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BAFFINLAND IRON MINES CORPORATION

Integration Report: Marine Mammals in Eclipse Sound, Milne Inlet and Pond Inlet

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REPORT

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Executive Summary

Baffinland Iron Mines Corporation (Baffinland) received a Project Certificate from the Nunavut Impact Review Board (NIRB) to develop the Mary River Project (hereafter, "the Project"), an iron mine on northern Baffin Island in the Qikiqtani Region of Nunavut Territory. Subsequently, an amendment to the Project was made to allow for development of the Early Revenue Phase.

Iron ore mined at Mary River is transported to a marine port in Milne Inlet and loaded on ore carriers. Marine transportation of the ore takes place in waters inhabited by narwhal, bowhead whale, beluga, ringed seal, bearded seal, harp seal, walrus and polar bear. The Project Certificate includes Terms and Conditions that were developed following a review of potential ecosystem and socio-economic effects of the proposed Project, and a number of these relate to monitoring, mitigation and adaptive management of potential impacts on marine mammals.

Baffinland has conducted baseline and monitoring studies for marine mammals during 2006-2008, and 2013-present. The Project is now in the Early Revenue Phase, and the first ore was shipped in 2015. Marine mammal monitoring conducted since 2013 is part of the Environmental Effects Monitoring for the Project, and was developed using a series of questions that informed testable hypotheses. Under Baffinland's Shipping and Marine Wildlife Management Plan, significant effects detected during hypothesis testing, or significant deviation from baseline conditions, may trigger adaptive management if the change is determined to be Project-related.

Marine mammal monitoring conducted for the Project from 2013 through 2015 has included: regional (extensive) aerial surveys at the level of the Eclipse Sound narwhal stock; intensive aerial photographic surveys in Milne Inlet and the adjacent Tremblay Sound to measure the response of narwhal to ore carriers and other large vessels associated with the Project; shore-based visual observations of narwhal abundance and behaviour in Milne Inlet; acoustic surveys of narwhal and other marine mammals as well as anthropogenic sound sources in Milne Inlet; and marine mammal observations by shipboard observers. In addition, Baffinland conducted a series of workshops to gather Inuit Quajimajatuqangit (IQ) and input from local communities on topics related to marine mammals, shipping, and Baffinland's marine mammal monitoring program.

Baffinland has collected a considerable amount of data on marine mammals in the Project area, especially on narwhal. Despite this effort, results of individual monitoring studies have been inconclusive. The purpose of this report is to investigate and summarize those results and to synthesize and evaluate the relevance of existing marine mammal information and analyses to the Project's Terms and Conditions and in context of the marine mammal monitoring and adaptive management goals of the program. The overall goal is to further develop and improve the current marine mammal program developed for the Project, identify strengths and/or deficiencies, and recommend improvements in the current program, as required. To this end, this report will begin with a brief overview of the Terms and Conditions, and the questions that were used to develop hypotheses to be tested in the monitoring program; review the findings of the monitoring program in the context of those questions; and then discuss strengths and deficiencies (gaps) in the program and options for moving forward. Options or recommendations will focus on development or continuation of monitoring programs that help to guide adaptive management strategies for operations, and community-based monitoring programs. These recommendations will ideally aim to achieve a more focused and collaborative program, and may identify potential for new research partnerships.

As a result of high natural spatial and temporal variability in the distribution and abundance of narwhals, the confounding effect of hunting and other vessel activity occurring at the same time as Project-related large vessel transits, and small sample sizes that do not allow for statistical testing, the results are inconclusive (Table 1). Moreover, Golder conducted a third party review of the 2015 aerial survey report prepared by LGL and identified serious concerns about the statistical analysis of the data. Other issues with the existing time series include annual modifications in the survey design (timing, trackline, and replication) and data collected (e.g., switching between quantitative and qualitative data, collecting data for different parameters, adding and dropping parameters) that reduce the ability to detect changes over time.

Table 1: Summary of conclusions for each set of hypotheses in the marine mammal monitoring/management program

Hypothesis Number	Null and Alternate Hypotheses	State of Knowledge
Shore-based Narwhal Monitoring		
1	H_0: Narwhal distribution and relative abundance does not significantly change in response to a large vessel transit H_A: Narwhals move away from a vessel and narwhal numbers decrease in response to a large vessel transit	Results are inconclusive because of the high spatial and temporal variability in abundance and distribution of narwhal. Some of the highest abundances of narwhals were observed in conjunction with some large vessel transits. At other times the narwhals appear to have left Milne Inlet, but the causal link to vessel transits is unclear.
2	H_0: Narwhal group characteristics do not significantly change in the presence of a vessel H_A: Narwhal group characteristics do significantly change in the presence of a vessel	Results are inconclusive because of small sample sizes and also because the data collected have changed from year to year.
3	H_0: Narwhal behaviour does not significantly change in the presence of a vessel H_A: Narwhal behaviour does significantly change in the presence of a vessel	Results are inconclusive because of small sample sizes and also because the data collected have changed from year to year. Qualitative descriptions of several narwhal responses to shipping indicate that in some large vessel transits more than half the narwhals remained in the vicinity.
4	H_0: Narwhals do not habituate to large vessel shipping H_A: Narwhals habituate to large vessel shipping	Unable to determine at this time.

Hypothesis Number	Null and Alternate Hypotheses	State of Knowledge
Aerial Survey		
1	H_0: Narwhal regional distribution and relative abundance does not significantly change in response to a large vessel transit H_A: Narwhals move away from a vessel and narwhal numbers decrease in response to a large vessel transit	Results are inconclusive because of the high spatial and temporal variability in abundance and distribution of narwhal and because of inability to collect sufficient data from Before/During/After photographic surveys in Milne Inlet and Tremblay Sound. Golder's third party review of the 2015 aerial survey report found the survey design and statistical analysis to be flawed.
2	H_0: Narwhals do not habituate to large vessel shipping H_A: Narwhals habituate to large vessel shipping	Unable to determine at this time.
Acoustic study		
1	H_0: Presence of narwhal calls does not significantly change relative to a large vessel transit H_A: Presence of narwhal calls does significantly change relative to a large vessel transit	The 2014 and 2015 acoustic reports did not conduct statistical tests of a relationship but the authors suggest from visual inspection of the data that the numbers of narwhal calls were reduced during large vessel transits. Re-examination of the data does not support this conclusion.
2	H_0: Narwhal call types and frequency of calls do not significantly change in response to large vessel transits H_A: Narwhal call types and frequency of calls do significantly change in response to large vessel transits	This hypothesis was not tested in the acoustic reports. Visual inspection of the data does not appear to support a change in call types and frequency of calls during large vessel transits.

Overall, the results of the monitoring studies have been inconclusive in assigning a causal relationship between the distribution of marine mammals, specifically narwhals, and shipping. Even if there were no other anthropogenic impacts in the Project area, confirming a causal relationship between narwhal distribution and shipping from observational data would be extremely challenging given the high level of variability in narwhal distributions in space and time within their summer range. Developing an understanding of the relationship between narwhals and shipping, with the monitoring methods that were in use between 2013 and 2015, may simply not be possible because of the confounding effect of narwhal hunting which takes place in the same area and at the same time as large shipping transits, even by combining the information obtained from several monitoring methods.

According to literature estimates of received sound levels that are likely to elicit avoidance (135 dB) or disturbance-onset (120 dB) behaviours, the zone of influence around large vessels should be less than 1 km and may be less than 200 m for the vessels analysed in 2015. If the narwhals are more sensitive than other toothed whales and respond to any shipping sound above the background level, the zone of influence would be larger. The indication from the data presently available from Baffinland studies is that any avoidance that is occurring is a short-term effect only, but that is based primarily on IQ observations of narwhal behaviours. Whether these observations

represent the same individual narwhals returning to the area and becoming habituated to shipping is unknown and cannot be addressed without analysis of individual movements which could most readily be obtained from satellite-tracked tagging studies. In an animal more predictable in its spatial and temporal distribution, it would be feasible to assume habituation had occurred if densities of the animal were initially lower in the vicinity of the shipping track but then recovered over time so that there was no longer a gradient of abundance relative to shipping activity. With the inherently high variability in narwhal density, it is unlikely that such an analysis will provide any clarity on the question of habituation.

One option for further study is the use of satellite-based tags which would provide information on the spatial position of individual narwhals. If used in conjunction with acoustic monitoring tags placed on the same narwhals, and analysed relative to data on ship position, such a study would address other issues related to determination of effects:

- Do narwhals move away from ships? What is the distance between individual narwhals and ships? This can be identified from satellite tags and also from behavioural observations conducted from Bruce Head.
- What is the received sound level from ships, measured at the position of the narwhal? This can be measured by placing an acoustic tag on the narwhal as well as the tracking tag.
- If narwhals swim away from ships, and given the large range occupied by individual narwhals on the summering grounds, does avoidance of ships cause them to swim farther or faster than they would in the absence of ships? If this occurs, what are the physiological consequences? Does it mean that narwhals in the presence of ships use more energy than what is used by narwhals when ships are absent? This also can be determined by tagging studies, from the position and speed of narwhals relative to shipping, and because the tags can be set to record parameters such as duration of dives. Observations from the Bruce Head shore-based monitoring program can also be used to evaluate the swimming speed and orientation of narwhals in the presence of ships, as well as any changes that may occur in behaviours of narwhals.
- Do individual narwhals habituate to ships, and if so, how long does it take for habituation to occur? Habituation would be considered to have occurred if the zone of influence of ships were to decrease (i.e., narwhals remain in the vicinity of ships rather than moving away from them, for example).

An objective of this report was to determine whether the marine mammal monitoring, mitigation and adaptive management program was meeting the Terms and Conditions of NIRB Certificate No. 5 (Amendment #1), and to review what other options might exist for meeting these conditions. In assessing these options and comparing the value of monitoring methods, it is important to consider whether the value provided by new options outweighs the value of continuing a time series that has been established by the existing monitoring plan. It will be apparent, however, from review of the two to three years of monitoring per survey method assessed in the present report that there has already been considerable year-to-year change in the methods and data collected by the different programs. This is not an ideal situation as it unnecessarily complicates the task of determining change over time.

The status of each NIRB Term and Condition relevant to marine mammals has been assessed along with options for the future marine mammal program (Table 2).

Table 2: Summary of Terms and Conditions of NIRB Certificate, activities conducted to meet the Condition, and options for future marine mammal program

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
101	The Proponent shall incorporate into the appropriate monitoring plans the following items: ■ A monitoring program that focuses on walrus use of Steensby Inlet and their reaction to disturbance from construction activities, aircraft, and vessels	Not required at present time; not using Steensby Inlet	---
	Efforts to involve Inuit in monitoring studies at all levels	Involved as field observers in shore-based program 2013-2016, shipboard observers 2013-2015, aerial survey 2013-2015.	Continued involvement in shore-based and aerial survey programs. Consider further training, e.g., of Nunavut Arctic College students including data analysis.
	Monitoring protocols that are responsive to Inuit concerns	Has been the goal of all protocols	Continue to keep this a priority
	Marine monitoring protocols are to consider the use of additional detecting devices to ensure adequate monitoring through changing seasonal conditions and daylight	Used acoustic monitoring in 2014-2015	Passive acoustic monitoring can differentiate presence/absence but not very quantitative and not informative as to narwhal's received sound levels. Consider tagging study with sufficient number of tagged narwhals.
	Schedule for periodic aerial surveys as recommended by the Marine Environment Working Group	Aerial survey conducted by Baffinland 2013-2015, data sharing with DFO 2016.	Continue to conduct aerial surveys or to partner as opportunities arise.
	Periodic aerial surveys for basking ringed seals throughout the landfast ice of Steensby Inlet, and a suitable control location. Surveys shall be conducted at an appropriate frequency to detect change inter-annual variability	Not required at present time	---
	Shore-based observations of pre-Project narwhal behavior in Milne Inlet, that continues at an appropriate frequency throughout the Early Revenue Phase (not less than three years)	Bruce Head shore-based monitoring, 2013-2015	Continue program. Consider cameras for data collection in "blind spots" missed from Bruce Head

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
	Monitoring strategy focused on assessing and mitigating interaction between humans and wildlife at the port site(s).	Not discussed in the present report	----
105	The Proponent shall ensure that measures to reduce the potential for interaction with marine mammals, particularly in Hudson Strait and Milne Inlet, are identified and implemented prior to commencement of shipping operations. These measures could include, but are not limited to: a. Changes in the frequency and timing (including periodic suspensions) of shipping during winter months in Hudson Strait and during the open water season in Milne Inlet , i.e., when interactions with marine mammals are likely to be the most problematic b. Reduced shipping speeds where ship-marine mammal interactions are most likely c. Identification of alternate shipping routes through Hudson Strait for use when conflicts between the proposed routes and marine mammals could arise. Repeated winter aerial survey results showing marine mammal distribution and densities in Hudson Strait would greatly assist in this task.	As provided in Shipping and Marine Wildlife Management Plan. Community consultations identified winter shipping as more problematic in Eclipse Sound than summer (Appendix A, Sections 2-3). Ship speeds are already reduced. Hudson Strait routes are not in use.	No additional options proposed at this time
106	The Proponent shall ensure that shipboard observers are employed during seasons where shipping occurs and provided with the means to effectively carry out assigned duties. The role of shipboard observers in shipping operations should be taken into consideration during the design of any ore carriers purpose-built for the Project, with climate controlled stations and shipboard lighting incorporated to permit visual sightings by shipboard observers during all seasons and conditions. Any shipboard lighting incorporated should be in accordance with the *Canada Shipping Act, 2001's Collision Regulations*, and should not interfere with safe navigation of the vessel. .	Marine mammal observers saw very few mammals; safety hazard of vessel transfers at Pond Inlet. Program currently discontinued	Ship's officers required to report collisions

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
107	The Proponent shall revise the proposed "surveillance monitoring" to improve the likelihood of detecting strong marine mammal, seabird or seaduck responses occurring too far ahead of the ship to be detectable by observers aboard the ore carriers. A baseline study early in the shipping operations could employ additional surveillance to detect potential changes in distribution patterns and behavior. At an ambitious scope, this might be achieved using unmanned aircraft flown ahead of ships, or over known areas of importance for seabirds or haul-out sites in the case of walruses, in accordance with the requirements of their Special Flight Operations Certificate.	Experimental use of UAV in 2014 had limited success and was discontinued	No other options identified at this time.
108	The Proponent shall ensure that data produced by the surveillance monitoring program is analysed rigorously by experienced analysts (in addition to being discussed as proposed in the FEIS) to maximize their effectiveness in providing baseline information, and for detecting potential effects of the Project on marine mammals in the Regional Study Area. It is expected that data from the long-term monitoring program be treated with the same rigor.	All data have been analysed by experienced consultants	Ongoing.
109	The Proponent shall conduct a monitoring program to confirm the predictions in the FEIS with respect to disturbance effects from ships noise on the distribution and occurrence of marine mammals. The survey shall be designed to address effects during the shipping seasons, and include locations in Hudson Strait and Foxe Basin, Milne Inlet, Eclipse Sound and Pond Inlet. The survey shall continue over a sufficiently lengthy period to determine the extent to which habituation occurs for narwhal, beluga, bowhead and walrus.	Shore-based, aerial, acoustic and shipboard observer programs are intended to assess disturbance. Differentiating effects of large vessels vs. smaller vessels and hunting is problematic. Monitoring studies conducted to date focus on narwhal; limited information on beluga, bowhead and walrus	Aerial surveys provide information on disturbance effects at regional scale or population decline (may not require fortnightly program; consider focus on peak narwhal period). Shore-based program provides information on smaller-scale reactions of narwhal. Both have limited ability to detect habituation. Consider narwhal tagging studies. May be opportunity for collaboration with DFO/WWF tagging study

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
110	The Proponent shall immediately develop a monitoring protocol that includes, but is not limited to, acoustical monitoring, to facilitate assessment of the potential short term, long term, and cumulative effects of vessel noise on marine mammals and marine mammal populations. The Proponent is expected to work with the Marine Environment Working Group to determine appropriate early warning indicator(s) that will ensure rapid identification of negative impacts along the southern and northern shipping routes.	Passive acoustic monitoring conducted near Bruce Head 2014-2015. No direct measures of received sound by narwhals. Early warning indicator(s) have not been developed	Consider acoustic tags on narwhals along with spatial position tags
111	The Proponent shall develop clear thresholds for determining if negative impacts as a result of vessel noise are occurring. Mitigation and adaptive management practices shall be developed to restrict negative impacts as a result of vessel noise. This shall include, but not be limited to: a. Identifications of zones where cumulative noise could be mitigated due to biophysical features (e.g., water depth, distance from migration routes, distance from overwintering areas etc.) b. Vessel transit planning, for all seasons, to determine the degree to which cumulative sound impacts can be mitigated through the seasonal use of different zones.	Thresholds have not been identified. Evidence for negative impacts is equivocal. Mitigation measures developed in Shipping and Marine Wildlife Management Plan	If sound impacts are considered the key potential stressor, measurement of received sound by narwhal in conjunction with tracking of their movements with respect to ships is likely the best option for identification of negative impacts

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
112	Prior to commercial shipping of iron ore, the Proponent, in conjunction with the Marine Environment Working Group, shall develop a monitoring protocol that includes, but is not limited to, acoustical monitoring that provides an assessment of the negative effects (short and long term cumulative) of vessel noise on marine mammals. Monitoring protocols will need to carefully consider the early warning indicator(s) that will be best examined to ensure rapid identification of negative impacts. Thresholds shall be developed to determine if negative impacts as a result of vessel noise are occurring. Mitigation and adaptive management practices shall be developed to restrict negative impacts as a result of vessel noise. This shall include, but not be limited to: d. Identification of zones where noise could be mitigated due to biophysical features (e.g., water depth, distance from migration routes, distance from overwintering areas etc.) e. Vessel transit planning, for all seasons f. A monitoring and mitigation plan is to be developed, and approved by Fisheries and Oceans Canada prior to the commencement of blasting in marine areas	Passive acoustic monitoring was conducted 2014-2015 but does not provide direct assessment of negative effects of noise on marine mammals. Early warning indicator(s) and thresholds still under consideration. Mitigation and adaptive management as described in in Shipping and Marine Wildlife Management Plan	See options for #111.
119	The Proponent shall, in conjunction with the Marine Environment Working Group, monitor ringed seal birth lair abundance and distribution for at least two years prior to the start of icebreaking to develop a baseline, with continued monitoring over the life of the project as necessary to test the accuracy of the impact predict ions and determine if mitigation is needed. Monitoring shall also include a control sit e outside of the Project's zone of influence.	Not applicable until 2 years before icebreaking	If required, consider potential collaboration with DFO/EC/WWF on polar bear/seal survey on ice, using infrared video and photographic aerial survey

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
120	The Proponent shall ensure that, subject to vessel and human safety considerations, all project shipping adhere to the following mitigation procedures while in the vicinity of marine mammals: a. Wildlife will be given right of way. b. Ships will when possible, maintain a straight course and constant speed, avoiding erratic behavior. c. When marine mammals appear to be trapped or disturbed by vessel movements, the vessel will implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife have moved away from the immediate area.	Mitigations as described in in Shipping and Marine Wildlife Management Plan	No other options identified at this time
121	The Proponent shall immediately report any accidental contact by project vessels with marine mammals or seabird colonies to Fisheries and Oceans Canada and Environment Canada respectively, by notifying the appropriate regional office of the: g. Date, time and location of the incident h. Species of marine mammal or seabird involved i. Circumstances of the incident j. Weather and sea conditions at the time k. Observed state of the marine mammal or sea bird colony after the incident l. Direction of travel of the marine mammal after the incident, to the extent that it can be determined	See #106	See #106
122	The Proponent shall summarize and report annually to the NIRB regarding accidental contact by project vessels with marine mammals or seabird colonies through the applicable monitoring report.	See #106	See #106

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
123	The Proponent shall provide sufficient marine mammal observer coverage on project vessels to ensure that collisions with marine mammals and seabird colonies are observed and reported through the life of the Project. The marine wildlife observer protocol shall include, but not be limited to, protocols for marine mammals, seabirds, and environmental conditions and immediate reporting of significant observations to the ship masters of other vessels along the shipping route, as part of the adaptive management program to address any items that require immediate action.	See #106	See #106
126	The Proponent shall design monitoring programs to ensure that local users of the marine area in communities along the shipping route have opportunity to be engaged throughout the life of the Project in assisting with monitoring and evaluating potential project-induced impacts and changes in marine mammal distributions.	Through community consultations and activities listed in #101	See #101

Local residents provided their views on Baffinland's marine mammal program at community workshops that gathered IQ in 2016, in particular identifying their interest in greater community involvement in the program (e.g., community-based monitoring) as well as their concerns about shipping through ice and preference for avoidance of shipping in March through June.

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1.0 INTRODUCTION

On 28 December 2012, Baffinland Iron Mines Corporation (Baffinland) received a Project Certificate from the Nunavut Impact Review Board (NIRB) to develop the Mary River Project (hereafter, "the Project"), an iron ore mine on northern Baffin Island in the Qikiqtani Region of Nunavut Territory. Ore produced at Baffinland's iron mine at Mary River is transported over land to a marine port at Milne Inlet and transferred to ships which transport the ore through waters adjacent to Baffin Island. The marine transportation of the ore takes place in waters inhabited by a variety of marine mammals, predominantly bowhead whale, narwhal, beluga, ringed seal, bearded seal, harp seal, walrus and polar bear. Baffinland is currently in the Early Revenue Phase and the first ore was shipped in July 2015.

The Project certificate that was provided to Baffinland on 28 December 2012 included Terms and Conditions that were developed following a review of potential ecosystem and socio-economic effects of the proposed Project. Subsequently an amendment to the Project was made to allow for development of the Early Revenue Phase.

