this exchange will be carried out.

*BIM's position*

BIM states that "*Canada is an active member of the International Maritime Organization (IMO) and is a signatory to IMO agreements such as the International Convention for the Safety of Life at Sea (SOLAS), the International Convention for the Prevention of Pollution from Ships (MARPOL), the International Loadline Conventions Convention on Load Lines, the International Safety Management Code (ISM), and the IMO International Convention for the Control and Management of Ships' Ballast Water and Sediment. The majority of operations described in this SMWMP are marine or port-related and are federally regulated by Transport Canada through the Canada Shipping Act and various International Regulations augmented by various Shipping Notices and Publications"* (Draft Shipping and Marine Wildlife Management Plan (SMWMP), Page 11).

BIM also identifies Project Certificate Condition #90 that "*The Proponent shall incorporate into its Shipping and Marine Mammals Management Plan provisions to achieve compliance with the requirements under the International Convention for the Control and Management of Ship's Ballast Water and Sediment (2004) or its replacement and as implanted by the* Canadian Ballast Water and Control Regulations *as may be amended from time to time*" (Draft Shipping and Marine Wildlife Management Plan, Table 1: List of Relevant Project Certificate Conditions, Page 14).

*DFO Science's analysis and assessment*

Biofouling of vessels is also an important vector for the transfer of NIS. As previously commented on BIM's ballast management plan, DFO Science has strong concerns that simply achieving compliance will not necessarily mitigate risk.

*Recommendations*

- DFO Science recommends the Proponent make reference to IMO "Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species" (Biofouling Guidelines, Resolution MEPC.207(62)) and include provisions for meeting these guidelines within their Shipping and Management plans.
- DFO Science recommends the Proponent include monitoring in their Ballast Water Management Plan to evaluate the number and types of organisms being discharged and transported. This would allow ship owners, as well as the Proponent, to evaluate the level of risk for species introductions, develop appropriate mitigation strategies to reduce risk, and inform DFO if a potential introduction occurs.

*BIM's position*

In Section 6.4.2 (Anti-Fouling Management), BIM states that "*In order to reduce or eliminate the risk of invasive aquatic species and pathogens being introduced into Canadian waters as a*

*result of ship hull biofouling, an anti-fouling coating will be in applied to the hulls of all Project vessels that will arrive and depart from Milne Port. The anti-fouling coating used 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*" (Draft Shipping and Marine Wildlife Management Plan, p. 74).

*DFO Science's analysis and assessment*

DFO Science is concerned that there is no mention of IMO guidelines for biofouling management of invasive species in this section or Section 6.4.1 (Ballast Water Management).

BIM makes reference to application of antifouling coatings to hulls of project vessels, but it is unclear to DFO Science if these include leased vessels used in the project.

*Recommendations*

- DFO Science recommends the Proponent make reference to the IMO "2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species" (Biofouling Guidelines, Resolution MEPC.207(62)) and include provisions for meeting these guidelines within their Shipping and Management plans.
- DFO Science requires clarification from BIM as to which vessels are considered "project vessels". If leased or contracted vessels are excluded, then DFO science suggests that leased or contracted vessels (i.e., all vessels associated with the project) should be required to adhere to the same standards.

*BIM's position*

In Section 6.4.1 (Ballast Water Management), BIM states "*In order to reduce or eliminate the risk of invasive aquatic species and pathogens being introduced into Canadian waters as a result of shipping, all ships will exchange ballast water in accordance with the Ballast Water Control and Management Regulations (Transport Canada 2006). The regulations require that ships transiting to Canadian ports exchange ballast water at sea in deep water away from coastal zones. This measure limits the potential for foreign harmful aquatic organisms or pathogens to be released in Canadian waters where they may colonize. Vessels are required to adhere to the Ballast Water Control and Management Regulations and will follow their own Ballast Water Management Plan (BWMP) (See Appendix EF)*" (Draft Shipping and Marine Wildlife Management Plan, p. 74)

*DFO Science's analysis and assessment*

DFO Science is concerned that this section neglects to make reference to IMO guidelines, the requirement for all international vessels to meet a discharge standard before September 8, 2024, and standards associated with these changes. DFO Science is also concerned that this section only mentions the need for vessels to follow their own plan instead of requiring vessels to follow BIM's Ballast Water Management Plan. The later could have elements that exceed or go beyond protective measures contained within the vessel's Ballast Water Management Plan and ensure risks are properly mitigated (see DFO Science Comments on BIM's Ballast Water Management Plan).