Since 2013, Baffinland has been conducting a marine mammal monitoring program designed to address the Terms and Conditions of NIRB Certificate No. 005 (Amendment #1). The components of this monitoring program as well as other existing information on marine mammal distribution and abundance in the Project area, namely Eclipse Sound, Milne Inlet and Pond Inlet, will be reviewed in the present Integration Report. The objective of the report is to synthesize and evaluate the relevance of existing marine mammal information to the Project's Terms and Conditions, in order to further develop and improve the current marine mammal program developed for the Project, identify strengths and/or deficiencies, and recommend improvements in the current program, as required. To this end, this report will begin with a brief overview of the Terms and Conditions, and the questions that were used to develop hypotheses to be tested in the monitoring program, review the findings of the monitoring program in the context of those questions, and then discuss strengths and deficiencies (gaps) in the program and options for moving forward. Options or recommendations will focus on development or continuation of monitoring programs that help to guide adaptive management strategies for operations, and community-based monitoring programs. These recommendations will ideally aim to achieve a more focused and collaborative program, and may identify potential for new research partnerships both inside and outside of the MEWG framework.

2.0 GOALS OF BAFFINLAND'S MARINE MAMMAL MONITORING PROGRAM

2.1 Terms and Conditions of the Project Certificate

The marine mammal monitoring program must meet the requirements of the Terms and Conditions of NIRB Certificate No. 005 (Amendment #1). These terms and conditions include requirements for marine mammal monitoring, for development of threshold levels and indicators for adaptive management of Baffinland activities relevant to marine mammals, and for Baffinland to undertake management and mitigation as indicated by the results of marine mammal monitoring relative to the developed thresholds and indicators. The full wording of Terms and Conditions directly applicable to marine mammal monitoring, adaptive management and mitigation in the Project area is provided in Baffinland (2016).

The Terms and Conditions include requirements that must be taken into consideration in evaluating the marine mammal monitoring program and in any discussion of improvements to the program that may be proposed. These program requirements are summarized in Table 3.

Table 3: Marine mammal program requirements and relevant Terms and Conditions of NIRB Project Certificate No. 005 (Amendment #1). In some cases the Term and Condition covers issues other than marine mammals, and if so, only the portion of the wording relevant to marine mammals is provided.

Monitoring Program Requirements	Relevant Terms and Conditions
Marine mammal monitoring is a component of Baffinland's comprehensive Environmental Effects Monitoring Program.	*(76) The Proponent shall develop a comprehensive Environmental Effects Monitoring Program to address concerns and identify potential impacts of the Project on the marine environment.*
Development of Baffinland's monitoring, adaptive management and mitigation programs or measures takes place in consultation with the Marine Environment Working Group.	*(77) A Marine Environment Working Group ("MEWG") shall be established to serve as an advisory group in connection with mitigation measures for the protection of the marine environment, and in connection with the Project Environmental Effects Monitoring program, as it pertains to the marine environment. Membership on the MEWG will include the Proponent, Environment Canada, Fisheries and Oceans Canada, the Government of Nunavut, the Qikiqtani Inuit Association and other agencies or interested parties as determined to be appropriate by these key members. Makivik Corporation shall also be entitled to membership on the MEWG at its election. The MEWG members may consider the draft terms of reference for the MEWG filed in the Final Hearing, but they are not bound by them.*
All possible opportunities are to be provided for involvement of the local/Inuit community in the monitoring, mitigation, and adaptive management programs.	*(101b, 101c) The Proponent shall incorporate into the appropriate monitoring plans the following items: (b) Efforts to involve Inuit in monitoring studies at all levels; (c) Monitoring protocols that are responsive to Inuit concerns*
	(126) The Proponent shall design monitoring programs to ensure that local users of the marine area in communities along the shipping route have opportunity to be engaged throughout the life of the Project in assisting with monitoring and evaluating potential project-induced impacts and changes in marine mammal distributions.
	(162) The Proponent should make all reasonable efforts to engage Elders and community members of the North Baffin communities in order to have community level input into its monitoring programs and mitigative measures, to ensure that these programs and measures have been informed by traditional activities, cultural resources, and land use as such may be implicated or impacted by ongoing Project activities.
	(163) The Proponent shall continue to engage and consult with the communities of the North Baffin region in order to ensure that Nunavummiut are kept informed about the Project activities, and more importantly, in order that the Proponent's management and monitoring plans continue to evolve in an informed manner.

Monitoring Program Requirements	Relevant Terms and Conditions
Monitor the abundance and distribution of marine mammals	*(99c-ii, 99d) The Proponent, working with the Marine Environment Working Group, shall consider and identify priorities for conducting the following supplemental baseline assessments: (c) Enhance baseline data on marine wildlife (fish, invertebrates, birds, mammals, etc.) and to provide more details on species abundance and distribution found in the Project area. This shall include, but not be limited to the following: Shore-based observations of pre-Project narwhal behavior in Milne Inlet. (d) Enhance the baseline for affected marine systems, which includes control sites to detect Project-related changes before they cause significant harm.*
	(101e) The Proponent shall incorporate into the appropriate monitoring plans the following items: (e) Schedule for periodic aerial surveys as recommended by the Marine Environment Working Group
Conduct behavioural observations of narwhal	*(99c-ii) The Proponent, working with the Marine Environment Working Group, shall consider and identify priorities for conducting the following supplemental baseline assessments: (c) Enhance baseline data on marine wildlife (fish, invertebrates, birds, mammals, etc.) and to provide more details on species abundance and distribution found in the Project area. This shall include, but not be limited to the following: (ii) Shore-based observations of pre-Project narwhal behavior in Milne Inlet.*
	(101g) The Proponent shall incorporate into the appropriate monitoring plans the following items: (g) Shore-based observations of pre-Project narwhal behavior in Milne Inlet
Consider additional detection methods to monitor marine mammals, as required	*(101d) The Proponent shall incorporate into the appropriate monitoring plans the following items: (d) Marine monitoring protocols are to consider the use of additional detecting devices to ensure adequate monitoring through changing seasonal conditions and daylight*
Monitor and mitigate for effects of port site activities on marine mammals	*(101i) The Proponent shall incorporate into the appropriate monitoring plans the following items: Monitoring strategy focused on assessing and mitigating interaction between humans and wildlife at the port site(s).*
	(112) A monitoring and mitigation plan is to be developed, and approved by Fisheries and Oceans Canada prior to the commencement of blasting in marine areas
Monitor and mitigate for effects of shipping on marine mammals Conduct a shipboard surveillance program. Meet requirements for reporting of collisions with marine mammals. Marine mammal observer protocol will include protocols for immediate reporting of significant observations to the	*(107) The Proponent shall revise the proposed "surveillance monitoring" to improve the likelihood of detecting strong marine mammal responses occurring too far ahead of the ship to be detectable by observers aboard the ore carriers. A baseline study early in the shipping operations could employ additional surveillance to detect potential changes in distribution patterns and behavior. At an ambitious scope, this might be achieved using unmanned aircraft flown well ahead of ships, or over haul-out sites in the case of walruses.*
	(120) The Proponent shall ensure that, subject to vessel and human safety considerations, all project shipping adhere to the following mitigation procedures while in the vicinity of marine mammals: (a) Wildlife will be given right of way; (b) Ships will when possible, maintain a straight course and constant speed, avoiding erratic behavior; and (c) When marine mammals appear to be trapped or disturbed by vessel movements, the vessel will implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife have moved away from the immediate area.

Monitoring Program Requirements	Relevant Terms and Conditions
ship masters of other vessels along the shipping route, as part of the adaptive management program to address any items that require immediate action.	*(121) The Proponent shall immediately report any accidental contact by project vessels with marine mammals or seabird colonies to Fisheries and Oceans Canada and Environment Canada respectively, by notifying the appropriate regional office of the: (a) Date, time and location of the incident; (b) Species of marine mammal or seabird involved; (c) Circumstances of the incident; (d) Weather and sea conditions at the time; (e) Observed state of the marine mammal or sea bird colony after the incident; and, (f) Direction of travel of the marine mammal after the incident, to the extent that it can be determined.*
	(122) The Proponent shall summarize and report annually to the NIRB regarding accidental contact by project vessels with marine mammals or seabird colonies through the applicable monitoring report.
	(123) The Proponent shall provide sufficient marine mammal observer coverage on project vessels to ensure that collisions with marine mammals and seabird colonies are observed and reported through the life of the Project. The marine wildlife observer protocol shall include, but not be limited to, protocols for marine mammals, seabirds, and environmental conditions and immediate reporting of significant observations to the ship masters of other vessels along the shipping route, as part of the adaptive management program to address any items that require immediate action.
Monitor and mitigate for effects of shipping on marine mammals Monitor for effects of ship tracks / icebreaking	*(103e) The Proponent shall report annually to the NIRB regarding project-related ship track and sea ice information, including: (e) Marine bird and mammal species and number of individuals attracted to ship tracks in ice.*
	(119) The Proponent shall, in conjunction with the Marine Environment Working Group, monitor ringed seal birth lair abundance and distribution for at least two years prior to the start of icebreaking to develop a baseline, with continued monitoring over the life of the project as necessary to test the accuracy of the impact predictions and determine if mitigation is needed. Monitoring shall also include a control site outside of the Project's zone of influence.
Monitor and mitigate for effects of shipping on marine mammals Monitor and mitigate for effects of noise Identify thresholds for effects of noise Develop indicators for negative effects of noise	*(109) The Proponent shall conduct a monitoring program to confirm the predictions in the FEIS with respect to disturbance effects from ships noise on the distribution and occurrence of marine mammals. The survey shall be designed to address effects during all seasons of the year, and include locations in Hudson Strait and Foxe Basin. The survey shall continue over a sufficiently lengthy period to determine the extent to which acclimation occurs for narwhal, beluga, bowhead and walrus.*
	(110) The Proponent shall develop a monitoring protocol that includes, but is not limited to, acoustical monitoring, to facilitate assessment of the potential short term, long term, and cumulative effects of vessel noise on marine mammals and marine mammal populations. The Proponent is expected to work with the Marine Environment Working Group to determine appropriate early warning indicator(s) that will ensure rapid identification of negative impacts.

Monitoring Program Requirements	Relevant Terms and Conditions
	(111) The Proponent shall develop clear thresholds for determining if negative impacts as a result of vessel noise are occurring. Mitigation and adaptive management practices shall be developed to restrict negative impacts as a result of vessel noise. This shall include, but not be limited to: (a) Identifications of zones where cumulative noise could be mitigated due to biophysical features (e.g., water depth, distance from migration routes, distance from overwintering areas etc.); and, (b) Vessel transit planning, for all seasons, to determine the degree to which cumulative sound impacts can be mitigated through the seasonal use of different zones.
	(112a, b) Prior to commercial shipping of iron ore, the Proponent, in conjunction with the Marine Environment Working Group, shall develop a monitoring protocol that includes, but is not limited to, acoustical monitoring that provides an assessment of the negative effects (short and long term cumulative) of vessel noise on marine mammals. Monitoring protocols will need to carefully consider the early warning indicator(s) that will be best examined to ensure rapid identification of negative impacts. Thresholds shall be developed to determine if negative impacts as a result of vessel noise are occurring. Mitigation and adaptive management practices shall be developed to restrict negative impacts as a result of vessel noise. This shall include, but not be limited to: (a) Identification of zones where noise could be mitigated due to biophysical features (e.g., water depth, distance from migration routes, distance from overwintering areas etc.); (b) Vessel transit planning, for all seasons.
All data will be analysed rigorously by qualified analysts.	*(108) The Proponent shall ensure that data produced by the surveillance monitoring program is analysed rigorously by experienced analysts (in addition to being discussed as proposed in the FEIS) to maximize their effectiveness in providing baseline information, and for detecting potential effects of the Project on marine mammals in the Regional Study Area. It is expected that data from the long-term monitoring program be treated with the same rigor.*

2.2 Questions and Hypotheses of the Existing Marine Mammal Program

The Shipping and Marine Wildlife Management Plan (Baffinland 2016) identifies the questions that were considered in formulating hypotheses needed to guide development of the Environmental Effects Monitoring program. These questions arose during the preparation and review of the Environmental Impact Statement and Addendum (Early Revenue Phase), as well as during the issuance of the NIRB Project Certificate.

2.2.1 Questions Supporting Hypothesis Formulation

As outlined in the Marine Environmental Effects Monitoring Plan (Appendix H of the Shipping and Marine Wildlife Management Plan [Baffinland 2016]), the following questions were considered in formulating hypotheses for the environmental effects program:

1) Will marine mammal distribution and abundance change as a result of Baffinland shipping activity along the northern shipping route during the open-water season?
    a) What is the spatial-temporal distribution of marine mammals in the absence of shipping?
    b) How far away from the ship will marine mammals avoid it?
    c) What is the duration of avoidance for a single ship passage?
    d) What received sound levels from ore carriers result in marine mammal avoidance? Or do mammals respond to the approaching vessel rather than just the received noise levels?
    e) Will marine mammals habituate to frequent and regular ship passages?
    f) If yes to (e), how long will it take marine mammals to habituate?
    g) What natural factors influence narwhal distribution and abundance, independent of shipping?
2) Will narwhal behaviour change during and after a project vessel passage?
    a) What is narwhal behaviour in Milne Inlet before Project shipping?
    b) Does relative abundance and distribution of narwhals change during and after a ship passage?
    c) Is narwhal group composition affected?
    d) Does narwhal behaviour change during and after a ship passage?
    e) How does subsistence hunting affect narwhal behaviour?
    f) Do the number and characteristics of narwhal calls change in the presence of shipping?
3) What are short-term, long-term, and cumulative effects of shipping and underwater noise on marine mammals?

2.2.2 Hypotheses

As outlined in the Marine Environmental Effects Monitoring Plan (Appendix H of the Shipping and Marine Wildlife Management Plan [Baffinland 2016]), the overarching null hypotheses to be tested during the study were:

- Marine mammal distribution and relative abundance does not change in the presence of open-water shipping.
- Marine mammal behaviour does not change in the presence of open-water shipping.

Each component of the monitoring program was planned to address specific testable hypotheses representing sub-components of the overarching hypotheses.

Table 4: List of null and alternate hypotheses summarized for each marine monitoring program conducted by Baffinland

Hypothesis Number	Null Hypothesis	Alternate Hypothesis
Shore-based Narwhal Monitoring		
1	Narwhal distribution and relative abundance does not significantly change in response to a large vessel transit	Narwhals move away from a vessel and narwhal numbers decrease in response to a large vessel transit
2	Narwhal group characteristics do not significantly change in the presence of a vessel	Narwhal group characteristics do significantly change in the presence of a vessel
3	Narwhal behaviour does not significantly change in the presence of a vessel	Narwhal behaviour does significantly change in the presence of a vessel
4	Narwhals do not habituate to large vessel shipping	Narwhals habituate to large vessel shipping
Aerial Survey		
1	Narwhal regional distribution and relative abundance does not significantly change in response to a large vessel transit	Narwhals move away from a vessel and narwhal numbers decrease in response to a large vessel transit
2	Narwhals do not habituate to large vessel shipping	Narwhals habituate to large vessel shipping
Acoustic study		
1	Presence of narwhal calls does not significantly change relative to a large vessel transit	Presence of narwhal calls does significantly change relative to a large vessel transit
2	Narwhal call types and frequency of calls do not significantly change in response to large vessel transits	Narwhal call types and frequency of calls do significantly change in response to large vessel transits

A framework for assessing the marine mammal monitoring results and determining management response is described in the Marine Environmental Effects Management Plan (MEEMP) which is a component of the Shipping and Wildlife Management Plan (Baffinland 2016). Evaluating this framework, which is an element common to all components of the MEEMP, is beyond the scope of the present report, and the framework description is included here only to provide an overall context to how the marine mammal monitoring results are intended to be used.

In the event that a null hypothesis is rejected or a measureable change is observed, the protocol in the MEEMP is to further assess the data and determine if the change is Project-related. If the change is assessed as not likely to be Project-related, the analyses are to be documented and the results shared. If the change is assessed as likely to be Project-related, a required level of management response is determined. Levels of response in the marine mammal program and examples of what such a response might entail are listed in Table 5.

Table 5: Levels of management response to detected Project-related changes in marine mammals, triggers leading to initiation of response, and examples of potential responses, as outlined in the MEEMP (Baffinland 2016)

Level of Response	Trigger for Response	Examples of Potential Response(s)
Low	One null hypothesis was rejected, and changes are likely Project-related. (Note exception below for aerial survey)	■ Identify the source and location of the observed change ■ Identify specific sampling stations that will help monitor the observed change in subsequent years ■ Have external reviewers examine the technical soundness of the statistical test ■ Examine need for and specific requirements of increased monitoring based on findings of the marine mammal integration report ■ Further evaluation of data to determine next steps
Moderate	Triggering level is exceeded, and exceedance is likely due to the Project, AND/OR Two or more null hypotheses have been rejected, AND/OR Aerial survey only: One null hypothesis was rejected, and changes are likely Project-related.	The actions indicated for low level response, plus: ■ Determine if management or mitigation is required based on trend analysis and/or an evaluation of the potential pathway of effects ■ Develop a high level response 'trigger' with input from MEWG and other stakeholders ■ Conduct a risk assessment which considers other monitoring results in combination with the monitoring target where the observed change occurred ■ Evaluate the need for increased monitoring or additional monitoring ■ Identify next steps based on points above
High	Response trigger is exceeded.	■ Discuss overall effects on ecosystem and next steps with regulatory agencies ■ Implement mitigation measure while monitoring to assess their effectiveness ■ Implement increased monitoring to define the magnitude and/or spatial extent of the effects

2.3 Role of Integration of Monitoring Results

The Shipping and Marine Wildlife Management Plan (Baffinland 2016) identified two major causes of complexity in interpretation of the potential response of marine mammals, specifically narwhal, to shipping: the large natural variation in distribution and abundance of narwhal, and the difficulty of separating the effects of hunting and movements of small vessels such as those used by hunters from the effects of large vessel movements through the Project area. Because of the difficulty in attributing changes in narwhal distribution and abundance to the passage of a large vessel, it was proposed that results from all marine monitoring studies should be considered in an integrated fashion each year and reviewed in order to determine whether shipping effects on narwhal necessitate adaptive management activities, and, if so, what level of response is warranted (Baffinland 2016).

The remainder of this document will focus on the integration of Baffinland's monitoring studies and related sources of information to address the Terms and Conditions, and the information required by the Shipping and Marine Wildlife Management Plan. Initially the results of the studies will be addressed in the context of the questions summarized in Section 2.2.1. A gap analysis of the results relative to Terms and Conditions and to Management Plan requirements, as well as options for Baffinland's marine mammal program, will be presented in Section 4.0.

3.0 INTEGRATION OF MONITORING STUDIES

3.1 Sources of Information

3.1.1 Marine Mammal IQ - Community Workshops

Baffinland conducted a series of workshops in the local communities to learn about contemporary Inuit land use in Eclipse Sound and Navy Board Inlet areas. At these workshops, Inuit Quajimajatuqangit (IQ), defined as ''the combining of the traditional knowledge, experience and values of Inuit society, along with the present Inuit knowledge, experience and values that prepare the way for future knowledge, experience and values'' (Dale and Armitage 2010), was shared and documented.

Subjects relevant to the marine mammal integration report that were discussed in the workshops included:

- Seasonal activities related to marine mammals
- Narwhal distribution
- Shipping
- Community input on marine mammal monitoring, mitigation and adaptive management

Summaries of workshop discussions, excerpted from the report by Jason Prno Consulting Services (2017), are presented in Appendix A.

3.1.2 Baffinland's Baseline and Monitoring Studies on Marine Mammals

Baseline and monitoring studies related to marine mammals and conducted by Baffinland between 2006 and 2015 were included as sources of information. The 2016 reports are not yet available and therefore have not been included. Studies that have been conducted by Baffinland include aerial surveys, shore-based monitoring, shipboard observations, and acoustic monitoring (Table 6). The studies used are identified in Section 7.0 at the end of this report.

Table 6: Summary of years in which baseline and monitoring studies on marine mammals were conducted by Baffinland along the northern shipping route and adjacent water bodies

Year	2006	2007	2008	2013	2014	2015	2016
Aerial surveys	✓	✓	✓	✓	✓	✓	✓
Photographic aerial survey (for effects of shipping)						✓	
Shore-based visual monitoring				✓	✓	✓	✓
Shipboard-observer visual monitoring				✓	✓	✓	
Acoustic surveys				✓	✓		

3.1.3 Shipping in the Project Area

Vessel movements along the northern shipping route, in particular Milne Inlet, recorded during aerial surveys, shore-based visual monitoring and/or vessel Automatic Identification System data in 2013 through 2015 are summarized in Appendix B.

3.1.4 Other Sources of Information

Other sources of information used in this report include published and grey literature, and interviews with MEWG members and other marine mammal scientists. Studies used are referenced in the list of References at the end of this report.

Several government and non-governmental organizations were conducting studies in 2016 and/or may do so in the near future that have potential applications to Baffinland's marine mammal monitoring objectives. These unpublished and planned future studies are summarized briefly below.

3.1.4.1 Narwhal Acoustic Research

Oceans North conducted a three-year field study of narwhal acoustic presence (i.e., detection of calls) and communication (i.e., frequency and type of call). The field work concluded in the autumn of 2016, with removal of the hydrophones. Hydrophones were operated during the ice free season in four locations – one hydrophone in Tremblay Sound, two in Milne Inlet (north end Ragged Island and north end Low Island), and one in Guys Bight (at floe edge on Baffin Bay side of Eclipse Sound). Data analysis was being undertaken in collaboration with researchers at Scripps Institute of Oceanography (K. Westdahl, Oceans North, pers. comm.).

Oceans North, in collaboration with Scripps Institute of Oceanography, commenced a year-round long-term hydrophone deployment in Eclipse Sound in the autumn of 2016.

3.1.4.2 Narwhal Tagging Research

DFO conducted a tagging study of narwhals in Tremblay Sound in 2016 with support from the World Wildlife Fund (S. Ferguson, DFO, pers. comm. October 2016). The purpose of DFO's tagging program is to describe seasonal migrations and habitat use of narwhals. As of October, 2016, two satellite tags were still transmitting. In 2017, DFO is proposing to tag narwhals in Eclipse Sound at the floe edge and in Admiralty Inlet as well as in Tremblay Sound. Greenland is also conducting tagging studies involving the same narwhal population.

In 2016, DFO found it difficult to capture enough narwhals for tagging using the nets they have used for the past decade, so in 2017 DFO is proposing to use additional methods for tag implantation (e.g., delivery of tags using jab sticks, air rifles, etc.). Narwhal hunters have started to use nets, which has made the narwhals much more wary and harder to capture using nets. DFO monitors their nets continuously, and will immediately go out with two zodiacs to disentangle and tag the whale when they see movement of the buoys that indicates a whale is in the net. There has been no direct mortality of narwhals using DFO's method, whereas most narwhals entangled in hunters' nets are killed. DFO Fishery Management discourages hunting by netting due to bycatch of other species (e.g., fish) and lack of selectivity (the nets do not catch only the tusked males that are preferred by the hunters).

3.1.4.3 Narwhal Aerial Survey

DFO conducted a High Arctic narwhal survey in 2016, using a photographic aerial survey method, and these data are being used to assess Canadian narwhal stocks (S. Ferguson, DFO, pers. comm.). One objective for DFO in conducting this survey was that narwhal numbers were apparently reduced in their previous survey of Eclipse Sound, conducted in 2013 (DFO, 2015). The survey design used by DFO in 2013 targeted Eclipse Sound in expectation there would be large numbers of narwhals there, but they were not abundant. Narwhals were still abundant in Admiralty Inlet in 2013, and Stephen Ferguson speculated that narwhals might be in the process of moving further north due to climate change. Dr. Ferguson stated that he thinks narwhals used to use deeper water in Eclipse Sound more in past years than they currently do in summer. He thinks that formerly there was more summer sea ice in Eclipse Sound used by narwhal for protection from killer whales, and that the use of Milne Inlet and Tremblay Sound by narwhal may have increased since the loss of sea ice.

DFO's narwhal aerial surveys conducted in 2016 in the area of interest for Baffinland's northern shipping route (Pond Inlet, Eclipse Sound, Milne Inlet, Koluktoo Bay and Tremblay Sound) were shared with Baffinland under a data-sharing agreement, and selected surveys from the peak abundance period of narwhals (August) are being analysed by Golder.

DFO does not expect to conduct an aerial survey of narwhal in the Eclipse Sound area in 2017.

3.1.4.4 Killer Whale Research

DFO has conducted tagging studies for killer whales in the Eclipse Sound area but plans to use photo identification methods in future studies (S. Ferguson, DFO, pers. comm.).

3.1.4.5 Seal and Polar Bear Aerial Survey

In June 2016, DFO and Environment Canada collaborated to conduct an aerial survey of seals and polar bear in Eclipse Sound, simultaneously recording still photographic imagery and infrared video from the aircraft. The survey was conducted at a time when seals would be expected to be basking on ice. The objective was to identify habitat, including habitat for pupping, and to develop an index of habitat suitability. The survey was intended to collect data for all seal species present on the ice, and included pups.

A similar survey is planned to take place in June 2017.

3.1.4.6 Parks Canada Plans

Eclipse Sound, Pond Inlet, Milne Inlet and Tremblay Sound may fall within the boundaries of the proposed Lancaster Sound National Marine Conservation Area (NMCA) (F. Mercier and D. Blanchard, Parks Canada, pers. comm.). Boundaries of the proposed NMCA will be finalized only after consultations with local communities and other stakeholders.

Parks Canada does not currently conduct research or monitoring studies in the Eclipse Sound area. Ultimately whether Parks Canada engages in research or monitoring in the NMCA area would depend on the Management Plan for the NMCA. The NMCA's management approach is focused on species and habitats, and will be developed through discussions with local communities and stakeholders. Parks Canada anticipates that narwhal will be a species of interest. Zoning for protection of sensitive habitats may occur as part of the management plan.

3.2 Integrated Monitoring Results

Results from the marine mammal monitoring program relevant to each of the questions recorded in Section 2.1 as having contributed to hypothesis generation will be discussed below.

3.2.1 Will marine mammal distribution and abundance change as a result of Baffinland shipping activity along the northern shipping route during the open-water season?

This question was divided into a number of component questions:

3.2.1.1 What is the spatial-temporal distribution of marine mammals in the absence of shipping?

Far more data exist to address this question with respect to narwhal than for other marine mammal species living in the Project area, so the available information will be summarized separately.

3.2.1.1.1 Narwhal

Aerial surveys designed to determine narwhal abundance and distribution throughout Baffinland's northern shipping route were conducted in 2006, 2007, 2008, 2013, 2014, and 2015 (Figure 1 through Figure 4). Note that the survey design changed each year, which can obscure year-to-year comparisons. Incidental observations of other marine mammals were also recorded during the surveys and will be discussed in Section 4.2.1.1.2.

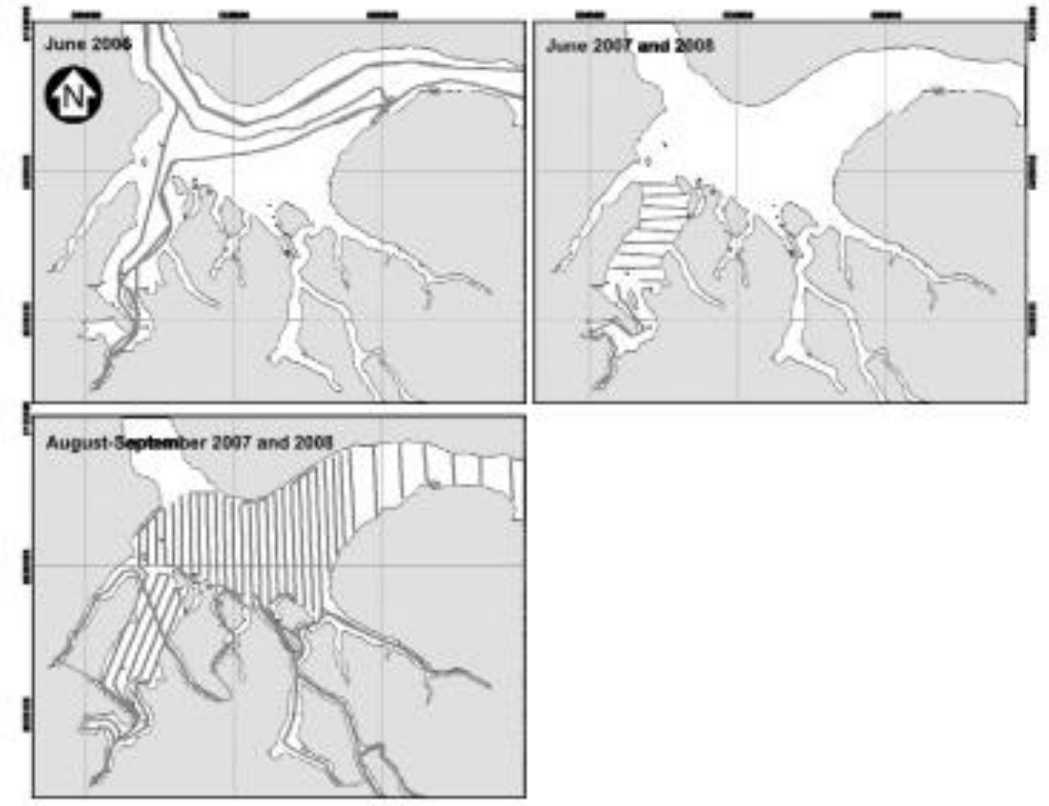

Figure 1: Aerial survey transect design for narwhal monitoring in 2006, 2007 and 2008. Source: Baffinland (2012a)

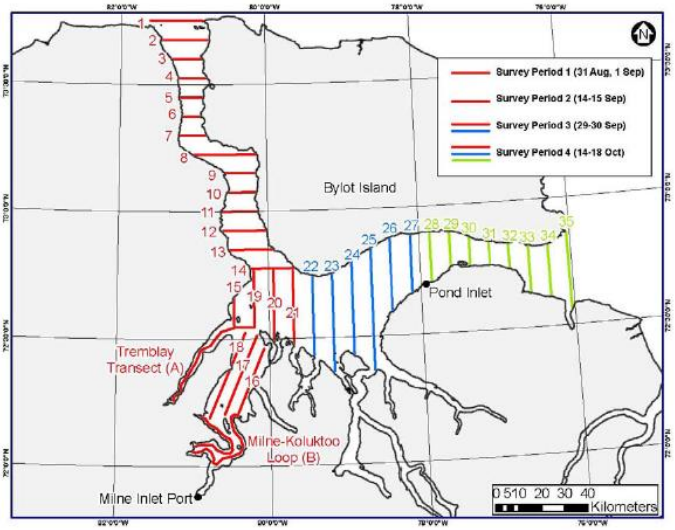

Figure 2: Aerial survey transect design for marine mammal monitoring in 2013. Source: LGL (2015a)

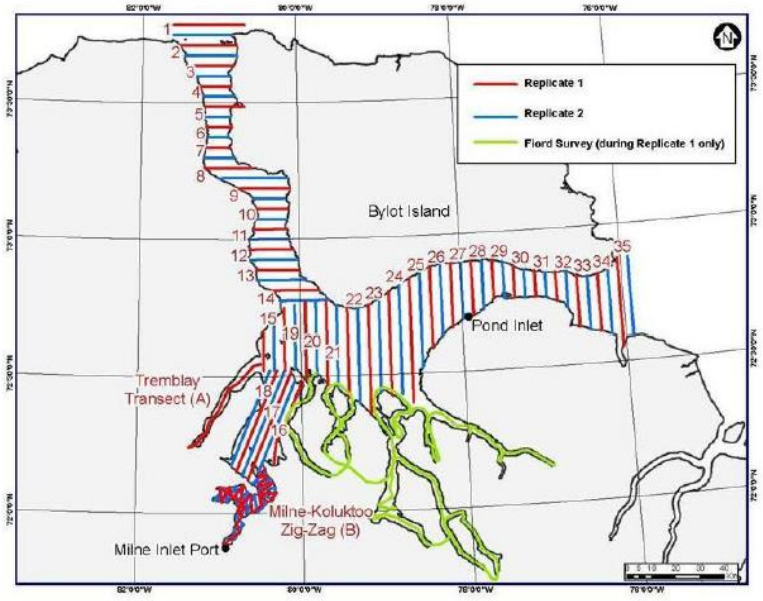

Figure 3: Aerial survey transect design for narwhal monitoring in 2014. Source: LGL (2015b)

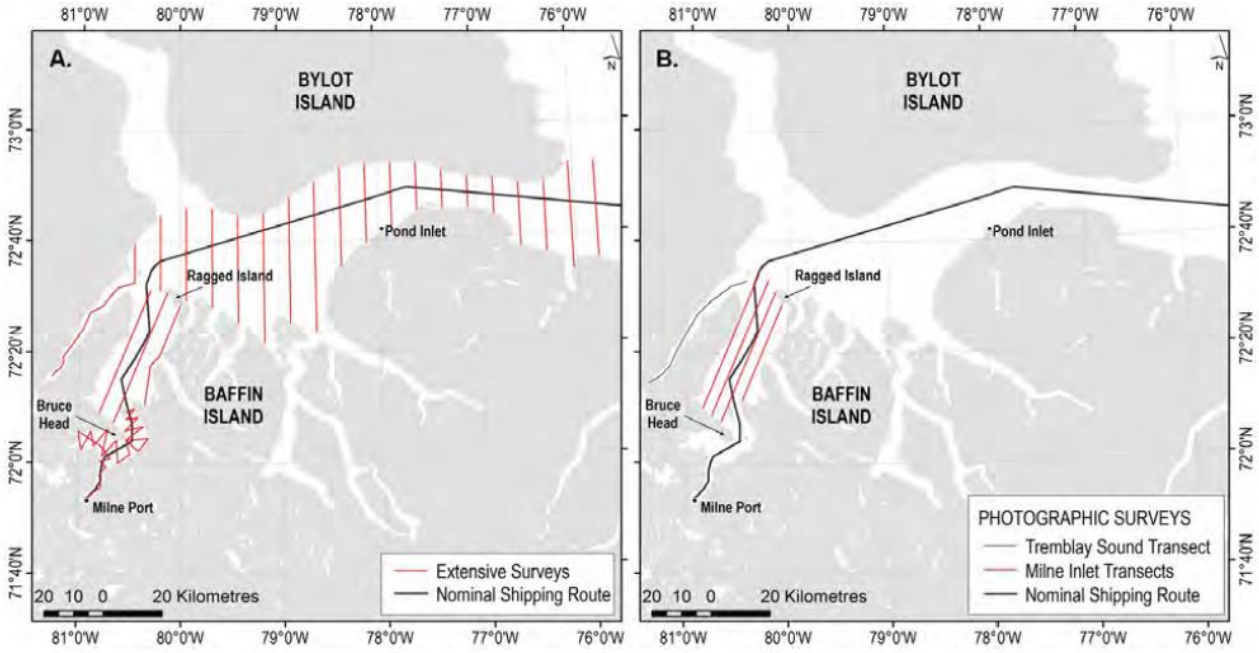

Figure 4: Aerial survey transect designs for narwhal monitoring by (A) extensive and (B) photographic surveys in 2015. Source: LGL (2016a)

Dates between June and October were surveyed over the six years of study (Table 7).

Table 7: Dates of aerial surveys conducted for marine mammals between 2006 and 2015. Note that two replicates per biweekly period were surveyed in 2007-2008 and 2013-2014 but only one replicate in 2015. Additional dates were surveyed by DFO in 2013.

Year of Study	June	July	August	September	October
2006	21, 27				
2007	14, 20, 22 (Milne Inlet only)	29, 31	1, 4, 7, 8, 10, 12, 30, 31	1, 3, 8, 9, 10, 13, 14, 15, 17, 18	
2008			4, 5, 7, 10, 21, 22, 23, 24, 25, 26, 29, 31	1, 2, 3	
2013			31	1, 14, 15, 29, 30	14, 16
2014			1, 2, 3, 4, 14, 15, 16, 17, 30, 31	1, 2, 14, 15, 16, 17, 29, 30	1, 2, 17, 18, 20, 21, 22
2015			1, 16, 17, 31	15, 17	

The northern shipping route and adjacent waters were divided into thirteen geographic strata for description of spatial trends in the data (Figure 5).

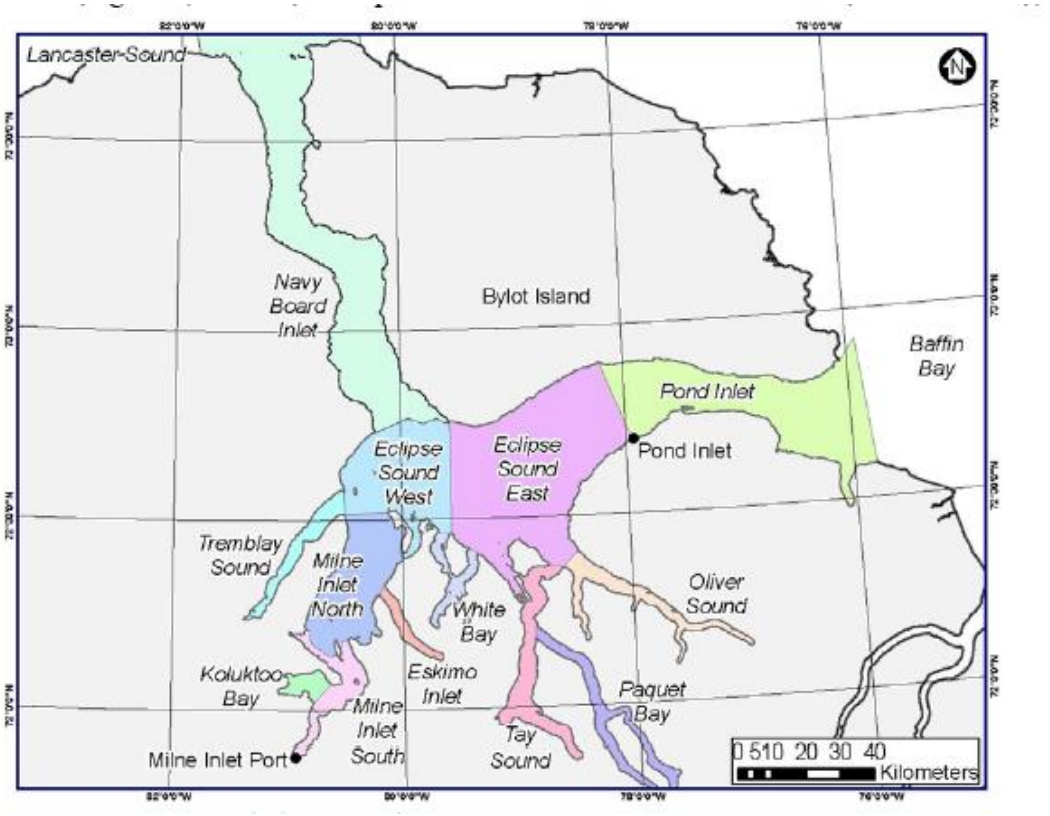

Figure 5: Thirteen geographic strata used for aerial survey data analysis. Source: LGL (2015a)

No narwhals were observed in June surveys which were conducted only in 2006 and 2007. Peak densities of narwhals were observed from mid-August through mid-September, generally in Milne Inlet, Koluktoo Bay and Tremblay Sound and Eclipse Sound West (Figure 6 through Figure 8). After mid-September, few or no narwhals were observed in these areas. Low densities of narwhals were found in Eclipse Sound East, Pond Inlet and Navy Board Inlet throughout the sampling period, persisting in these areas until mid- to late October.

Seasonal observations of narwhals obtained from the aerial surveys were consistent with the seasonal distribution as described by local IQ (Appendix A). According to IQ, narwhal begin migrating into Eclipse Sound through Pond Inlet and Navy Board Inlet when the ice starts to break up in July. In August, September, and October, narwhal are present in the Milne Inlet area. In October and November, narwhal migrate back out to Baffin Bay through Eclipse Sound and Pond Inlet to overwinter.

Seasonal distribution of narwhals as determined by the aerial surveys and described by IQ were also consistent with tagging studies conducted by Dietz et al. (2001) and Watt et al. (2012).

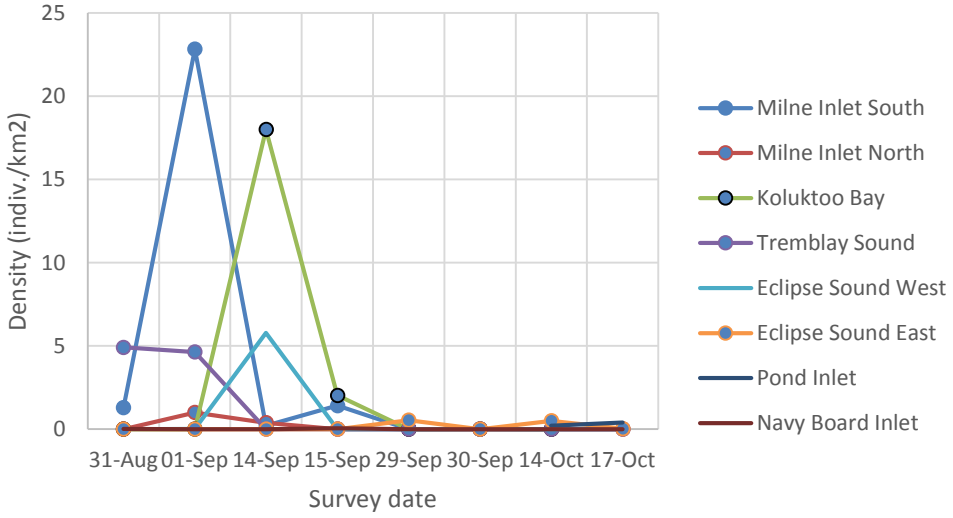

Figure 6: Spatial and temporal trends in narwhal density determined from aerial surveys in 2013

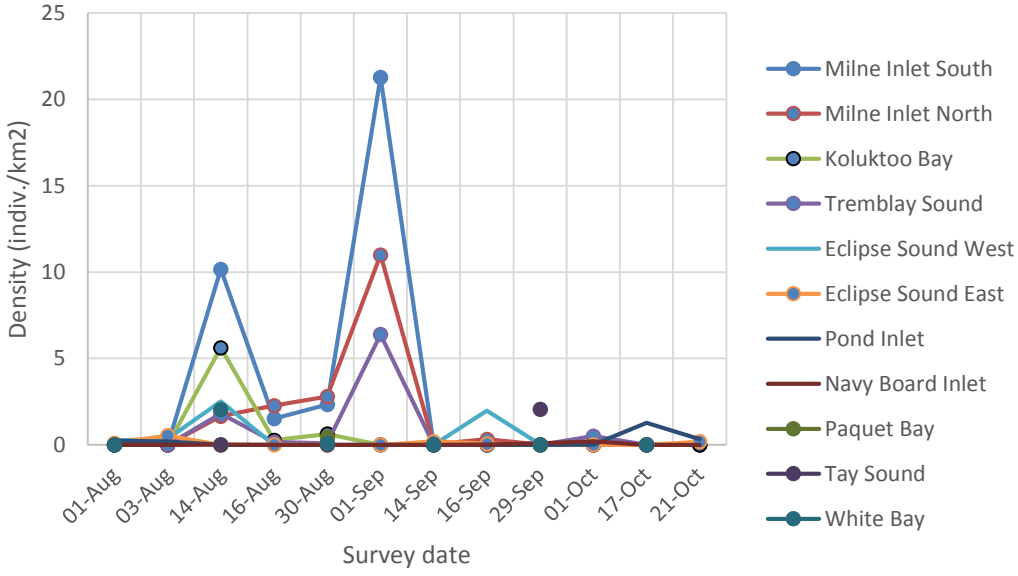

Figure 7: Spatial and temporal trends in narwhal density determined from aerial surveys in 2014

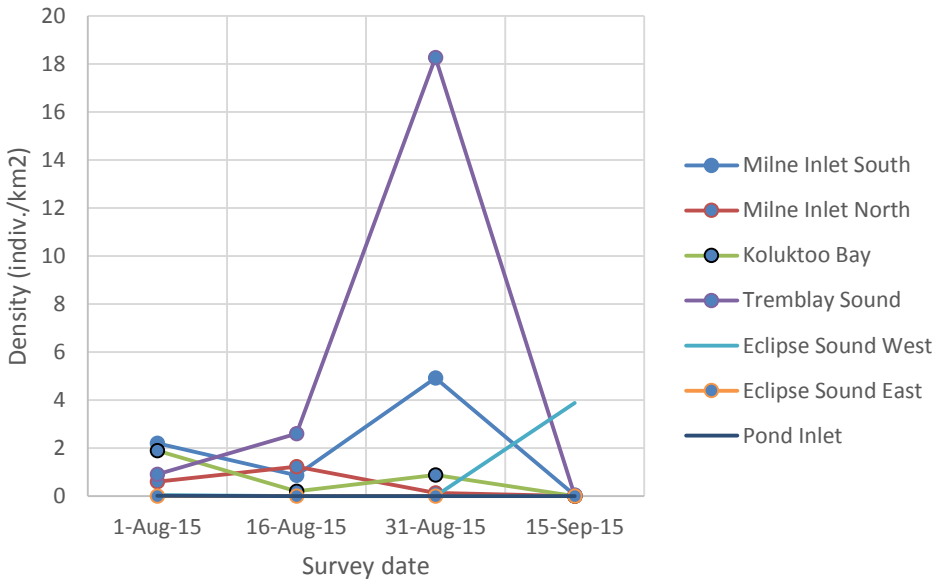

Figure 8: Spatial and temporal trends in narwhal density determined from aerial surveys in 2015

Comparing survey results by geographic stratum, abundance of narwhals was highly variable both within and among years (Figure 9 and Figure 10).