*Recommendations*

- DFO Science recommends that the Proponent clearly state the need for all Project vessels to adhere to requirements in the IMO International Convention for the Control and

Management of Ships' Ballast Water and Sediment (hereafter BWM Convention), Transport Canada Regulations, as well as any enhanced measures stated in BIM's Ballast Water Management Plan. This includes the need for new-build vessels and eventually all vessels to meet the Regulation D-2 discharge standard, and to conduct exchange plus treatment.

*BIM's position*

BIM states that *"The D-1 standard concerns ballast water exchange, which must be undertaken within open ocean areas, defined as waters >200 nautical miles from land and in seas >200 m deep"* (Ballast Water Management Plan, Page 7).

*DFO Science's analysis and assessment*

Canada currently requires exchange to be undertaken in waters > 2000 m depth.

*Recommendations*

- DFO recommends this mistake be corrected to ensure that BIMs Ballast Water Management Plan is consistent with Canada's Ballast Water Regulations.

*BIM's position*

BIM states that "*Verify by inspection that all foreign flag vessels chartered to perform Baffinland trade have a record of their Ballast Water Exchange and sampling results according to the Regulations".* (Ballast Water Management Plan, Section 2, p. 9)

*DFO Science's analysis and assessment*

This statement seems to suggest that ballast sampling will be conducted by the ship's crew yet the Transport Canada standard reporting forms (Ballast Water Management Plan Appendix A Page 18) specify "*sampling of ballast water is primarily a matter for the authorized authority, and there is unlikely to be any need for crew members to take samples except at the express request, and under the supervision, of the authorized authority*".

*Recommendations*

- DFO Science requests the Proponent clarify and specify what sampling results they are referring to and who will be responsible for conducting the sampling. Is BIM only referring to samples collected by an Inspector or will there be an expectation that all vessel crews will conduct sampling? In the latter case, will BIM conduct any verification of self-monitoring results?

*BIM's position*

In Section 2.2 – Roles and Responsibilities, BIM describes the specific responsibilities related to the management and monitoring of ballast water (Ballast Water Management Plan, p. 11–12).

*DFO Science's analysis and assessment*

The role of Transport Canada water inspectors is not included in section 2.2.

*Recommendations*

- DFO Science recommends that BIM add the role and responsibilities of the Transport Canada Ballast Water Inspector compared to that of the Ballast Water Monitor employed by BIM with the understanding that enforcement is to be conducted by Transport Canada while the Ballast Water Monitor is providing secondary/augmented review of ballast water

management in addition to ballast sampling/testing. Transport Canada will conduct document inspections for all vessels and may test salinity on a subset of vessels.

- DFO Science also recommends that BIM's Ballast Water Monitor should report any potential non-compliance events directly to Transport Canada.

*BIM's position*

BIM states that "*If ballast water measurements indicate that a Project vessel is not compliant with the Regulations or BWM Convention, the results will be immediately reported to Baffinland's Head of Shipping and Logistics… Baffinland will initiate adaptive management measures (see Section 4.0)*" (Ballast Water Management Plan, p. 13).

*DFO Science's analysis and assessment*

Transport Canada is not mentioned in the response chain outlined within the Proponents Ballast Water Management Plan.

*Recommendations*

- Any issues of potential non-compliance should be reported directly to Transport Canada. Adaptive management measures (i.e., contingency measures) should be developed in advance following recommendations already developed by the IMO. Contingency measures should be approved by Transport Canada and initiated only under the guidance of Transport Canada.