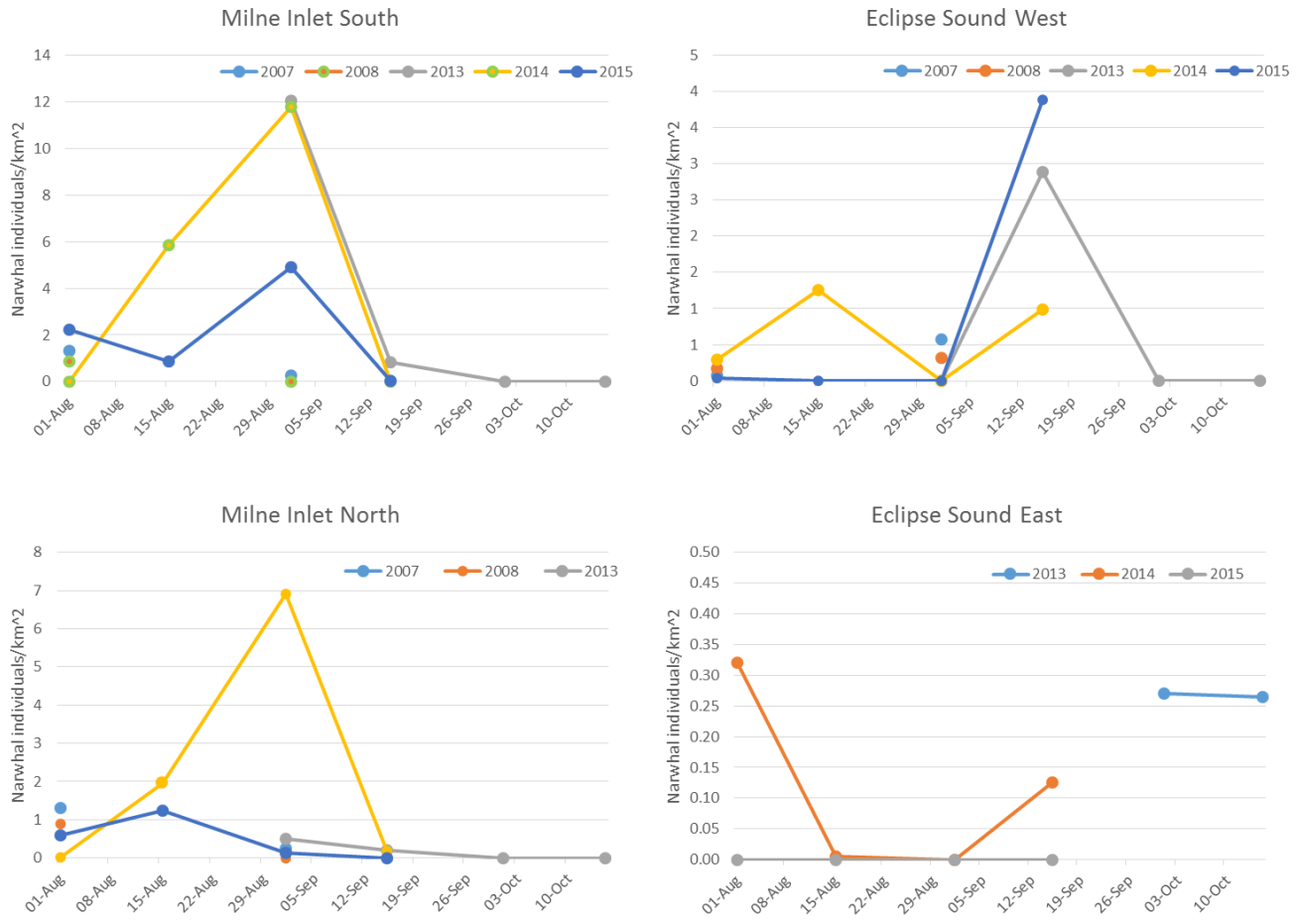

Figure 9: Comparison of narwhal densities (mean density per survey period) determined from aerial surveys in 2007, 2008, 2013, 2014 and 2015, part 1 of 2

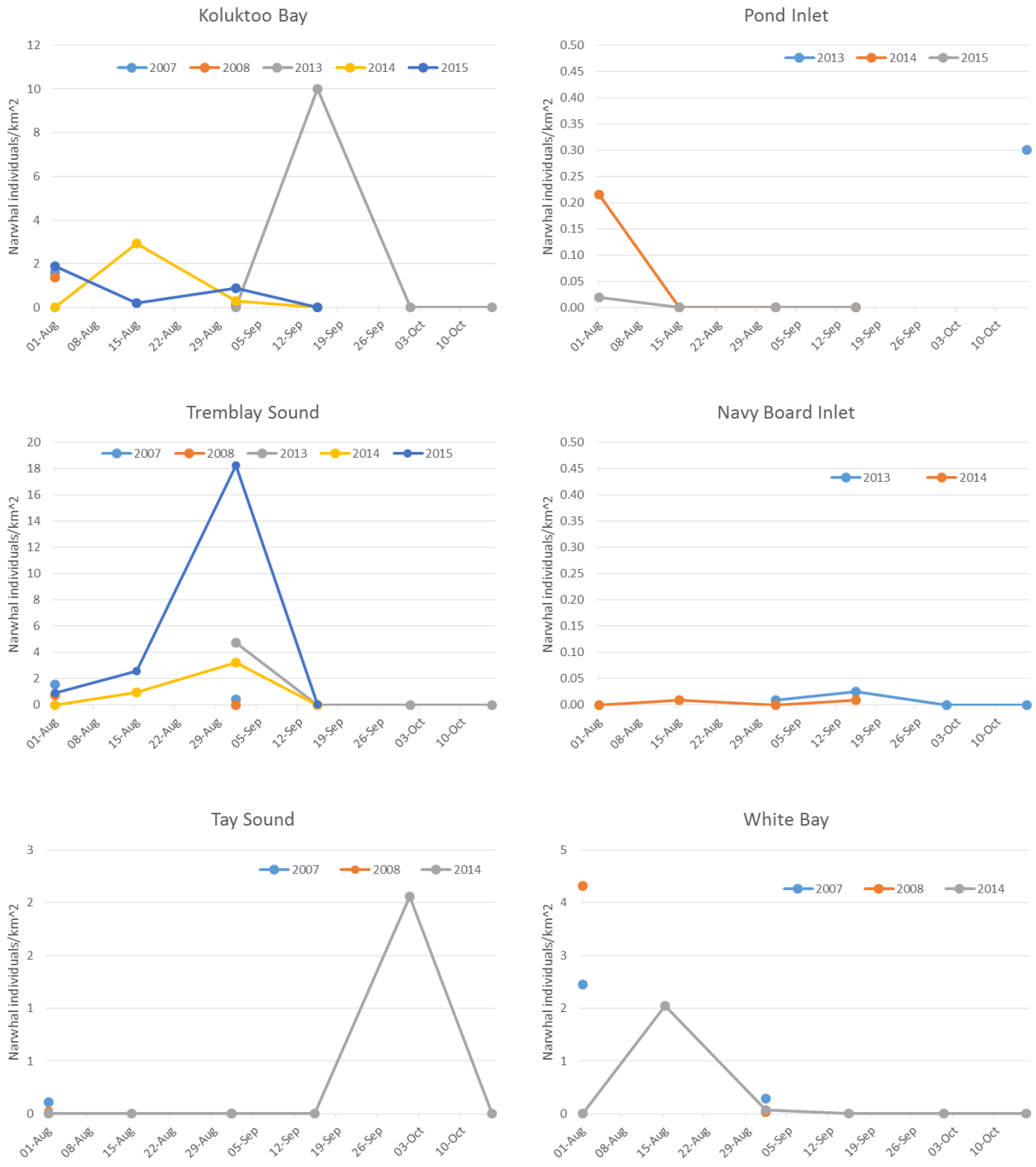

Figure 10: Comparison of narwhal densities (mean density per survey period) determined from aerial surveys in 2007, 2008, 2013, 2014 and 2015, part 2 of 2

Considerable variability in narwhal density per stratum was present in replicate surveys which were typically separated by one day (maximum three days). The magnitude of difference in paired replicates was calculated as [(higher value – lower value)/lower value]. All years, dates and geographic strata were included, but replicates with one or more zero density were excluded. The median magnitude of difference was 2.93 (i.e., the higher replicate density replicate was 2.93 times the lower replicate density). The magnitude of differences between the two replicates ranged from 0.06 to 70.0 (Figure 11).

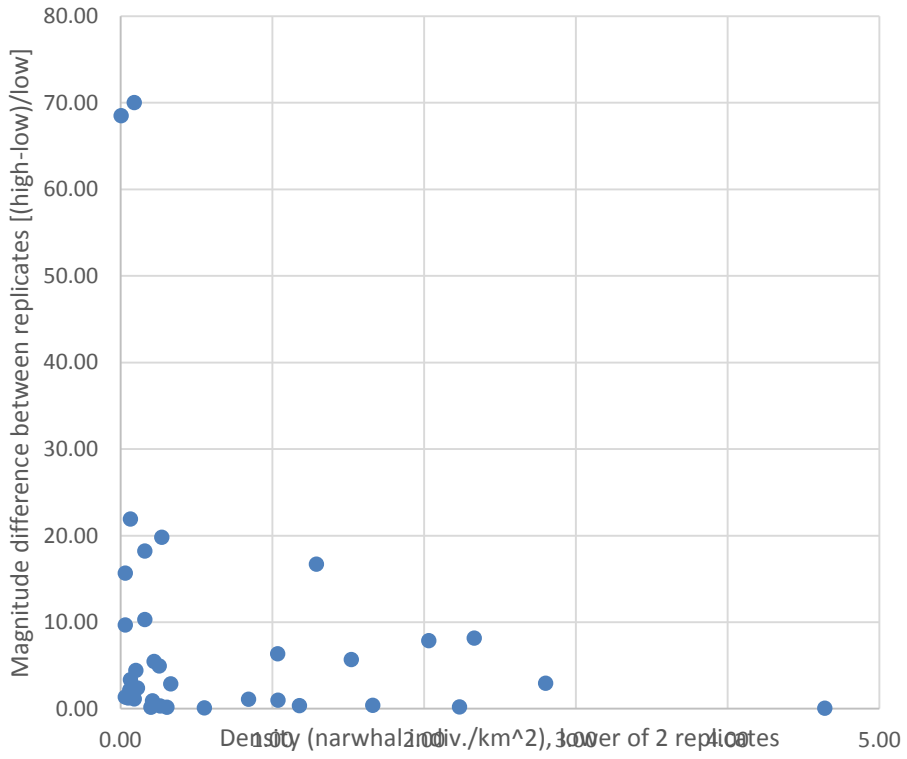

Figure 11: Magnitude of difference in narwhal densities measured by replicate aerial surveys in 2013 and 2014

A statistical analysis of the 2013 and 2014 data by LGL detected no inter-annual differences in abundance (LGL 2015c). LGL (2015b) refer to having carried out a power analysis for the 2014 data, which determined that the extensive aerial survey had sufficient statistical power to detect “large scale” changes in narwhal distribution and abundance. LGL concluded that detecting “relatively small” and even “moderate” changes using the “extensive” aerial survey approach was unlikely given the large natural variation in narwhal distribution and abundance. The magnitude of change (e.g., quantitatively expressed in percent or absolute change in density) that LGL determined could be detected was not stated in LGL (2015b) and there is no description of what was considered a “large”, “moderate” or “relatively small” change. Golder did not carry out a power analysis but based on observed variability is in agreement with LGL’s statement that the extensive aerial survey would not be able to detect changes unless a significant decline in narwhal density at the regional scale were to take place. An example would be a decline at the scale of the Eclipse Sound narwhal population, which is the scale at which Fisheries and

Oceans Canada conducts narwhal stock assessment (DFO 2015). Given the range size of narwhal (347 to 767 km^2 occupied over a five day period based on tagging studies in Admiralty Inlet; Laidre et al. 2006), movements in and out of smaller spatial strata such as Koluktoo Bay, Milne Inlet South and Tremblay Sound (Table 8) appear to be well within the normal short-term space occupancy of the species.

Table 8: Area of geographic strata surveyed for marine mammals in 2013 aerial surveys. Source: LGL (2015a)

Geographic stratum	Area (km^2)
Eclipse Sound East	1,956.7
Eclipse Sound West	835.5
Koluktoo Bay	75.8
Milne Inlet North	657.7
Milne Inlet South	180.7
Navy Board Inlet	2,103.6
Pond Inlet	1,432.2
Tremblay Sound	155.9

3.2.1.1.2 Other Marine Mammals

The description of other marine mammals presented in this section is only a brief, high-level account of species presence during the baseline period. In general, surveys conducted for marine mammals in the study area have been focused on narwhal and, especially for smaller pinnipeds, are likely to underestimate abundance and distribution.

In 2006, 2007 and 2008, Baffinland conducted surveys in June and bi-weekly during August and September to describe the distribution of marine mammal species (Baffinland 2012a). During the 2006, 2007 and 2008 aerial surveys in Eclipse Sound and its bays and inlets, bowhead, beluga, narwhal, killer whale, walrus, bearded seal, ringed seal, harp seal, and polar bears were sighted (Figure 12 through Figure 23). Narwhal was the most abundant marine mammal sighted in the area. Few pinnipeds were sighted apart from the harp seal in 2007. High-level aerial surveys can detect only a small fraction of pinnipeds in the water except for the largest species (e.g., walrus). Large aggregations of pinnipeds such as sometimes occurred with harp seals were more visible to aerial survey observers than individual seals and were more likely to be counted.

No bowhead whales were sighted during aerial surveys in June 2006, but they were observed in 2007 and 2008. Most sightings were in Milne Inlet, Eclipse Sound, and to a lesser extent in Koluktoo Bay, and in 2007 there were also a few sightings in Tremblay Sound and Tay Sound.

There were three killer whale sightings in Eclipse Sound on 17 September 2007.

Ringed seal surveys were conducted in Eclipse Sound and Milne Inlet in June of 2006, 2007, and 2008. Ringed seal surveys in 2007 and 2008 focused on Milne Inlet and Koluktoo Bay.

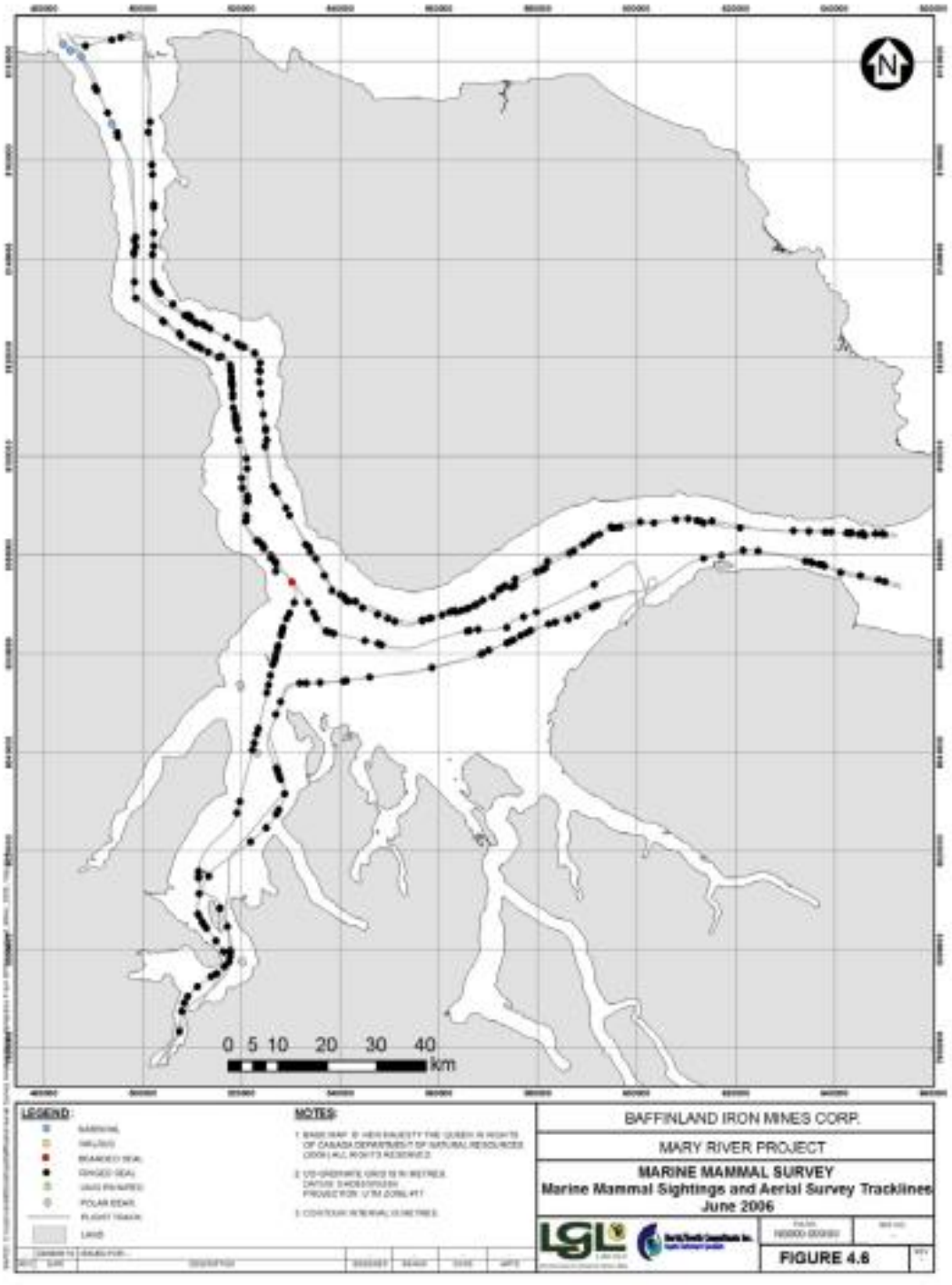

Figure 12: Marine mammal sightings and aerial survey tracklines, June 2006. Source: Baffinland 2012a

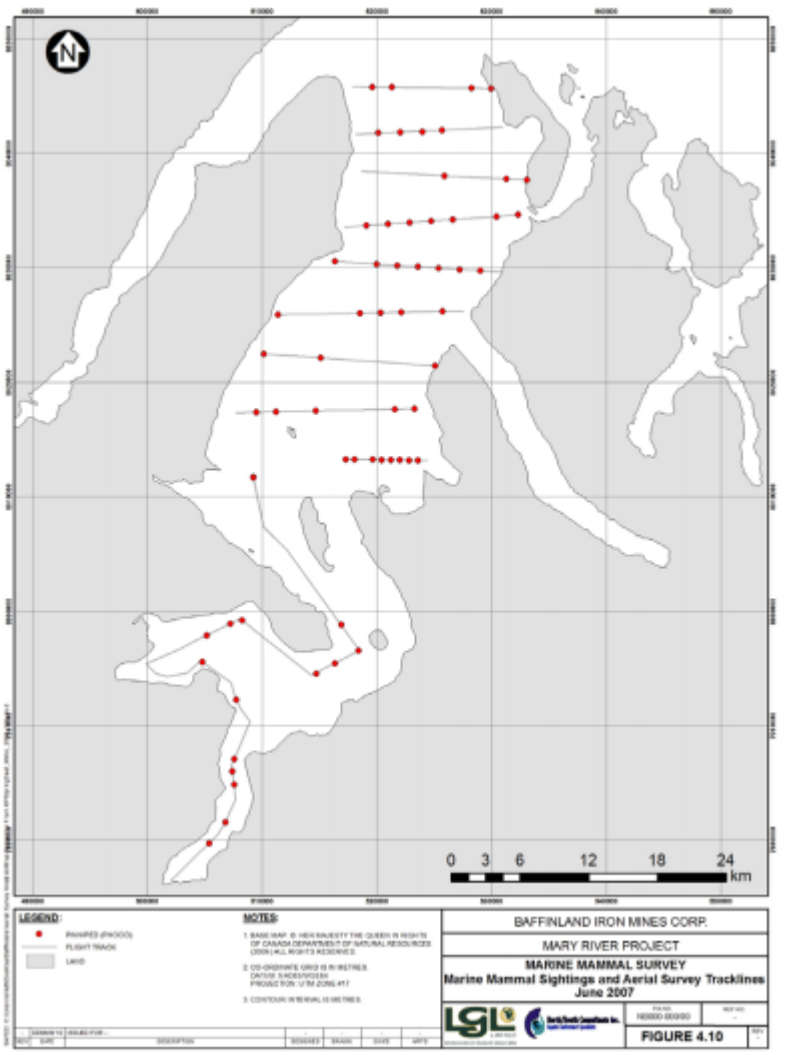

Figure 13: Ringed seal sightings and aerial survey tracklines in Milne Inlet, June 2007. Source: Baffinland 2012a