## 3.7 Cumulative Effects

*BIM's position*

BIM repeatedly states in Sections 4.3.1 (Ringed Seal), 4.3.2 (Narwhal), 4.3.3. (Beluga Whale), and 4.3.4 (Bowhead Whale) that "*However, the cumulative sound level ('loudness') is not predicted to increase when multiple vessels are present in the same area – it would remain roughly equivalent to that of the single (larger) vessel at any single point within the zone of acoustic overlap. This is due to the logarithmic nature of sound underwater (i.e., the cumulative effect of multiple co-occurring noise sources is not linear in scale)*" (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 20–23).

*DFO Science's analysis and assessment*

BIM states that the cumulative sound level of multiple vessels would remain roughly equivalent to the sound level of one vessel. The sound pressure level of two vessels of the same acoustic signature is louder than the sounds pressure from one vessel and results in an increase of 3dB. As pointed by BIM, sound levels are represented by a logarithmic scale and an increase in 3dB can be significant. Based on the inadequate modeling conducted by the Proponent, DFO Science cannot make a proper assessment. DFO Science requires the Proponent conduct noise propagation modelling including the cumulative noise of two cape-size carriers.

*Recommendations*

- DFO Science requires the Proponent conduct noise propagation modelling including the cumulative noise of two cape-size carriers. Without this information, DFO Science is not able to make a proper assessment.

*BIM position*

BIM presents information on the cumulative effects to marine mammals (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, Section 4.3, p. 19–23).

*DFO Science's analysis and assessment*

BIM states that they evaluated the Cumulative Impact of the project on marine mammals. However, BIM does not provide an evaluation of the impacts cumulatively. DFO Science is concerned that marine mammals will be impacted by noise from shipping and from project construction, by icebreaking, by potential oil spills not only in the Regional Project Area but also outside the Regional Project Area. BIM does not provide any analysis that looks at the combined overall potential impact of all these activities. As a result, DFO Science cannot make a proper assessment.

*Recommendations*

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

*BIM's position*

BIM states "*The addition of 23 cruise ships in future years to summer ship traffic in Eclipse Sound and Baffin Bay suggests that some interaction (overlap in noise fields when passing) will potentially occur between cruise ships and Mary River ore traffic. The expected transit distance if it does occur will be several hundred metres at minimum. The frequency and magnitude of these potential interactions are small and are not expected to result in cumulative noise effects to marine mammals*" (Knight Piésold Consulting Memorandum TSD27 – Cumulative Effects Assessment, p. 20).

*DFO Science's analysis and assessment*

DFO Science is concerned that although the frequency of these interactions may be low, when they do occur they will be occurring for extended periods of time over 100's of meters. DFO Science requires clarification from BIM on how they expect marine mammals will respond to this disturbance. DFO Science questions if there are any mitigation measures in effect to address this.

*Recommendations*

- DFO science recommends all iron ore carriers stop and reduce noise when cruise ships are in the area. Since this will happen infrequently according to BIM, this mitigation measure should be feasible.

# 4.0 Conclusions

The proposed extended shipping season through the Northern Shipping Route as well as the increase in vessel traffic and ballast discharge associated with the Mary River Project is unprecedented in scale for the Canadian Arctic. As stated in previous DFO Science reviews, the Northern Shipping Route covers an area is important for several marine mammal species with special conservation status, including narwhal, bowhead and walrus, as well as the marine and anadromous fish communities and habitats that support them (DFO 2019a). Bearded and ringed

seals are also known to be abundant and are considered to be important components of the arctic marine ecosystem (DFO 2019a).

Based on the material presented in the FEIS and the new supporting documents that were submitted by BIM from May 13 – June 17, 2019, DFO Science disagrees with the Proponent's overall conclusion that the proposed project operations will inflict no significant impacts and that any effects on the marine ecosystem are completely reversible. The statements and conclusions are not supported by evidence (information, data, analyses), justification, or rationale (e.g., residual effects assessment). These concerns have been raised in past reviews (DFO 2012a,b, 2014) and hinder DFO Science from conducting a proper assessment of supporting and supplementary materials.

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

- There are many instances where the Proponent does not use existing data, current data, or data that are representative of the region included in their assessment. For example, BIM should use the most recent stock estimates to calculate percent of the population(s) impacted. As well, in the case of the ballast water modelling, real discharge and water chemistry data (not estimates) should be used for the model.
- The impact of increased vessel traffic will have a negative impact on the marine environment. Although BIM presents a number of possible scenarios, DFO Science recommends assessing impacts on the maximum vessel scenario in order to apply a precautionary approach in the absence of data. It is currently unclear what this maximum vessel traffic scenario is in terms of the number and types of vessels.
- Inconsistencies regarding the delineation of the shipping season, including icebreaking dates, are present throughout the various documents. Correct dates need to be consistently presented in all of the documents.
- BIM needs to provide more information regarding the alternate shipping route. This should include the calculation of the proportion of the marine mammal population(s) predicted to be impacted during use of the alternate shipping route.
- Any future alternate anchorage sites that are identified by BIM must be properly assessed for potential impacts to marine mammals, invertebrates, fishes, and fish habitat.
- Icebreaking activities should not occur. In particular, DFO Science is concerned with icebreaking activities at the beginning and end of the shipping season and the impact on marine mammals. For example, icebreaking activities during the fall may impede the formation of ice across the inlets (e.g., ice type, lack of formation, rubble) and result in narwhal ice entrapments during the fall migration. Icebreaking may also negatively impact ringed seals by causing displacement, separation of mothers and pups, destruction of resting and birth lairs, vessel-seal collisions, and crushing of seals by moving sea ice (Yurkowski et al. 2019b).
- With the proposed increase in vessel traffic and shipping, it is likely that the risk and incidence of Arctic whale injury and mortality due to ship strikes will increase. Vessel strikes are likely underestimated for bowhead within and outside the RSA. Icebreaking impacts and vessel strikes for ringed seals are also not adequately considered within the assessment.
- Noise will have a negative impact on marine mammals. For example, the large number of vessels transiting from the Milne Port and those awaiting entry may deter whales from entering Eclipse Sound. This highlights the concern that noise impacts both inside and

outside the RSA (i.e., Nunavut Settlement Area) should be assessed. Furthermore, spring icebreaking could result in a change in migratory patterns and lead to a lack of immigration into the area.

- Mitigation measures for marine mammals need to be implemented for the entire shipping season. DFO Science is unable to conduct a proper review of mitigation measures in the event animals are trapped, disturbed or separated as BIM does not provide the instructions for vessel operators in the report (Socio-economic Assessment of Icebreaking Operations, p. 14). For approach limits, DFO Science recommends that seals need to be included and have appropriate buffer limits. In the absence of data, DFO Science recommends using the USFWS and FAA guidelines.
- The amount of ballast water to be discharged as a result of this project is estimated to be the third largest in Atlantic Canada and the fourth largest nationally. The increased number of vessels that will be continuously discharging ballast at the port will impact the physical, chemical, and biological characteristics of the marine environment (e.g., fish, fish habitat, and invertebrates). Hull fouling, as well as ballast discharge, has high risk/potential to introduce non-indigenous species and aquatic invasive species (NIS/AIS).
- BIM should require all vessels to use exchange plus treatment to minimize the risk of introducing NIS/AIS. Temperature, salinity, and organisms (type and number) in both ballast water and the environment should be regularly monitored using scientifically rigorous sampling design. Likewise biological monitoring of vessel fouling should be conducted. Monitoring will allow the Proponent to assess efficacy and risk associated with management strategies (e.g., Bailey et al. 2011) as well as ensure vessel compliance with mitigation measures. This concern and recommendation has repeatedly been stated in both Marine Environment Working Group (MEWG) meetings and previous DFO Science reviews of BIM's project proposal (e.g., DFO 2019a).
- BIM intends to regularly update program design based on annual monitoring results and/or recommendations provided by the MEWG and the NIRB. However, DFO Science is concerned that there is no mechanism and accountability for the implementation of recommendations provided by both the Marine Environmental Working Group (MEWG) and DFO Science. DFO's past reviews and recommendations have rarely been incorporated into BIM's updates to monitoring programs.
- DFO Science is concerned about the lack of a scientifically rigorous approach to the collection of baseline and monitoring data for impact assessment of many of the project activities (DFO 2019a). For example, DFOs review of the power analysis identified insufficient power within the current sampling design for a number of Marine Environmental Effect Monitoring Sampling Program (MEEMP) activities (e.g., benthic communities). These need to be re-evaluated and redesigned to ensure that change can be detected, and the potential project impacts can be scientifically assessed.
- To ensure scientific rigor, DFO Science should be given the opportunity to review marine (and freshwater) related monitoring plans from BIM, independent of the MEWG, to ensure that the Proponent's monitoring plans will produce results that are relevant to the monitoring objectives, (DFO 2019a) This would benefit future project assessments.
- In order to provide a comprehensive assessment of the impact of all project vessels on marine mammals, the Proponent should collect appropriate information/data using an