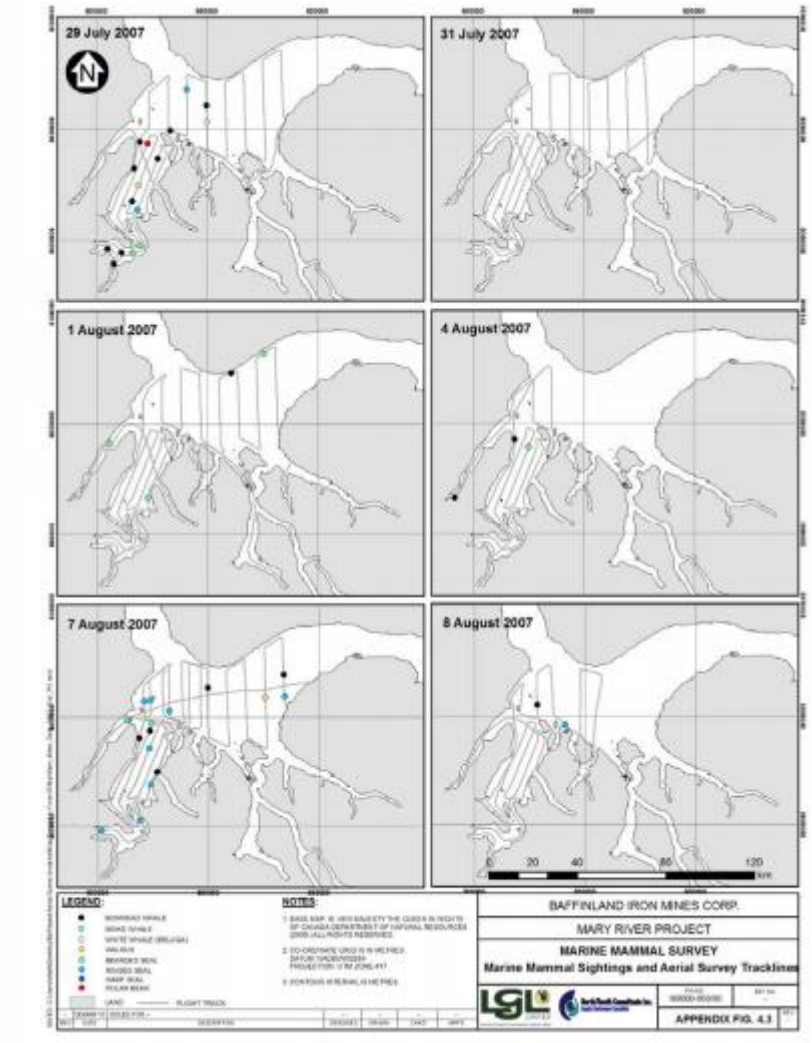

Figure 14: Marine mammal sightings (narwhal excluded) and aerial survey tracklines, July and August 2007. Source: Baffinland 2012a

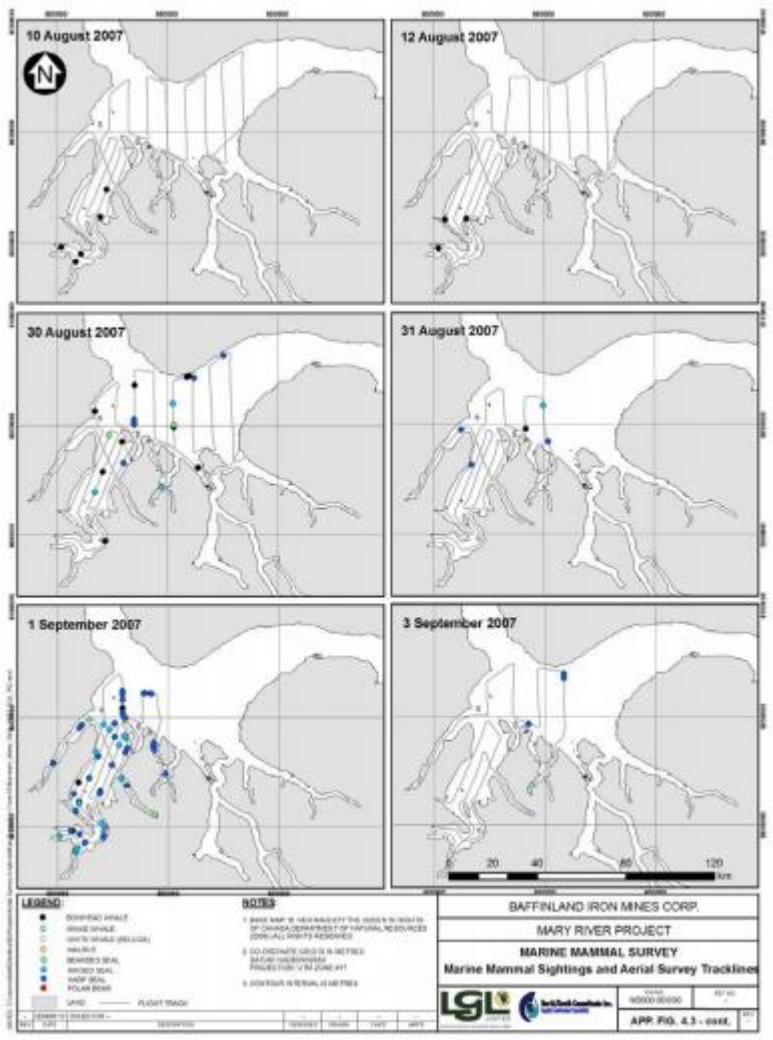

Figure 15: Marine sightings (narwhal excluded) and aerial survey tracklines, August and September 2007. Source: Baffinland 2012a

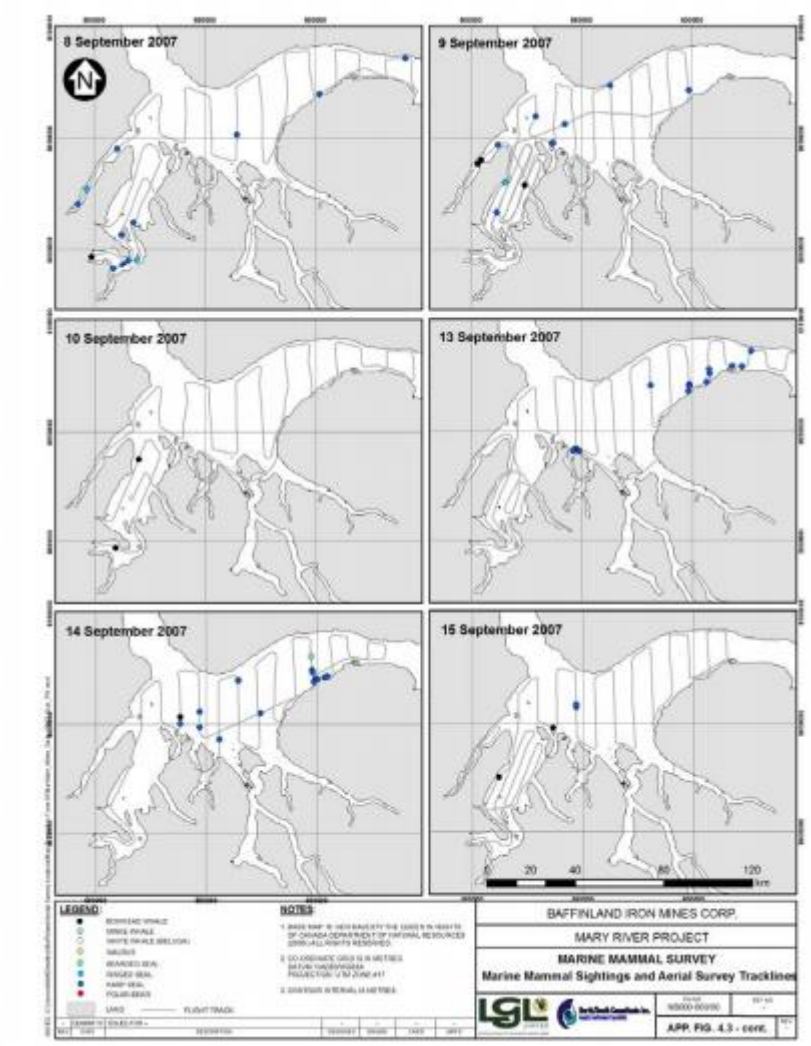

Figure 16: Marine mammal sightings (narwhal excluded) and aerial survey tracklines, August and September 2007. Source: Baffinland 2012a

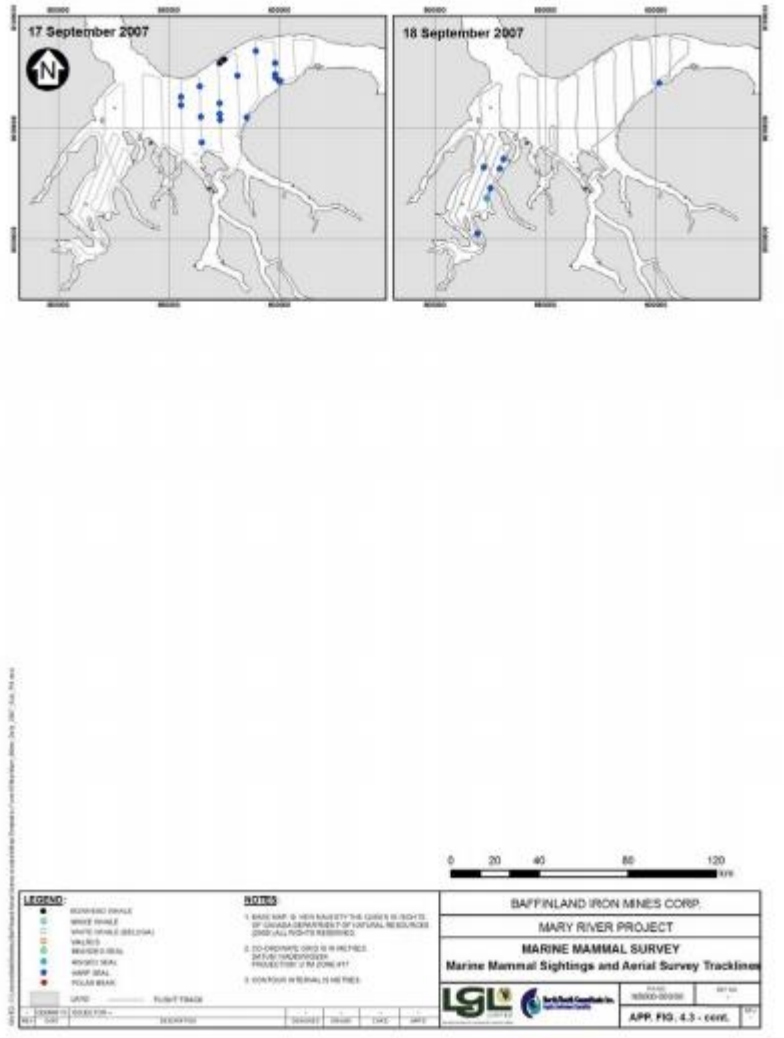

Figure 17: Marine mammal sightings (narwhal excluded) and aerial survey tracklines, September 2007. Source: Baffinland 2012a

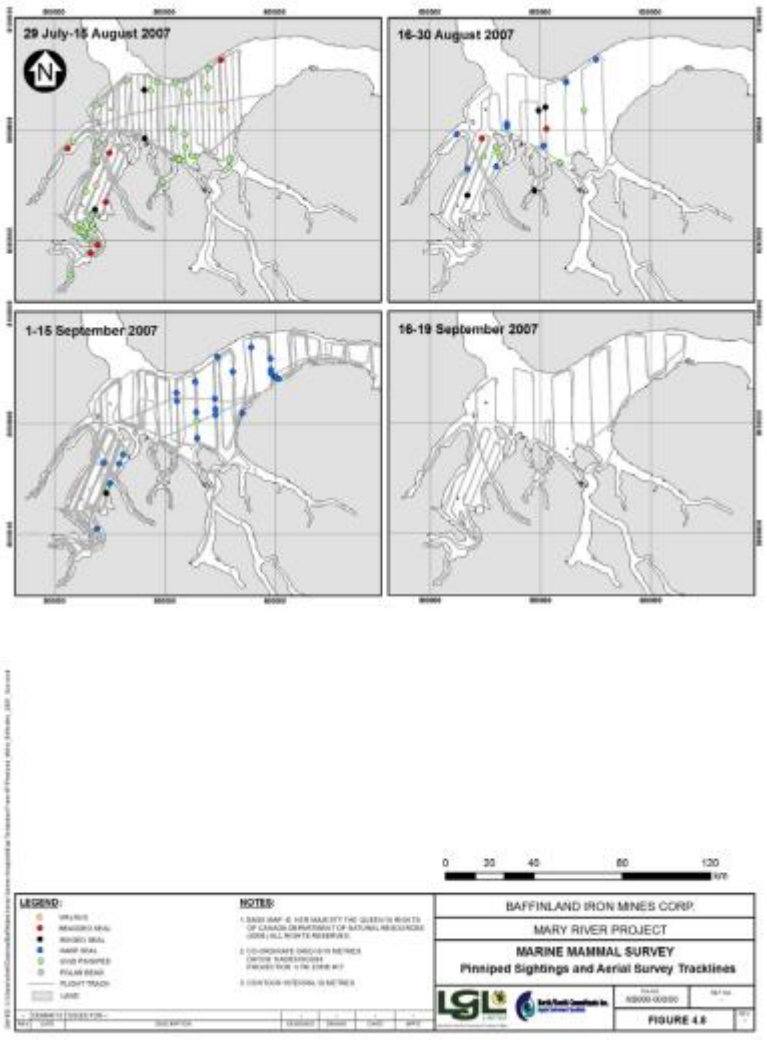

Figure 18: Seal, walrus and polar bear sightings, July through September 2007. Source: Baffinland 2012a

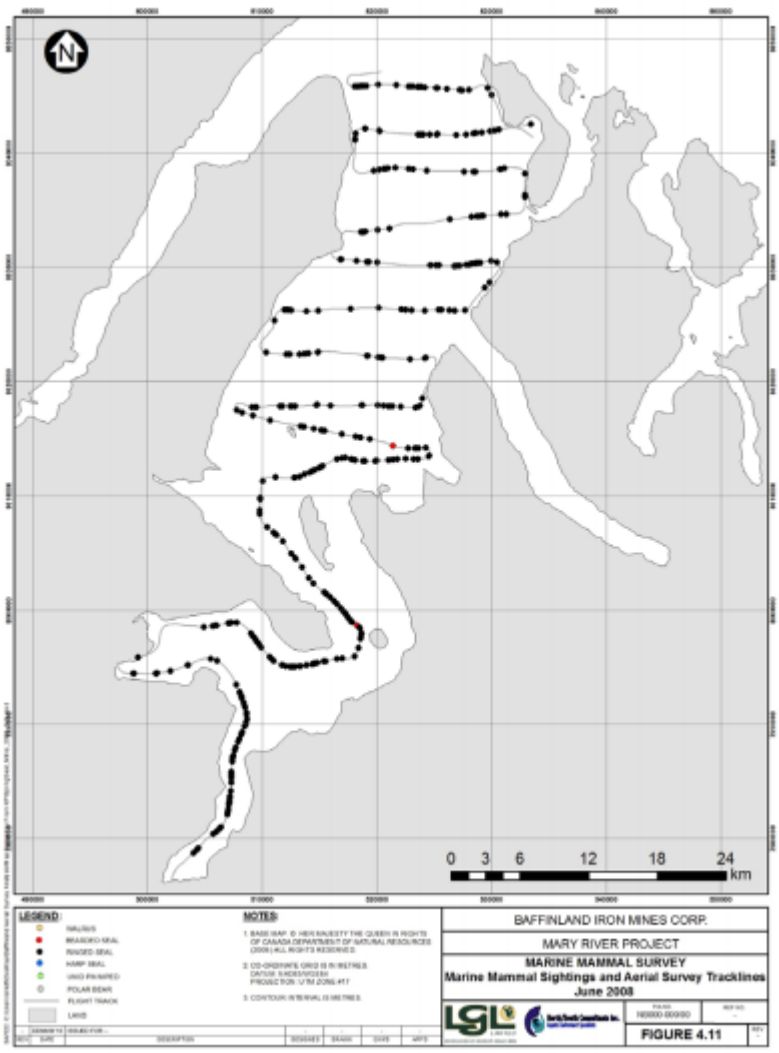

Figure 19: Seal, walrus and polar bear sightings and aerial survey tracklines in Milne Inlet, June 2008. Source: Baffinland 2012a

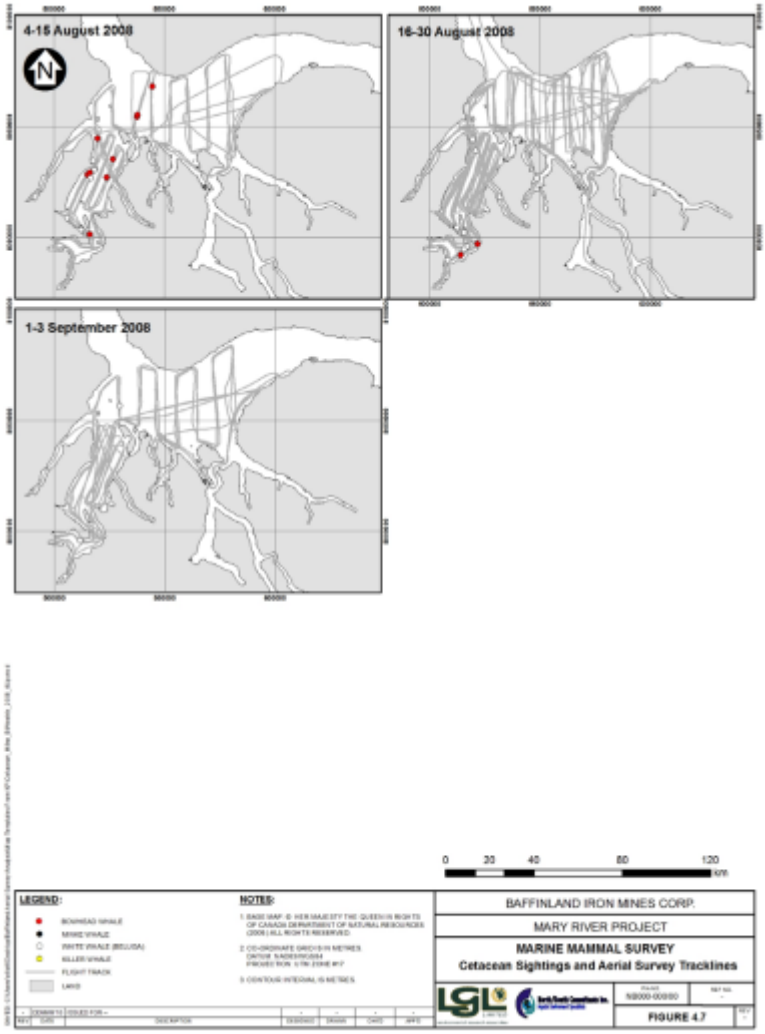

Figure 20. Whale sightings (narwhal excluded from figure) and aerial survey tracklines, August and September 2008. Source: Baffinland 2012a

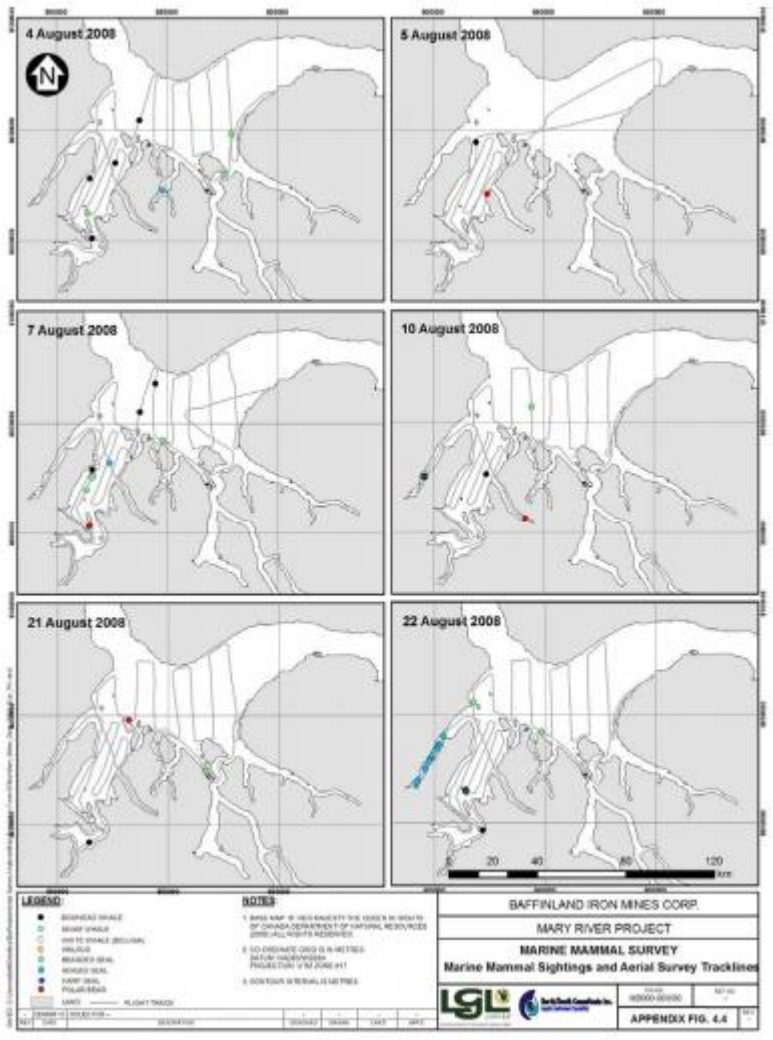

Figure 21: Marine mammal sightings (narwhal excluded) and aerial survey tracklines, August 2008. Source: Baffinland 2012a

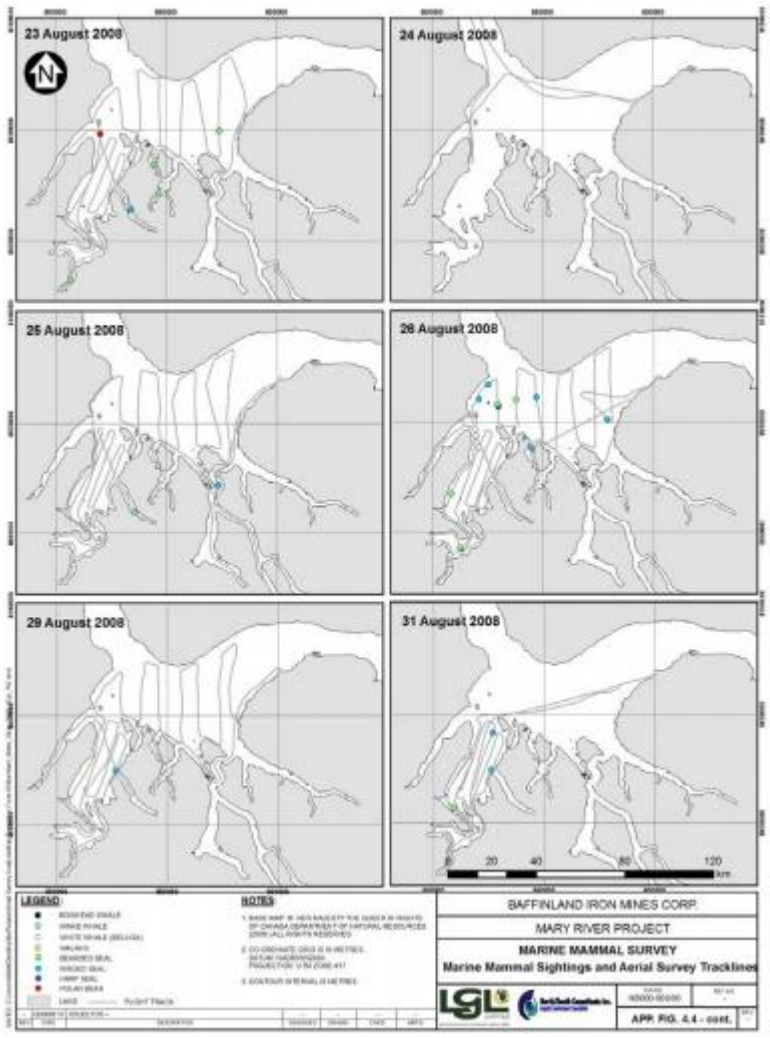

Figure 22: Marine mammal sightings (narwhal excluded) and aerial survey tracklines, August 2008. Source: Baffinland 2012a

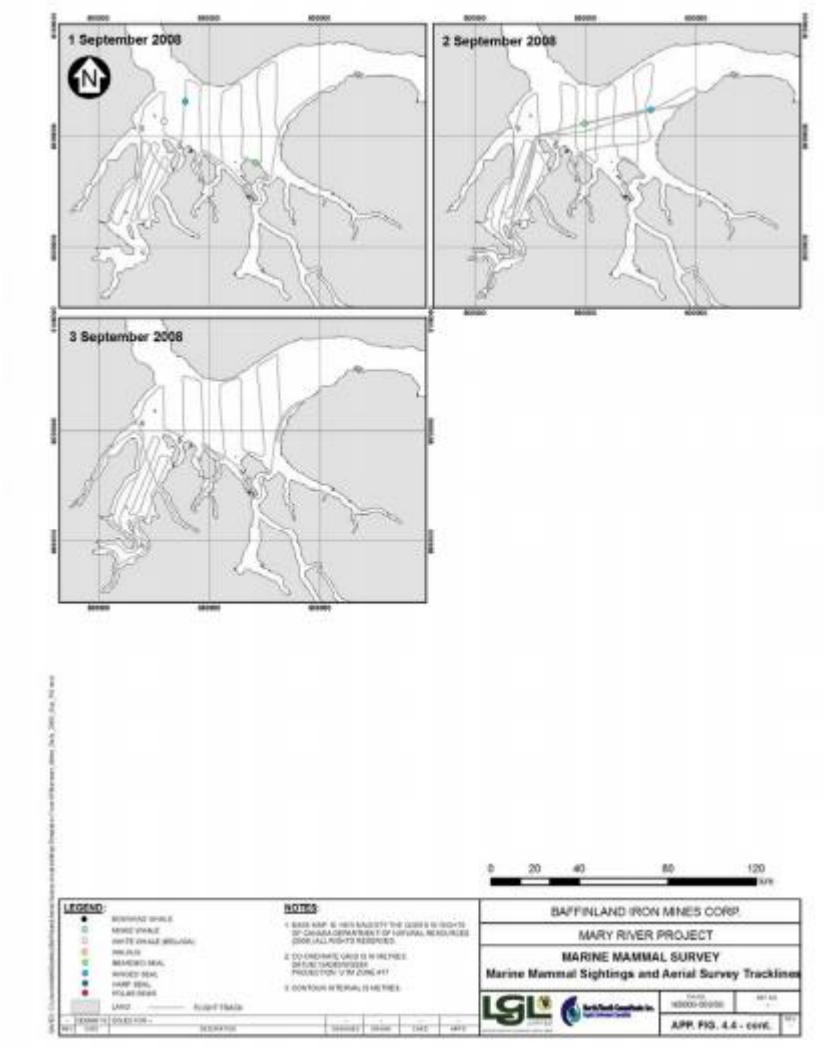

Figure 23: Marine mammal sightings (narwhal excluded) and aerial survey tracklines, September 2008. Source: Baffinland 2012a

3.2.1.2 How far away from the ship will marine mammals avoid it?

The wording of this question presupposes that marine mammals avoid ships, but the question of whether avoidance occurs or not should be addressed first, leading to the supplemental question in Section 3.2.1.2.1.

3.2.1.2.1 [Supplemental question]: Do marine mammals avoid ships?

Several approaches were used by Baffinland in 2015 to evaluate the distribution and abundance of marine mammals in response to ships.

- An 'extensive' aerial survey program, similar to those undertaken in 2013 and 2014
- A more focused photographic survey program to compare narwhal densities Before/During/After ship passage
- Bruce Head shore-based visual surveys. (Behavioural responses of narwhals were also studied but will be discussed in Section 3.2.2.

Statistical analysis of narwhal distribution in the 2015 extensive and photographic surveys (LGL 2016a) was critiqued by Golder (2016). A number of issues with both analyses and with data gaps were identified, and because of these Golder considers the response of narwhals to large ships along Baffinland's shipping route is inconclusive.

In both the extensive and photographic aerial surveys in 2015, orientation of the transects parallel to the long axis of Milne Inlet and Tremblay Sound, and to the shipping track in Milne Inlet (Figure 4) may lead to significant biases. As any behaviour displacement disturbance would be expected to generally follow a line of travel perpendicular to the vessel, a spatially weighted selection of perpendicular transects or a zig zag pattern would provide more reliable data with respect to shipping disturbance.

With respect to the extensive aerial survey, among other issues that affected the results of the LGL analysis, the occurrence of hunting in the study area was not accounted for in the statistical analysis, and geographic strata with no shipping were included in the analysis. The conclusion of LGL (2016a) that 11 times more narwhals when no vessels were present compared to when more than two vessels were present is based on this flawed analysis and is questionable. As identified in Section 3.2.1.1, densities of narwhals are extremely variable both spatially and temporally. Much care is needed before drawing conclusions with correlation types of analysis, such as the extensive aerial survey, where no specific treatment effect has been controlled in an experimental design. There are inconsistencies in apparently significant findings, such as the stated avoidance of vessels but absence of significant differences in abundance between years with high versus low vessel densities. LGL did acknowledge the existence of many of these problems, but their importance in potentially invalidating the statistical findings is not sufficiently stressed in the LGL report.

It should be noted also that only a single replicate per two-week survey period was collected in 2015, but two replicates were generally collected in 2013 and 2014. Given the large temporal variance of narwhal distribution and abundance between replicates collected in a single survey period, the single-replicate approach may over- or under-estimate narwhal abundance by a factor which may be as high as 70, based on empirical data (Figure 11).

Issues with the statistical analysis of the photographic aerial surveys by LGL (2016a), are similar to those identified for the extensive aerial survey. In addition, there are some issues specific to the photographic survey. For example, distance to the narwhals was determined from the closest approach between the narwhal and the ship trackline rather than the distance between the narwhal and the actual ship position. In some cases, the distance between the narwhal and the ship trackline was measured through a land barrier (Stephens Island). The main difficulty with the analysis, however, is the absence of complete Before/During/After surveys for Milne Inlet, as required by the statistical design, for any ship transit.

During the four photographic surveys, there was never more than one ore carrier actively transiting Milne Inlet at any given time, but there were two days when two to three large vessels were active in Milne Inlet on the same day (30 August and 4 September). Small vessels were active in Milne Inlet during all surveys and on some dates narwhal hunts were underway. Other large vessels, including cruise ships and ore carriers were present in Eclipse Sound during the surveys (Table 9).

Table 9: Summary of photographic aerial surveys conducted in 2015

Survey Date	Active vessels	Vessel movements	Milne Inlet Surveys (times)	Tremblay Sound Surveys (times)
18 Aug.	Ore carrier M/V *Golden Ice*	Departed Milne Port, transited northbound through Milne Inlet	Before (1358-1443h) Before/During (1929-2014h)	Surveyed (time not specified) but the photos were not analysed
	6 small boats; no hunting observed	Milne Inlet		
	Tug M/V *Svitzer Nerthus*	Active in Assomption Harbour		
	Tug M/V *Svitzer Njal*	Active in Assomption Harbour		
	Sailboat	Active south of Ragged Island		
	Cruise ship M/V *Academik Ioffe* Ore carrier M/V *Golden Saguenay* Sailboat Aventura Ore carrier M/V *Nordic Olympic*	In Eclipse Sound, Pond Inlet, and/or Navy Board Inlet		
22 Aug.	Ore carrier M/V *Nordic Odyssey*	Transited northbound through Milne Inlet into Eclipse Sound (out of survey area approx. 1315h)	6 replicates surveyed between 0814 and 1456h	During (1306-1316h) After (1501-1512h)
	1 small boat; no hunting observed	Milne Inlet		
	Ore carrier M/V *Nordic Olympic*	Circling in Eclipse Sound waiting for anchorage at Ragged Island		

Survey Date	Active vessels	Vessel movements	Milne Inlet Surveys (times)	Tremblay Sound Surveys (times)
30 Aug.	Ore carrier M/V *Golden Saguenay*	Before survey, southbound in Milne Inlet from Ragged Island During survey, south of Bruce Head, southbound (0833-1125h)		
	Ore carrier M/V *Nordic Oshima*	Southbound in Milne Inlet to Ragged Island (1340-1458h)	During (1339-1426h) After (1610-1657h) After (1701-1747h)	Before (1326-1334h) During (1435-1446h) After (1755-1805h)
	2 hunting boats	Milne Inlet		
	Cruise ship M/V *Akademik Ioffe* Cruise ship M/V *Le Soleal* Cruise ship M/V *Sea Explorer I* Ore carrier M/V *Nordic Orion*	Outside of Milne Inlet		
4 Sept.	Ore carrier M/V *Golden Brilliant*	Northbound through Milne Inlet into Eclipse Sound (1027-1310h)	Before/During (0952-1038h) During (1041-1123h) During (1127-1210h) During (1214-1300h)	Not surveyed
	Ore carrier M/V *Nordic Oshima*	Southbound from Ragged Island anchorage through Milne Inlet (1353-1608h)	During (1416-1502h) During (1506-1553h) During/After (1556-1643h)	
	Ore carrier M/V *Golden Ruby*	Southbound through Milne Inlet to Ragged Island anchorage (1652-1800h)	After Nordic Oshima/During Golden Ruby (1646-1732h)	
	19 sightings of small boats; 1 was close to the narwhal herd for first 4 replicates; 7 sightings of hunting vessels during last 4 replicates; narwhal carcass observed			
	Cargo ship M/V *Anna Desgagnes*	Westbound from Pond Inlet to southern Navy Board Inlet		

Two of the four surveys had surveys conducted in matching time periods for both Milne Inlet and Tremblay Sound (highlighted rows in Table 10). There were no matched Before data for any of the surveys.

Table 10: Narwhal densities determined from photographic surveys. No confidence limit is presented for 18 August survey as the confidence limit given in the 2015 survey report contains a mistake and does not include the mean value.

Date	Vessel and movement	Milne Inlet		Tremblay Sound	
		Time of survey	Indiv./km^2 Mean (95%CL)	Time of survey	Indiv./km^2 Mean (95%CL)
18 Aug.	Ore carrier M/V *Golden Ice* - Departed Milne Port, transited northbound through Milne Inlet	Before (1358-1443h)	0.11 (no CL)	Before	No data (photos not analysed)
		Before/During (1929-2014h)	0.46 (no CL)	Before/During	No data (photos not analysed)
22 Aug.	Ore carrier M/V *Nordic Odyssey* - Transited northbound through Milne Inlet into Eclipse Sound (start time not reported; ship left survey area approx. 1315h)	Before (surveys started at 0814, which is presumed to be during the Before period) (6 replicates were surveyed between 0814 and 1456h, no narwhals were observed)	0	Before	No data
		During	0	During (1306-1316h)	22.71 (8.55-60.29)
		After (last replicate occurred at 1456h)	0	After (1501-1512h)	28.20 (10.37-76.66)
30 Aug.	Ore carrier M/V *Golden Saguenay* - Before survey, southbound in Milne Inlet from Ragged Island During survey, already south of Bruce Head (0833-1125h)	Before / During / After	No data	Before / During / After	No data
	Ore carrier M/V *Nordic Oshima* - Southbound in Milne Inlet to Ragged Island (1340-1458h)	Before	No data	Before (1326-1334h)	5.95 (2.63-13.47)
		During (1339-1426h)	0.16 (0.02-1.64)	During (1435-1446h)	80.50 (29.68-218.33)
		After (1610-1657h)	1.04 (0.09-12.68)	After	No data
		After (1701-1747h)	6.58 (0.52-83.55)	After (1755-1805h)	40.70 (15.01-110.35)

Date	Vessel and movement	Milne Inlet		Tremblay Sound	
		Time of survey	Indiv./km^2 Mean (95%CL)	Time of survey	Indiv./km^2 Mean (95%CL)
4 Sep.	Ore carrier M/V *Golden Brilliant* - Northbound through Milne Inlet into Eclipse Sound (1027-1310h)	Before/During (0952-1038h)	2.28 (0.25-20.99)	Before/During	No data
		During (1041-1123h)	4.33 (0.62-30.08)	During	No data
		During (1127-1210h)	2.81 (0.40-19.91)		
		During (1214-1300h)	6.35 (0.77-52.68)		
	Ore carrier M/V Nordic Oshima - Southbound from Ragged Island anchorage through Milne Inlet (1353-1608h)	During (1416-1502h)	1.85 (0.21-16.07)	During	No data
		During (1506-1553h)	2.98 (0.64-13.91)		
		During/After (1556-1643h)	1.12 (0.31-4.12)	During/After	No data
	Ore carrier M/V *Golden Ruby* - Southbound through Milne Inlet to Ragged Island anchorage (1652-1800h)	After *Nordic Oshima*/During Golden Ruby (1646-1732h)	0.23 (0.02-2.89)	After/During	No data

Bruce Head shore-based narwhal observation data has been recorded in relation to ship transits each year since 2013.

In 2013, a pilot study was conducted at Bruce Head from 6 to 26 August. The numbers of narwhals counted in the study area varied from day to day in August (Figure 24) and narwhals tended to be mostly located in the southern portion of the study area. The average number of sightings and individuals per count were 28.0 and 44.6, respectively. On three days, no narwhals were seen during abundance counts. On 13 and 14 August, total daily counts of 1,031 and 1,911 narwhals were observed in the study, representing 87% of all narwhals observed during the study. Three large vessels transited during the study area, of which two transited through the study area during periods when abundance counts were conducted with suitable sighting conditions (Table 11).

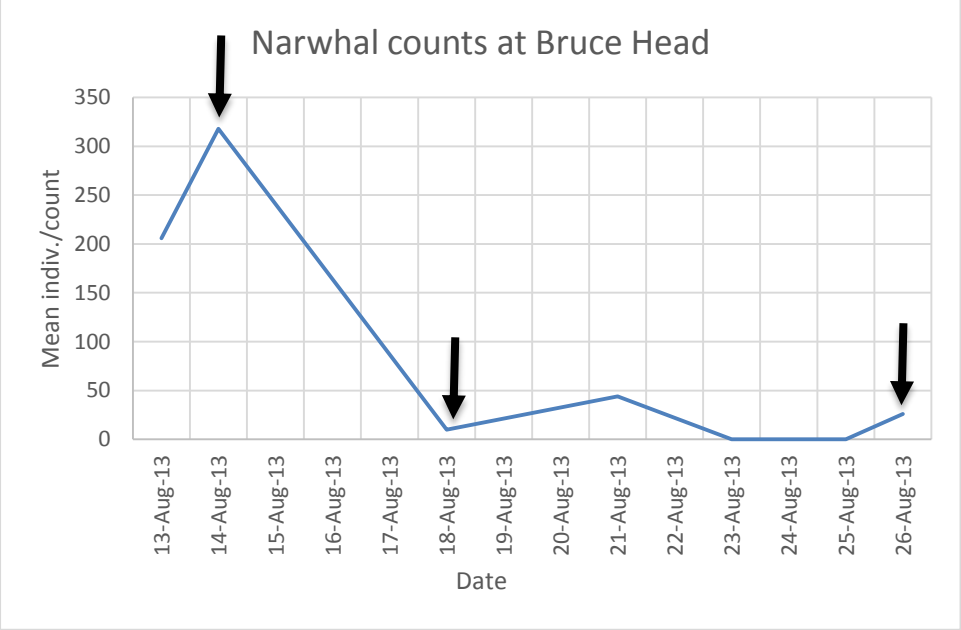

Figure 24: Mean daily count of narwhals at Bruce Head in 2013. Arrows indicate dates when large ships were observed transiting Milne Inlet. Modified from LGL (2014a)

Table 11: Narwhal counts from Bruce Head on two dates in 2013 with large vessel transits

Date	Average number of narwhals/count	
	Vessel presence	**Post-vessel**
14 Aug 2013	309.5 (during second vessel transit of the day)	277 (after second vessel transit of the day)
26 Aug 2013	20.5	5

Two sequential large vessel transits occurred on 14 August (Figure 25). The Baffinland-chartered large vessel, M/T *Jana Desgagnés*, passed through the study area at approximately 08:00, before the start of narwhal observations for the day. The largest counts of narwhals (~400) that were observed from Bruce Head were recorded in the two observation periods, at approximately 11:00-13:00, before the second vessel passage. A large cruise ship, the *Sea Adventurer,* passed through the study area during 13:44–14:55. The narwhal count decreased to ~220 narwhals when the vessel was in the study area, and remained between 250–300 narwhals in the two post-vessel counts. The second post-vessel count was made when sightability was poor, after which the study team departed the observation site. The numbers recorded during the post-vessel counts that day were some of the highest numbers recorded during any abundance count throughout the entire study period (Figure 24). In addition, four large vessels had transited through the area during the six days preceding the highest counts of the study period, 13 and 14 August.

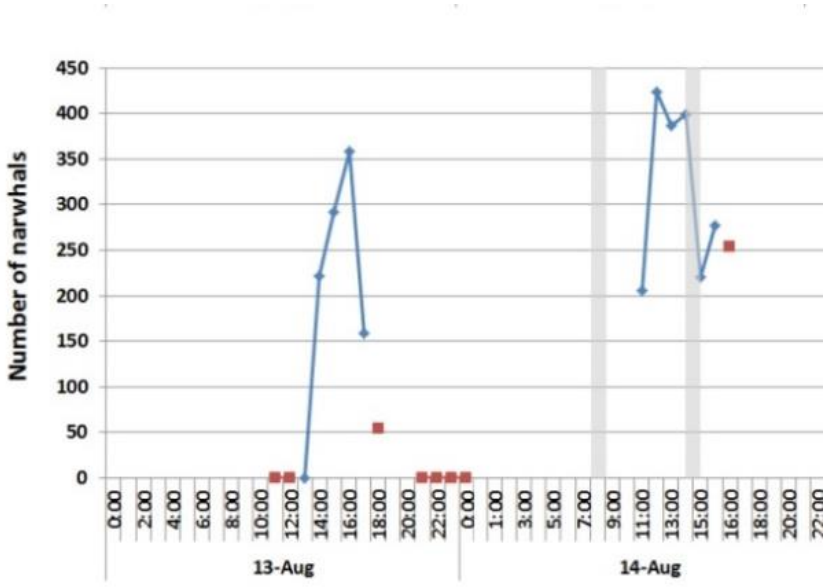

Figure 25: Narwhal counts from Bruce Head before, during and after transit of two large vessels on 14 August 2013. Grey bars indicate times when large vessels were present. Narwhal counts are in blue or red (good and poor sightability, respectively). Source: LGL (2016a)

The Baffinland cargo vessel M/V *Avataq* transited through the study area on 26 August from 18:39–19:30 (Figure 21). The number of narwhals recorded during abundance counts was low throughout the day, and decreased from a maximum of ~50 narwhals (mean of approximately 20 narwhals/count) to ~5 narwhals following the vessel passage (Figure 26). The overall number of narwhals observed during abundance counts in the preceding week had also been low, with small peaks of >50 narwhals on 18 and 21 August.