appropriate interval for the collection. This includes sightings/presence, density/abundance, behavior and reaction to vessels for different age classes, and incidence of strikes.

- DFO Science is concerned that baseline and monitoring programs for the Southern Shipping Route (for the use of Steensby Inlet) are not in place. Information collected from these programs would have informed this review as well as future impact assessments. Monitoring programs should be established in order to determine project impacts.
- In order to make all information and data available to the public, BIM should update their data portal with all historical documents (reports, monitoring plans) as it currently only contains reports after 2015.
- DFO Science also notes that many key components of the ecosystem received little consideration in the FEIS (e.g., benthic invertebrates, fishes). In addition, there was limited to no discussion of trophic effects, sub-lethal effects, or delayed mortality resulting from the Project. The cumulative effects assessment is not sufficiently comprehensive or quantitative enough to allow for a thorough environmental impact assessment of the Project. This also includes the assessment of impacts from climate change (DFO 2019a).

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(July 25, 2019)

# 7.0 Sources of information

This Science Response Report results from the Science Response Process Science Review of additional supporting materials for the Final Environmental Impact Statement Addendum for the Baffinland Mary River Project Phase 2 held on July 16, 2019.

Aulanier, F., Simard, Y., Roy, N., Gervaise, C., and Bandet, M. 2017. Effects of shipping on marine acoustic habitats in Canadian Arctic estimated via probabilistic modeling and mapping. Mar. Pollut. Bull. 125(1-2): 115–131.

Baffinland Iron Mines Corporation (BIM). 2018. IR Responses, Phase 2 proposal - Mary River Project. NIRB File # 08MN053.

Brickman, D. 2006. Risk assessment model for dispersion of ballast water organisms in shelf seas. Can. J. Fish. Aquat. Sci. 63: 2748–2759.

Carmack, E.C., and Macdonald, R.W. 2002. Oceanography of the Canadian Shelf of the Beaufort Sea: a setting for marine life. Arctic 55(5): 29–45.

Casas-Monroy, O., Linley, R.D., Adams, J.K., Chan, F.T., Drake, D.A.R., and Bailey, S.A. 2014. National risk assessment for introduction of aquatic nonindigenous species to Canada by ballast water. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/128. vi + 73 p.

Chan, F.T., Bronnenhuber, J.E., Bradie, J.N., Howland, K.L., Simard, N., and Bailey, S.A.. 2012. Risk assessment for ship-mediated introductions of aquatic nonindigenous species to the Canadian Arctic. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/105.

Chan, F.T., Briski, E., Bailey, S.A., and MacIsaac, H.J. 2014. Richness–abundance relationships for zooplankton in ballast water: temperate versus Arctic comparisons. ICES J. Mar. Sci. 71(7): 1876–1884.

Conlan, K., Aitken, A., Hendrycks, E., McClelland, C., and Melling, H. 2008. Distribution patterns of Canadian Beaufort Shelf macrobenthos. J. Mar. Syst. 74: 864–886.

Cusson, M., Archambault, P., and Aitken, A. 2007. Biodiversity of benthic assemblages on the Arctic continental shelf: historical data from Canada. Mar Ecol. Progr. Ser. 331: 291–304.

Davidson, E. 2016. Exploring the Characteristics of Spatial Distribution for Sperm Whales (*Physeter macrocephalus*) and Northern Bottlenose Whales (*Hyperoodon ampullatus*) in the Arctic: A Preliminary Study to Inform Conservation Management. 45 ECTS thesis submitted in partial fulfilment of a Master of Resource Management degree in Coastal and Marine Management, University Centre of the Westfjords, Ísafjörður, Iceland. xix + 119 p.

DFO. 2009. Advice relevant to identification of Eastern Canadian Arctic Bowhead (*Balaena mysticetus*) critical habitat. DFO Can. Sci. Adv. Sec. Sci. Advis. Rep. 2008/060.

DFO. 2012a. Technical Review of Baffinland's Mary River Project Draft Environmental Impact Statement (EIS). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/065.

DFO. 2012b. Science review of Baffinland's Mary River Project final environmental impact statement. DFO Can. Sci. Advis. Sec. Sci. Resp. 2012/016.

DFO. 2014. Science review of the final environment impact statement addendum for the early revenue phase of Baffinland's Mary River Project. DFO Can. Sci. Advis. Sec. Sci. Resp. 2013/024.

DFO. 2015a. Abundance estimates of narwhal stocks in the Canadian High Arctic in 2013. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/046.

DFO. 2015b. Risk assessment of alternate ballast water exchange zones for vessel traffic to the eastern Canadian Arctic. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/019.

DFO. 2018. Impact of the 2015 narwhal (*Monodon monoceros*) entrapment on the Eclipse Sound narwhal stock. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2018/012.

DFO. 2019a. Science Review of the Phase 2 Addendum to the Final Environmental Impact Statement for the Baffinland Mary River Project. DFO Can. Sci. Advis. Sec. Sci. Resp. 2019/015.

DFO. 2019b. Mitigation Buffer Zones for Atlantic Walrus (*Odobenus rosmarus rosmarus*) in the Nunavut Settlement Area. DFO Can. Sci. Advis. Sec. Sci. Resp. 2018/055.

DFO. 2019c. Science advice on the effectiveness of ballast water exchange plus treatment as a mechanism to reduce the introduction and establishment of aquatic invasive species in Canadian ports. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2019/003.

Doniol-Valcroze, T., Gosselin, J.F., Pike, D., Lawson, J., Asselin, N., Hedges, K., and Ferguson, S. 2015. Abundance estimates of narwhal stocks in the Canadian High Arctic in 2013. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/060. v + 36 p.

Elliott, R.E., Raborn, S., Smith, H.R., and Moulton, V.D. 2015. Marine mammal aerial surveys in Eclipse Sound, Milne Inlet, Navy Board Inlet, and Pond Inlet, 31 August – 18 October 2013. Final LGL Report No. TA8357-3. Prepared by LGL Limited, King City, ON for Baffinland Iron Mines Corporation, Oakville, ON. 61 p.

Environment and Climate Change Canada. 2019. ECCC's Technical Submission to the Nunavut Impact Review Board Respecting Mary River Project - Phase 2 Proposal by Baffinland iron Mines Corporation. NIRB File # 08MN053.

Finley, K.J., Miller, G.W., Davis, R.A., and Greene, C.R. 1990. Reactions of belugas, *Delphinapterus leucas*, and narwhals, *Monodon monoceros*, to ice-breaking ships in the Canadian high arctic. Can. Bull. Fish. Aquat. Sci. 224: 97–117.

Gervaise, C., Simard, Y., Roy, N., Kinda, B., and Ménard, N. 2012. Shipping noise in whale habitat: Characteristics, sources, budget, and impact on belugas in Saguenay-St. Lawrence Marine Park hub. J. Acoust. Soc. Am. 132(1): 76–89.

Goldsmit, J., Nudds, S.H., Stewart, D.B., Higdon, J.W., Hannah, C.G., and Howland, K.L. 2019a. Where else? Assessing Zones of Alternate Ballast Water Exchange in the Canadian Eastern Arctic. Mar. Pollut. Bull. 139: 74-90.

Goldsmit, J., McKindsey, C., Archambault, P., Howland, K.L 2019b. Ecological risk assessment of predicted marine invasions in the Canadian Arctic. PLoS ONE 14(2): e0211815.