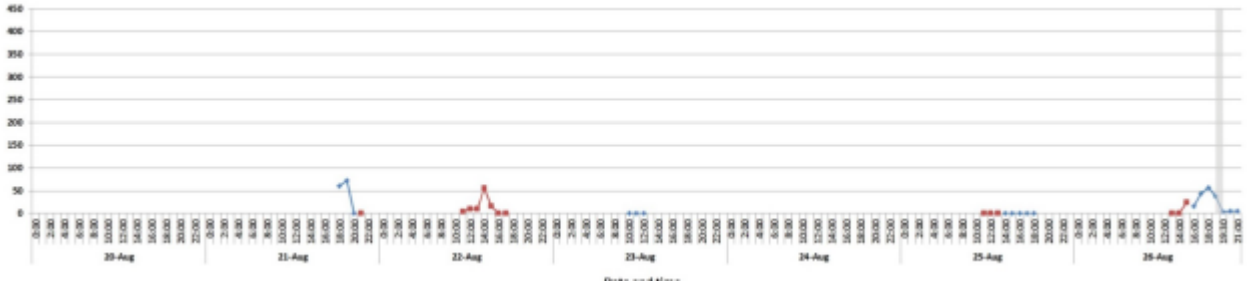

Figure 26: Narwhal counts from Bruce Head before and after transit of a large vessel on 26 August 2016. Source: LGL (2016a)

In the second year of the Bruce Head survey, data were collected from 30 July – 8 September 2014 (LGL 2015c).

Counts per observation period peaked on August 16 when more than 350 narwhals on average were seen in the study area during each count (Figure 27). Counts were highest during the period between 9 August 9 and 23 August.

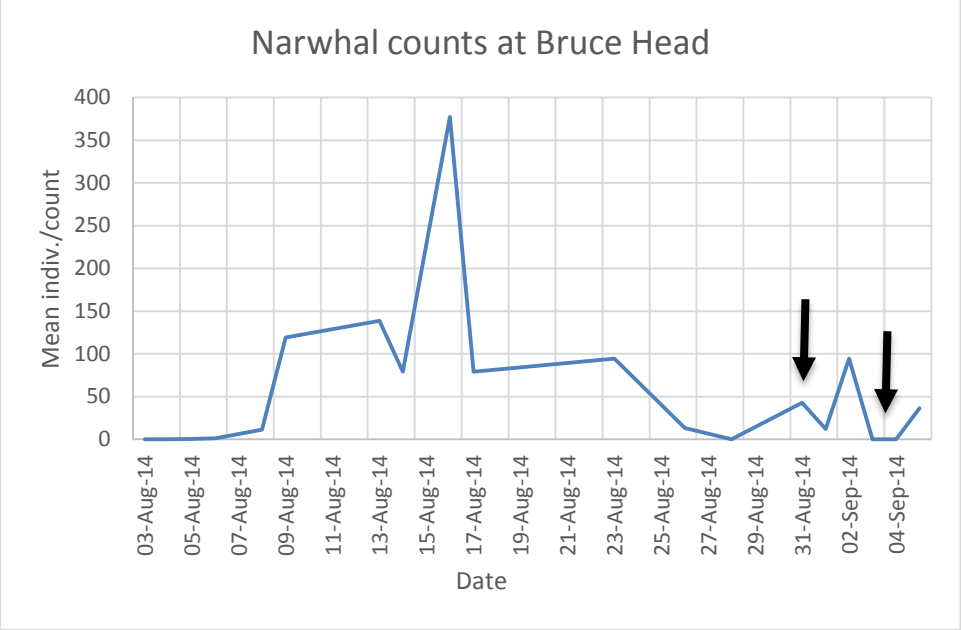

Figure 27: Mean narwhal count per observation period from Bruce Head in 2014. Black arrows indicate dates with large ship observations. Good and excellent sightability only. Modified from LGL (2015c).

Four large vessels chartered by Baffinland transited through the study area during periods when narwhal counts were attempted (Aug 15, 18, 31, and Sept 3). Of these four transits, only one occurred during periods when sighting conditions met criteria for inclusion in the analysis. Narwhal counts were also made when a large vessel (M/V *Akademik Ioffe)* chartered by an ecotourism operator was present. Narwhal abundance and distribution before, during, and after each of these transits is described below and shown in Figure 28.

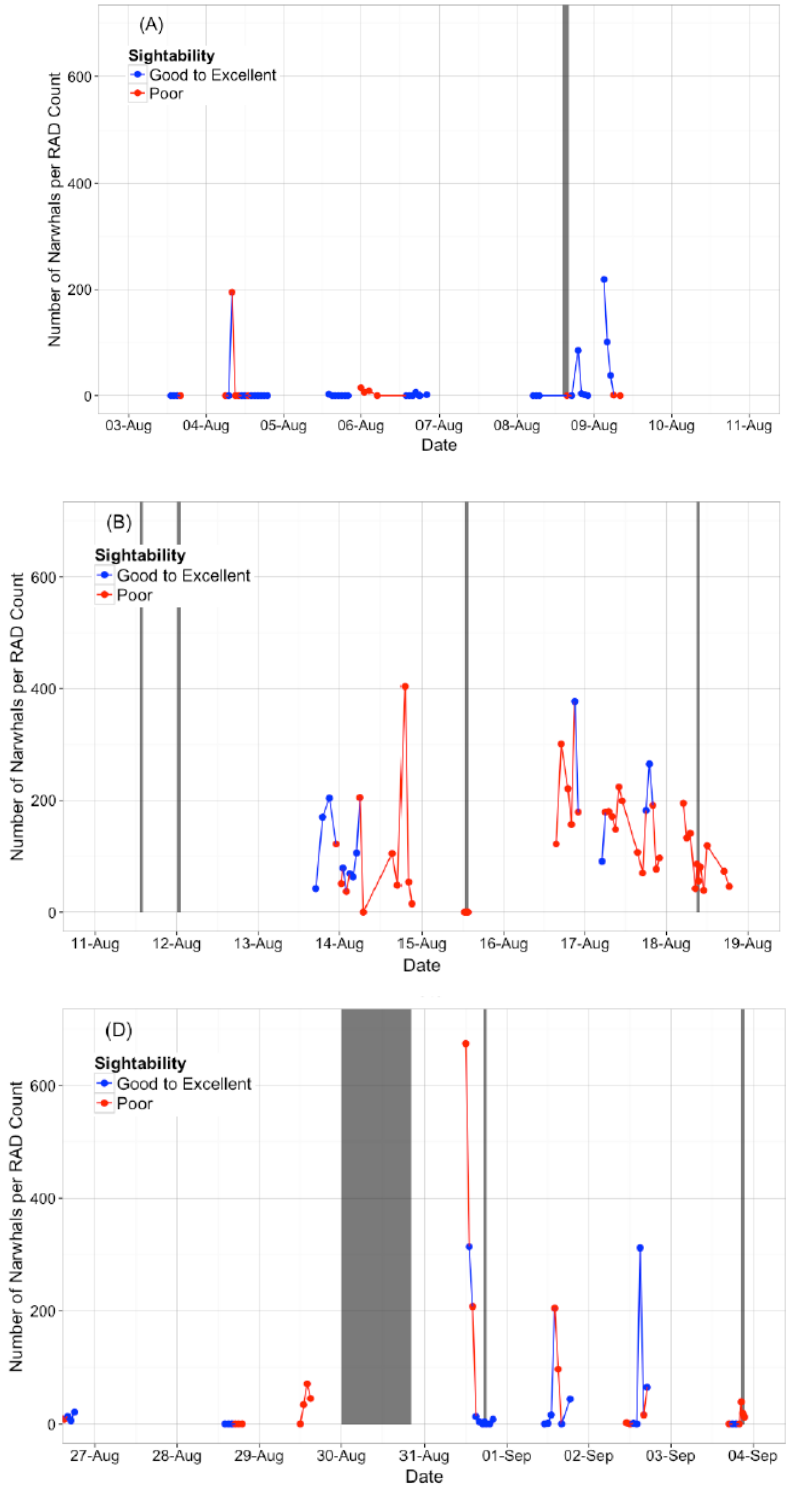

Figure 28: Narwhal counts from Bruce Head under good (blue) and poor (red) sightability conditions in 2014. Grey bars indicate large ship presence. Source: LGL (2015c)

During the period preceding 8 August, few narwhals were observed from Bruce Head (Figure 28). On 8 August, observers arrived at the observation site at 15:00 h and observed M/V Akademik Ioffe heading towards Koluktoo Bay. At 15:21, a count of narwhals was made under good and poor (snow flurries) sightability. No narwhals were observed. M/V Akademik Ioffe changed direction to head north. At 17:00, under conditions of good sightability, no narwhals were observed. No count was made at 18:00 because of rain. Hourly counts were made from 19:00 to 22:00 under good and excellent sightability and very few narwhals were observed. At 19:00, 85 narwhals were counted heading south in relatively large groups. At 20:00, one group of four narwhals was observed heading south; and one group of two narwhals was observed heading south at 21:00.

On 15 August, the M/T *Maria Desgagnés* transited south through the study area during high winds (30–42 km/h) and poor sightability. Pre (12:24 h), Centre (equivalent to During time period for aerial photographic study, with the vessel off Bruce Head) (12:55 h), and Post (13:32 h) counts were made, and no narwhals were observed.

On 18 August, narwhal counts were made hourly from 05:00 to 07:00 under conditions of good and poor sightability; between 100 and 200 narwhals were observed during all three counts and travel direction varied (south, north, and no direction). At 8:20, 42 narwhals were counted. The 08:20 count was still underway at 08:36 when a small fixed-wing aircraft flew north from Milne Inlet, circled low over the water (~100 ft) in stratum I, and then continued north through the SSA at an altitude of ~1000 ft. The “Pre” count commenced at 08:54 when the M/V *Claude A. Desgagnés* was visible to the south of Bruce Head. The majority of substrata had poor sightability; 86 narwhals were counted south of Bruce Head (heading north or with no travel direction). At 09:30, the “Centre” count commenced even though all substrata had poor sightability; 56 narwhals were counted heading south, in the area south of Bruce Head. At 15:00, 15 narwhals were counted north of Bruce Head (all under good or excellent sightability). At 16:00, a group of 4 narwhals was counted near the northern limit of the counted area.

On the same day, “Pre” (17:04), “Centre” (17:36) and “Post” (18:07) counts were made under conditions of good or excellent sightability as the M/V *Happy Delta* transited south. No narwhals were observed during the “Pre” and “Post” counts; a single narwhal north of Bruce Head and a group of 3 narwhals just southeast of Bruce Head were observed during the “Centre” count. No narwhals were observed during the 19:00 count. Eight narwhals south of Bruce Head and heading north were observed during the 20:00 count. An uncounted large number of narwhals were observed heading east out of Koluktoo Bay at the end of the 20:00 RAD count.

The northbound transit of the M/V *Happy Delta* was recorded late in the day of 3 September. No narwhals were observed at 17:00 under a variety of sighting conditions (excellent, good, poor, completely obscured by fog). Sightability was good to excellent by 18:00 but no narwhals observed. A small vessel (large canoe with outboard motor) was active during this count. At 19:00, no narwhals observed under good to excellent sightability. Hunting activity, including shooting at a seal, was observed at 19:10. At 20:00, no narwhals were observed; sightability was good or excellent. A “Pre” count was made at 20:43 under primarily good and excellent sightability; 39 narwhals were counted heading north in the area just south of Bruce Head, and a small vessel was present in the general area of the narwhals. At 21:12, a “Centre” count was made as the M/V *Happy Delta* transited north; sighting conditions had deteriorated on account of darkness such that many substrata had poor sightability; 19 narwhals were counted south of Bruce Head heading south. A “Post” count was attempted at 21:26, but was abandoned after counting 2 strata on account of poor sightability because of darkness. Twelve narwhals were counted south of Bruce Head, and travel direction varied (north, south, and no direction).

In 2015, shore-based monitoring took place at Bruce Head from 29 July to 5 September (LGL 2016b; Figure 29 through Figure 31). Ten ore carrier transits chartered by Baffinland were observed between 29 July and 5 September 2015. There were no observations of five additional ore carrier transits, four cargo vessel transits or one fuel tanker transit chartered by Baffinland.

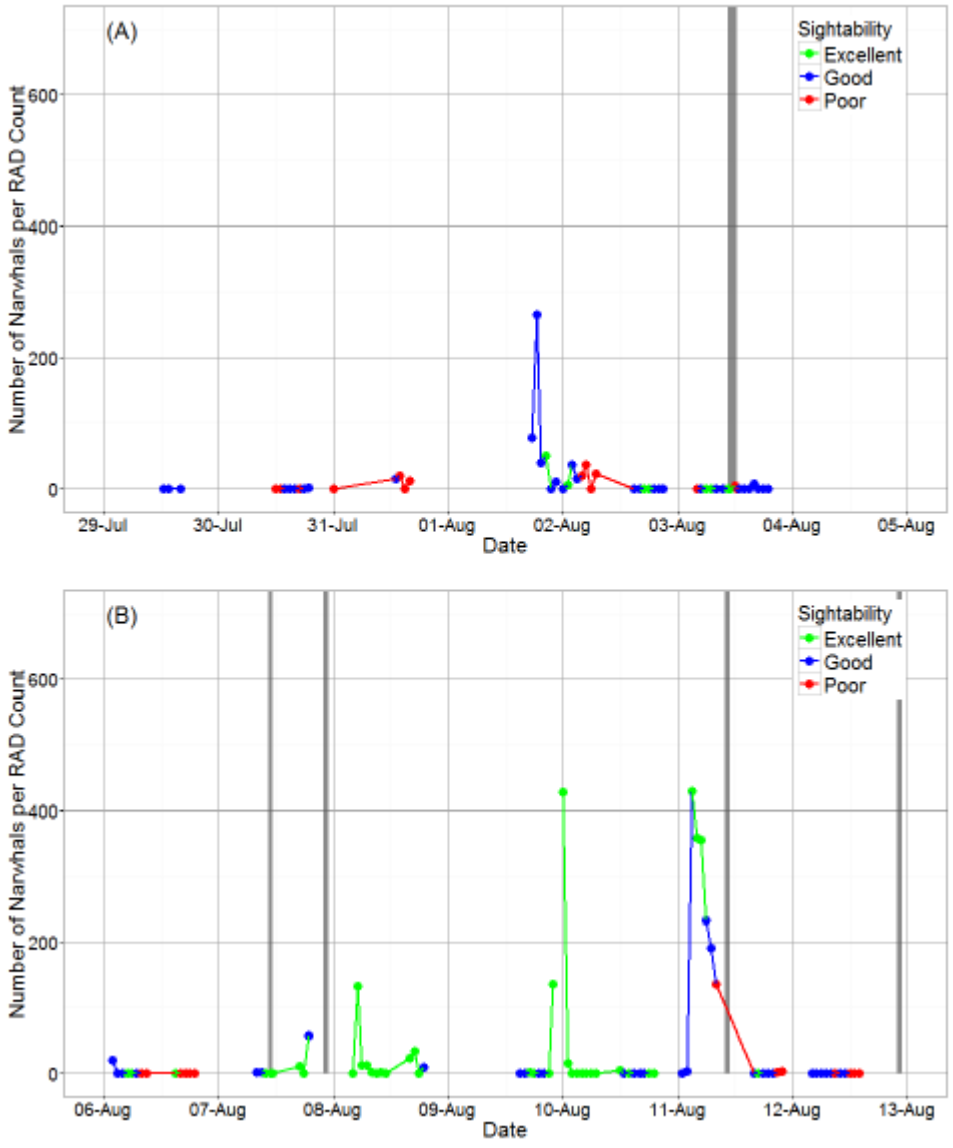

Figure 29: Narwhal counts from Bruce Head in 2015. Vertical lines indicate time 00:00 for each day, and the width of the grey shaded areas indicates the duration of large vessel presence in the study. Source: LGL (2016b)

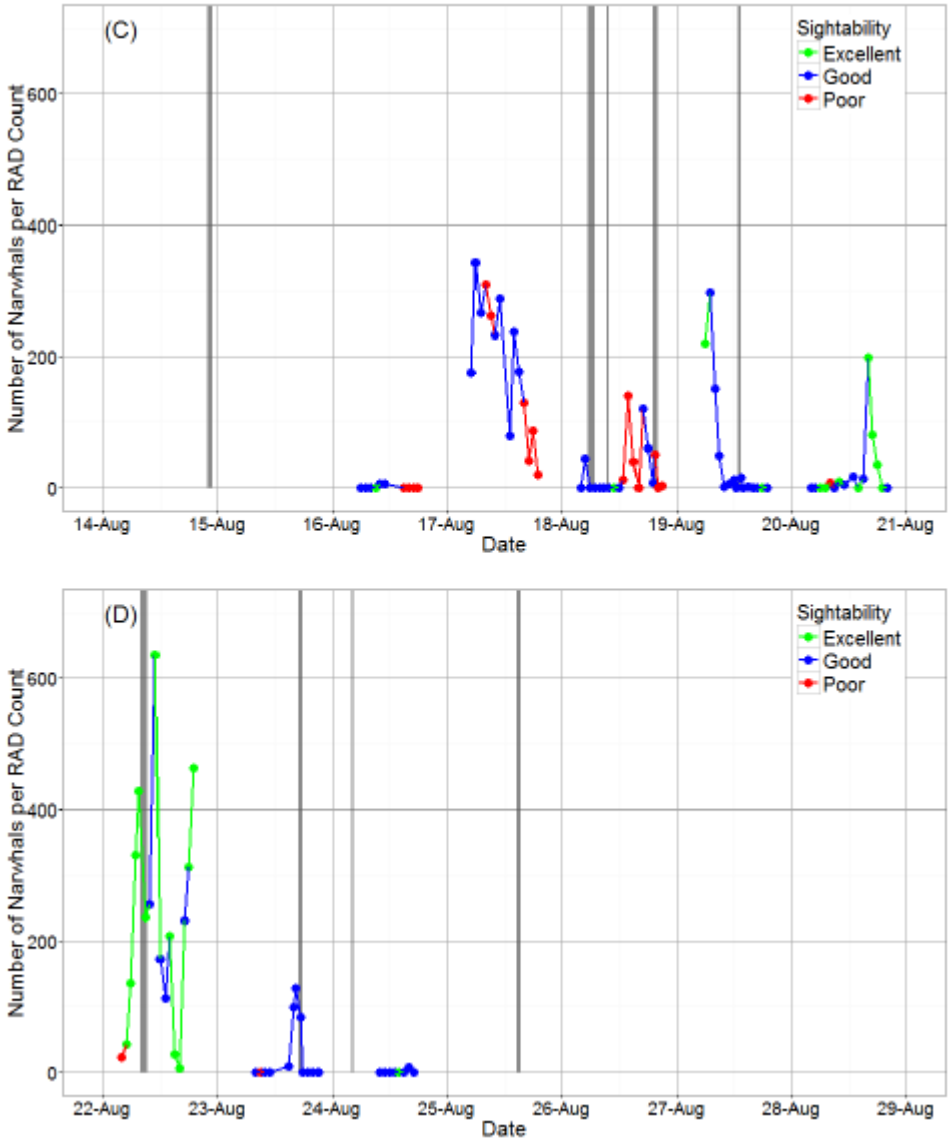

Figure 30: Narwhal counts from Bruce Head in 2015. Vertical lines indicate time 00:00 for each day, and the width of the grey shaded areas indicates the duration of large vessel presence in the study. Source: LGL (2016b)

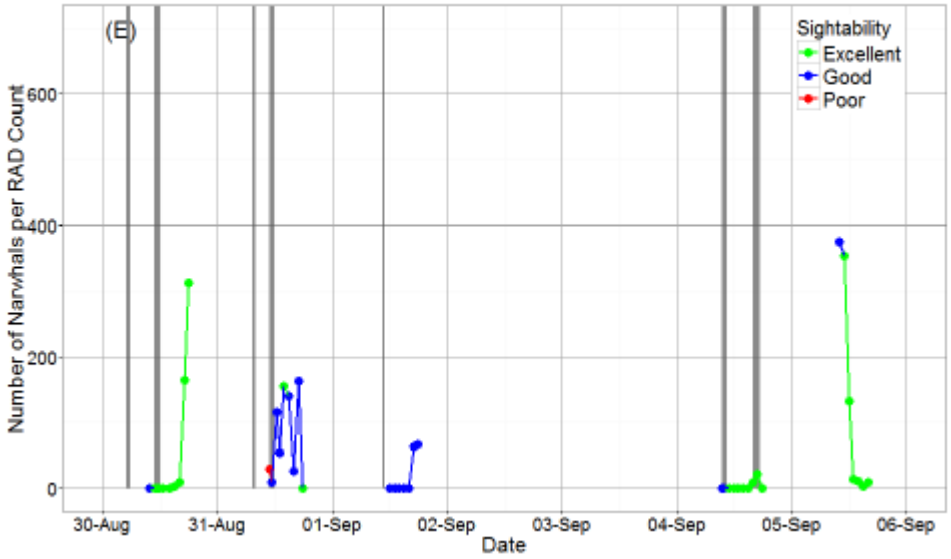

Figure 31: Narwhal counts from Bruce Head in 2015. Vertical lines indicate time 00:00 for each day, and the width of the grey shaded areas indicates the duration of large vessel presence in the study. Source: LGL (2016b)

Statistically significantly lower numbers of narwhals were observed when large vessels transited south vs. when large vessels were absent. Regardless of vessel presence or direction of vessel transit, a gradient in narwhal relative abundance was observed with the highest narwhal numbers in the southernmost strata. The lowest narwhal counts occurred when vessels transited south, and the highest narwhal counts occurred when large vessels transited north. The mean numbers of narwhals observed from Bruce Head were 5.8 (southbound large vessel transits), 25.0 (northbound large vessel transits north), and 17.7 (vessel absent). The highest counts overall occurred in the southernmost strata when large vessels transited north.