Heide-Jørgensen, M.P., Hansen, R.G., Westdal, K., Reeves, R.R., and Mosbech, A. 2013. Narwhals and seismic exploration: Is seismic noise increasing the risk of ice entrapments? Biol. Conserv. 158: 50–54.

Kelly, B.J., Gross, R., Bittinger, K., Sherrill-Mix, S., Lewis, J.D., Collman, R.G., Bushman, F.D., and Hongzhe, L. 2015. Power and sample-size estimation for microbiome studies using pairwise distances and PERMANOVA. Bioinformatics. 31(15): 2461-2468. doi.org/10.1093/bioinformatics/btv183

Laget, F. 2017. Transport d'espèces de dinoflagellés non-indigènes dans l'Arctique Canadien, suite au déversement des eaux de ballast par un navire domestique. M.Sc. Thesis. Université du Quebec à Rimouski. 130 p.

Laliberté, F., Howell, S.E.L., Lemieux, J-F., Dupont, F., and Lei, J. 2018. What historical landfast ice observations tell us about projected ice conditions in Arctic Archipelagoes and marginal seas under anthropogenic forcing. The Cryosphere 12: 3577–3588.

La Rosa, P.S., Brooks, J.P., Devch, E., Boone, E.L., Edwards, D.J., Wang, Q., Sodergren, E., Weinstock, G., and Shannon, W.D. 2012. Hypothesis Testing and Power Calculations for Taxonomic-Based Human Microbiome Data. PLoS ONE 7(12): e52078. doi:10.1371/journal.pone.0052078

Lesage, V., Barrette, C., Kingsley, M.C.S., and Sjare, B. 1999. The effect of noise on the vocal behavior of Belugas in the St. Lawrence River Estuary, Canada. Mar. Mamm. Sci. 15(1): 65–84.

Locke, A., Mandrak, N.E., and Therriault, T.W. 2011. A Canadian rapid response framework for Aquatic Invasive Species. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/114. vi + 30 p.

Marcoux, M., Montsion, L.M., Dunn, J.B., Ferguson, S.H., and Matthews, C.J.D. 2019. Estimate of the abundance of the Eclipse Sound narwhal (*Monodon monoceros*) summer stock from the 2016 photographic aerial survey. DFO Can. Sci. Advis. Sec. Res. Doc. 2019/028. iv + 16 p.

Matthews, C.J.D., Hornby, C.A., Ferguson, S.H., and Marcoux, M. 2019. Evaluation of LGL visual aerial survey data for estimating narwhal abundance in Eclipse Sound during the open water season 2013–2015. DFO Can. Sci. Advis. Sec. Res. Doc. 2019/029. iv + 23 p.

NAMMCO (North Atlantic Marine Mammal Commission). 2010. Report on the Joint NAMMCO/JCNB Scientific Working Group – narwhal. *In*: NAMMCO Annual Report 2009. NAMMCO. Tromsø, Norway. 291–296 p.

Nephin, J., Juniper, S.K., and Archambault, P. 2014. Diversity, Abundance and Community Structure of Benthic Macro- and Megafauna on the Beaufort Shelf and Slope. PLoS ONE 9(7): e101556. doi:10.1371/journal.pone.0101556

NMFS (National Marine Fisheries Service). 2018. 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p.

Nowacek, D.P., Johnson, M.P., and Tyack, P.L. 2004. North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli. Proceedings of the Royal Society of London 271: 227–231.

NRC (National Research Council). 2003. Ocean Noise and Marine Mammals. National Academies Press, Washington, DC. 220 p. https://doi.org/10.17226/10564.

Pine, M.K., Hannay, D.E., Insley, S.J., Halliday, W.D., and Juanes, F. 2018. Assessing vessel slowdown for reducing auditory masking for marine mammals and fish of the western Canadian Arctic. Mar. Pollut. Bull. 135: 290–302. doi:10.1016/j.marpolbul.2018.07.031

Radford, A.N., Kerridge, E., and Simpson, S.D. 2014. Acoustic communication in a noisy world: can fish compete with anthropogenic noise? Behav. Ecol. 25(5): 1022–1030. doi:10.1093/beheco/aru029

Reeves, R.R., Rosa, C., George, J.C., Sheffield, G., and Moore, M. 2011. Implications of Arctic industrial growth and strategies to mitigate future vessel and fishing gear impacts on bowhead whales. Mar. Policy 36(2): 454–462.

Roy, V., Iken, K., and Archambault, P. 2014. Environmental drivers of the Canadian Arctic megabenthic communities. PLoS ONE 9(7): e100900.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., and Tyack, P.L. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquat. Mamm. 33: 411−521.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P., and Tyack, P.L. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquat. Mamm. 45(2): 125–232. doi:10.1578/AM.45.2.2019.125

Stewart, D.B., Nudds, S.H., Howland, K.L., Hannah, C.G., and Higdon, J.W. 2015. An ecological and oceanographical assessment of alternate ballast water exchange zones in the Canadian eastern Arctic. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/037. vi + 75 p.

Thomas, T.A., Raborn, S., Elliott, R.E., and Moulton, V.D. 2015. Marine mammal aerial surveys in Eclipse Sound, Milne Inlet, Navy Board Inlet, and Pond Inlet, 1 August – 22 October 2014. Final LGL Report No. FA0024-2. Prepared by LGL Limited, King City, ON for Baffinland Iron Mines Corporation, Oakville, ON. 70 p.

Tougaard, J., Wright, A.J., and Madsen, P.T. 2015. Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. Mar. Pollut. Bull. 90(1): 196–208.

Tremblay, P. 2017. Évaluation du risque potentiel d'introduction d'espèces non-indigènes de mésozooplancton suite au déversement des eaux de ballast d'un navire domestique dans l'Arctique Canadien. M.Sc. Thesis. Université du Quebec à Rimouski. 126 p.

Watt, C.A., Orr, J., LeBlanc, B., Richard, P., and Ferguson, S.H. 2012. Satellite tracking of narwhals (*Monodon monoceros*) from Admiralty Inlet (2009) and Eclipse Sound (2010-2011). DFO Can. Sci. Advis. Sec. Res. Doc. 2012/046. iii + 17 p.

Watt, C.A., Marcoux, M., Dunn, J.B., Hodgson, R., Moore, R., and Ferguson, S.H. 2019. Effect of the 2015 narwhal (*Monodon monoceros*) entrapment on the Eclipse Sound narwhal stock. DFO Can. Sci. Advis. Sec. Res. Doc. 2019/030. iv + 12 p.

Wilson, S.C., Trukhanova, I., Dmitrieva, L., Dolgova, E., Crawford, I., Baimukanov, M., Baimukanov, T., Ismagambetov, B., Pazylbekov, M., Jüssi, M., and Goodman, S.J. 2017. Assessment of impacts and potential mitigation for icebreaking vessels transiting pupping areas of an ice-breeding seal. Biol. Conserv. 214: 213–222.

Yurkowski, D.J., Auger-Méthé, M., Mallory, M.L., Wong, S.N.P., Gilchrist, H.G., Derocher, A.E., Richardson, E., Lunn, N.J., Hussey, N.E., Marcoux, M., Togunov, R., Fisk, A.T., Harwood, L.A., Dietz, R., Rosing-Asvid, A., Born, E.W., Mosbech, A., Fort, J., Grémillet, D., Loseto, L., Richard, P.R., Iacozza, J., Jean-Gagnon, F., Brown, T.M., Westdal, K.H., Orr, J., LeBlanc, B., Hedges, K.J., Treble, M.A., Kessel, S.T., Blanchfield, P.J., Davis, S., Maftei, M., Spencer, N., McFarlane-Tranquilla, C.L., Montevecchi, W.A., Bartzen, B., Dickson, D.L., Anderson, C., and Ferguson, S.H. 2019a. Abundance and species diversity hotspots of tracked marine predators across the North American Arctic. Div. Dist. 25: 328–345.

Yurkowski, D.J., Young, B.G., Dunn, J.B., and Ferguson, S.H. 2019b. Spring distribution of ringed seals (Pusa hispida) in Eclipse Sound and Milne Inlet, Nunavut: implications for potential ice-breaking activities. Arctic Sci. 5(1): 54–61.

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