Passive acoustic monitoring of marine mammal calls conducted in 2014 (30 July to 26 September) and 2015 (2 August to 3 October) by Greeneridge (2015, 2016) may have detected fewer narwhal calls in the presence of ships. In each year, two acoustic monitoring devices were anchored in southern Milne Inlet, one near Bruce Head (ASAR-N) and the other near the mouth of Koluktoo Bay (ASAR-S). Greeneridge (2015) interpreted the details of the narwhal acoustic data during identified periods with reductions in narwhal calls and associated several of these events with medium or large vessel visits to Milne Inlet in 2014, as well as some reductions with no discernable cause (Greeneridge 2015):

- 5 August 2014: Narwhal calls were absent from both recorders on 5 August, although other sounds of unknown identity and classified as “other mammal” were detected. Acoustic masking by wind noise fails to account for the lack of detections on 5 August. The median wind speed on 5 August was 10.0 m/s, compared to 6 August (median wind speed = 9.0 m/s) and 8 August (median wind speed = 11.5 m/s), both days characterized by high call density. The apparent lack of narwhal calls is consistent with only three individuals being sighted during all seven counts on 5 August from Bruce Head. Bruce Head observers recorded sightability as being good or excellent on August 5. Visual observation logs from Bruce Head noted that the S/V *Bagheera*, a 15.7 m sailing yacht with a 105 HP engine, was in the vicinity beginning on 5 August (first sighting noted at 14:07, although the vessel may have arrived earlier). The *Bagheera* remained in the

area and was last documented on 6 August at 15:36. Narwhal calls resumed near ASAR-S on 6 August at 13:50 and near ASAR-N on 6 August at 16:48.

- 19 August 2014: Narwhal calls decreased to “few” around early afternoon 18 August, dropped to “none” from midafternoon 19 August through mid-afternoon 20 August, and increased steadily beginning around late evening 20 August on ASAR-S. A similar trend was seen on ASAR-N. During this period, AIS data indicate that the ecotourism vessel *Akademik Ioffe* was in the vicinity, reaching its closest point of approach to the recorders at 368 m of ASAR-N on 19 August at 22:40 EDT.
- 7 September 2014: Narwhal calls were also conspicuously absent from both recorders all day on 7 September. The Bruce Head visual monitoring study had concluded by this date, so no visual data exist to shed light on narwhal presence or absence during this period of silence.
- 12 September 2014: Narwhal call detections fell to few or none beginning 12 September on ASAR-N.
- 18 September 2014: Narwhal call detections fell to few or none beginning 18 September on ASAR-S. Based on AIS data, the Canadian Coast Guard icebreaker *Pierre Radisson* was anchored in Milne Inlet from 18 September until the end of the ASAR recordings.

Greeneridge (2015) concluded that masking of narwhal call detections by vessel sounds might account to some degree for the low numbers of narwhal calls on 19 to 20 August and 18 September when vessels were known to be present, and that the overall decline in call detections in September may also be attributable to narwhals migrating out of the Inlet (Table 12) or from Bruce Head (Figure 28) on these dates, Golder suggests the following reinterpretations:

- 5 August 2014: Very few narwhals were detected in Milne Inlet and none in Koluktoo Bay or Tremblay Sound during aerial surveys conducted from 1 to 4 August. With the exception of a single count of 200 narwhals on 4 August, no narwhals were observed from Bruce Head on 3 and 4 August and only a few the morning of 5 August. Given that virtually no narwhals were present for several days before the arrival of the S/V Bagheera in the afternoon of 5 August, it is unlikely that the presence of this vessel was the cause of the low detection of narwhal calls.
- 19 August 2014: Aerial surveys detected a high density of narwhals in Milne Inlet South and Koluktoo Bay during 14 to 15 August, followed by an order of magnitude decline on 16 to 17 August. The lowest narwhal counts from Bruce Head during the period 18 to 20 August occurred while the Akademik Ioffe was nearby, increased, and then decreased again several hours after its departure. Sightability was poor during this series of observations, but the results are consistent with the acoustic survey conclusion that narwhal may have been absent from Milne Inlet during the visit by the Akademik Ioffe.
- 7 September 2014: Bruce Head observations had concluded by this date, and it was midway between two aerial survey periods. High densities of narwhals were observed in Milne Inlet South in the 1 to 2 September aerial survey, but narwhals were absent by the next survey on 14 to 15 September through the last survey on 21 to 22 October. No narwhals were observed in Koluktoo Bay after 30 to 31 August. Thus the low number of narwhal calls on 7 September may have simply reflected the seasonal migration of narwhals out of the Milne Inlet area.
- 12 September 2014: The cessation of narwhal calls is most likely due to seasonal migration.
- 18 September 2014: The cessation of narwhal calls is most likely due to seasonal migration.

Table 12: Density of narwhals (individuals/km^2) determined from aerial surveys in 2014. Modified after LGL (2015b)

Geographic Stratum	Density of Narwhal (individuals/km^2)											
	1-2 Aug.	3-4 Aug.	14-15 Aug.	16-17 Aug.	30-31 Aug.	1-2 Sep.	14-15 Sep.	16-17 Sep.	29-30 Sep.	1-2 Oct.	17-20 Oct.	21-22 Oct.
Milne Inlet South	0	0	10.16	1.52	2.33	21.28	0	0	0	0	0	0
Milne Inlet North	0.02	0	1.66	2.27	2.8	11	0.03	0.32	0.01	0	0	0
Koluktoo Bay	0	0	5.62	0.27	0.63	0	0	0	0	0	0	0
Tremblay Sound	0	0	1.81	0.16	0.09	6.39	0	0	0	0.51	0	NA
Eclipse Sound West	0.26	0.34	2.51	0	0	0	0	1.97	0.03	0.07	0	0
Eclipse Sound East	0.1	0.54	0	0.01	0	0	0.19	0.06	0	0	0	0.18
Pond Inlet	0.23	0.2	0	0	0	0	0	0	0	0.01	1.27	0.33
Navy Board Inlet	0	0	0.01	0	0	0	0	0.02	0.09	0.19	0	0

3.2.1.2.2 Distance of response by narwhals to vessels

The nearest distance of approach of marine mammals to the large vessel from which shipboard observing was taking place was determined for most sightings by the observer (SEM 2013, 2014a, 2016). Twelve of the 13 narwhals observed were estimated to be within a distance of ≤100 m of the vessel (Figure 32). The reaction of the narwhals to the vessel was not recorded.

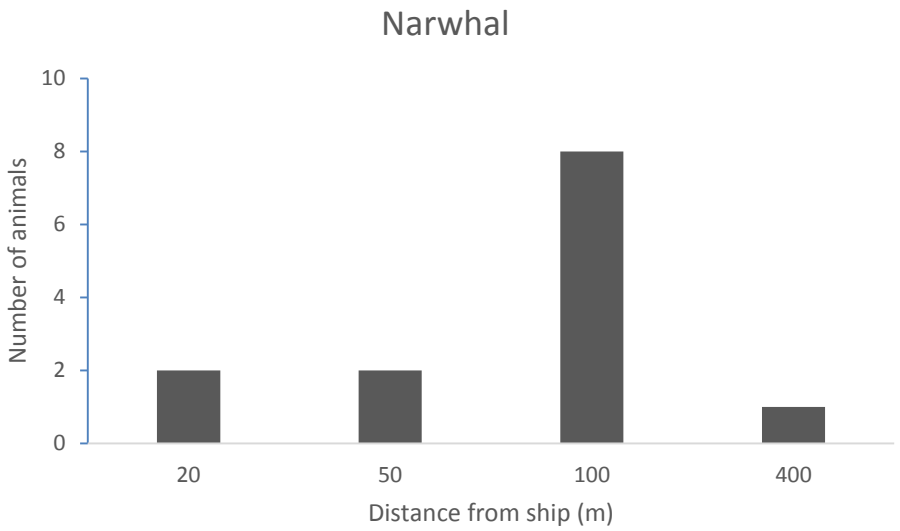

Figure 32: Estimated distance of narwhals from large vessel during shipboard observer surveys, 2013 to 2015.

More than half of the narwhals observed from Bruce Head in 2015 exhibited no observable response to the presence of large vessels (~58% of focal groups) (Figure 33). Of the responses recorded in the presence of large vessels, the most common was an increase in swimming velocity away from the vessel. On one occasion a narwhal approached a vessel: it swam toward the vessel head on, stopped, turned perpendicular to the vessel (twice), and then at a distance of 3.3 km from the vessel it swam perpendicularly away from the vessel. No observable response was documented for narwhals in the presence of medium and small vessels (LGL 2016a).

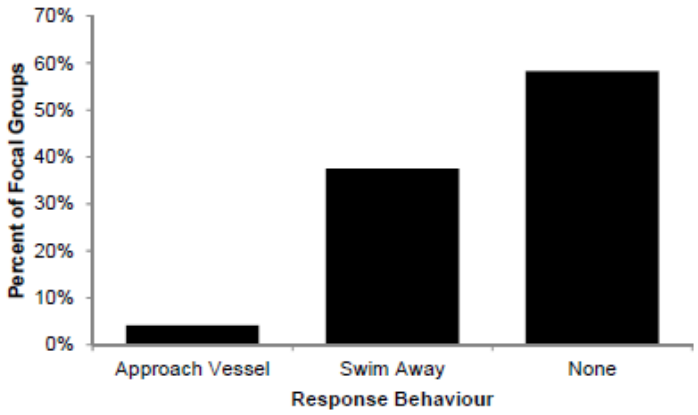

Figure 33: Behavioural response of narwhal focal groups to large vessel presence in 2015. Source: LGL (2016a)

Qualitative notes recorded by observers at Bruce Head in 2013 stated that narwhals moved away when a vessel was present and that this effect was more pronounced when the larger fuel and cargo vessels contracted by Baffinland were present versus the military vessel that was observed (LGL 2014a). This difference in response was attributed to the louder engine noise of the fuel and cargo vessels versus the military vessel. In response to the fuel and cargo vessels, narwhals were reported to move from the area near Bruce Head to the Koluktoo Bay area. It was noted that the military vessel "did not really bother narwhals".

During a vessel transit on 14 August 2013 observed from Bruce Head, the cruise ship Sea Adventurer approached within 2-3 km of a group of narwhals before eliciting a reaction (Figure 34). The group turned perpendicular to the ship's track and swam toward Bruce Head.

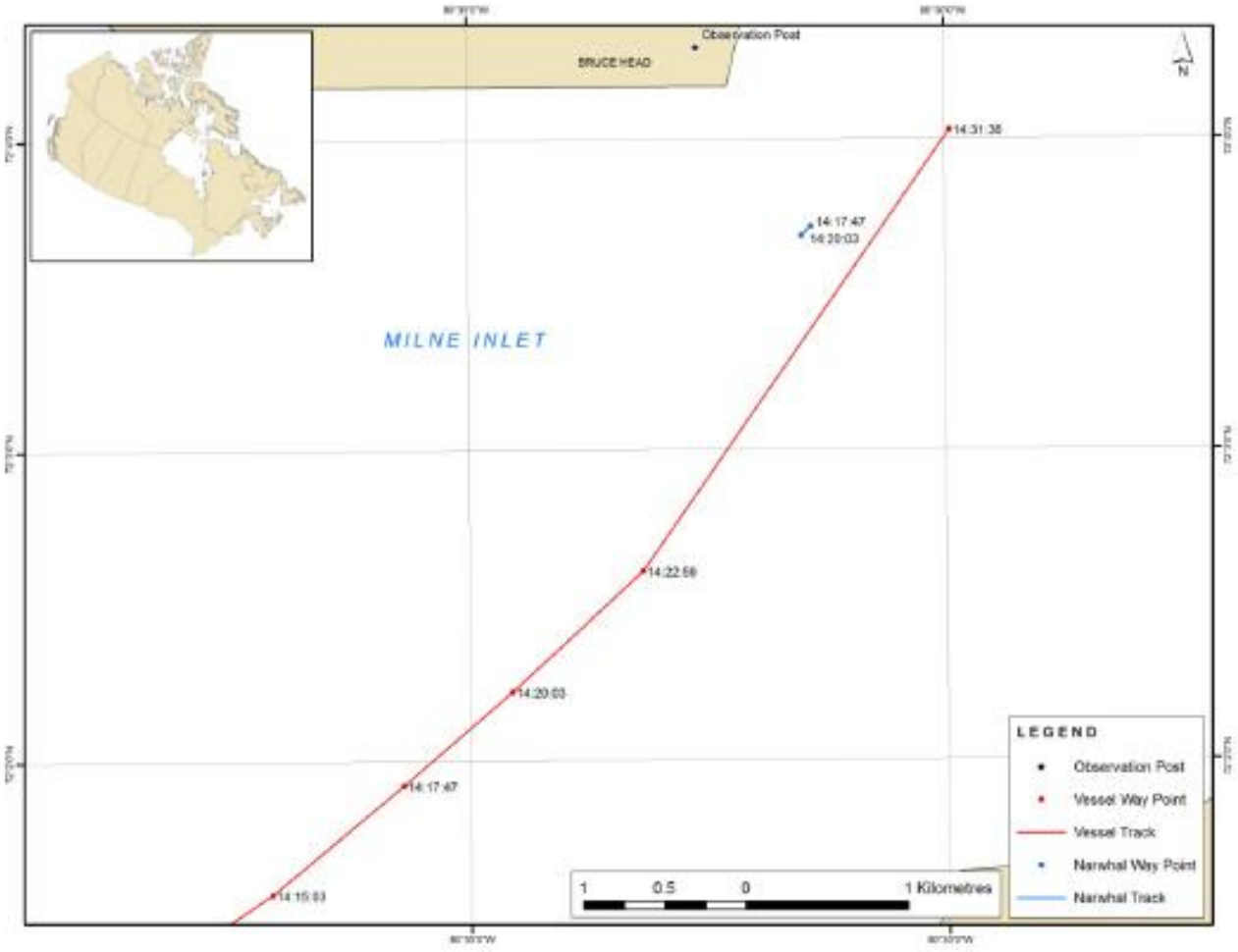

Figure 34: Narwhal position relative to vessel observations near Bruce Head on 14 August 2013. Times are shown for both the narwhal focal group and the vessel (cruise ship Sea Adventurer) as the vessel transited through the study area. After 14:20:03, the focal group turned perpendicular to the vessel trackline and swam toward Bruce Head (not shown on this plot). Source: LGL (2016a)

During another observation made from Bruce Head on 26 August 2013, the vessel approached within approximately 1 km of the narwhals before the end of the observation of this group (Figure 35). No information was provided on the response of the narwhals to the ship. Most focal group observations ended when the group dove, and that may be what occurred in this case.

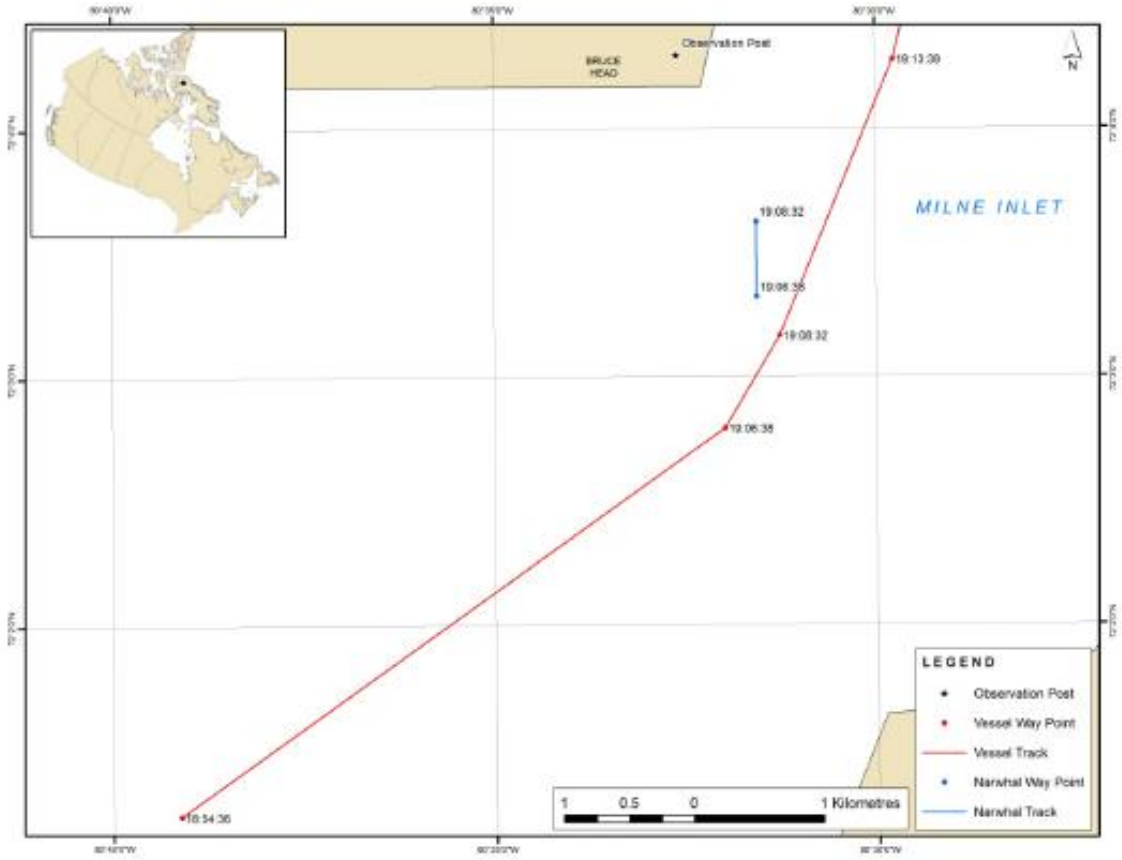

Figure 35: Narwhal position relative to vessel observations on 26 August 2013 near Bruce Head. Times are shown for the focal group and the vessel (Baffinland cargo vessel M/V Avataq) during the vessel transit. Source: LGL (2016a)

3.2.1.2.3 Distance of response of Ringed Seals to vessels

The only species other than narwhal for which distance data were collected by the shipboard observers was ringed seal (SEM 2013, 2014a, 2016). Distance from the vessel was determined for 29 ringed seals (Figure 36). Seals were observed at distances ranging from 10 m to approximately 300 m. The most frequently recorded (41%) distance from the vessel was 10 m.

Figure 36: Estimated distance ringed seals from large vessel during shipboard observer surveys, 2013 through 2015.

3.2.1.3 What is the duration of avoidance for a single ship passage?

Given the difficulty of determining whether avoidance has occurred, it is not surprising that the data do not readily allow for determination the duration of avoidance.

Observers at Bruce Head in 2013 (LGL 2014a) suggested in qualitative logbook notes that narwhals would move away when a vessel was present and that narwhals would be gone for two hours. It was noted that this observation was similar to what they had heard from elders and other hunters. One observer noted that some narwhals travelled to a “safe place” when a vessel was present and that narwhals came back for feeding. The comments in the logbook forms may summarize previous experience and knowledge of narwhal behaviour when vessels are present, and do not appear to be specific to what was observed during the study.

Data currently collected for Baffinland’s monitoring programs do not address this question clearly. As noted in Section 3.2.1.2.1, the response of narwhals to vessels is equivocal. On 14 August 2013 (Table 11), for example, narwhal abundance in Milne Inlet was very high during and after the observed large vessel transit. In a number of other examples, narwhals appeared to leave Milne Inlet either for Koluktoo Bay or exiting Milne Inlet to the north during the passage of vessels. It appears that many, but not all, narwhals move away from vessels, but there is no quantitative evidence for the duration of avoidance. Furthermore, given the high variability of narwhal density in Milne Inlet, it is unlikely that “Before” and “After” densities should be expected to match.

3.2.1.4 What received sound levels from ore carriers result in marine mammal avoidance? Or do mammals respond to the approaching vessel rather than just the received noise levels?

The data collected do not allow differentiation of response to noise levels from response that may have occurred as a result of other factors associated with an approaching vessel (e.g., visual cues).

From published literature, the best estimates for narwhal response levels to continuous sound levels are 120 dB (rms) for disturbance onset is 120 dB (rms), avoidance at 135 dB (rms), and hearing impairment (TTS) sound levels of 175 dB (rms), 100 sec exposure (Baffinland 2012b).

Greeneridge (2015) evaluated the received sound level of the two acoustic receivers in Milne Inlet with respect to vessel position obtained from Automated Identification System coordinate data in 2014 (Figure 37 through Figure 43). At the distances that the vessels were located relative to the anchored acoustic receivers, no received sound levels >130 dB were recorded, and levels >120 dB were rare. Distances associated with a received sound level ~120 dB, assumed to represent a 'disturbance onset' level for narwhals, were read from the figures and summarized in Table 13. In all cases, the sound of the ships was reduced to the 'disturbance onset' level over a distance of <1 km, in one case as low as 200 m.

The sound from the ships would be reduced to the assumed 'avoidance' level of received sound, 135 dB, at distances closer than the 'disturbance onset' level. The distances associated with a received level of 135 dB have not been estimated as this would require extrapolation in all cases outside the range of data collected in the field (Figure 37 through Figure 43).

Table 13: Estimated distance from vessel where received sound is reduced to 120 dB. Determined from Figures 37-43

Vessel	Vessel type and speed of travel	Distance from vessel (rounded to closest 100 m) for received sound to be ~120 dB
Golden Brilliant	Ore carrier, unloaded, 8.0-8.6 kts	200
	Ore carrier, loaded, 7.3-9.1 kts	800
Golden Ice	Ore carrier, unloaded, 6.6-7.0 kts	500-600 (extrapolated)
Svitzer Njal	Tug, 9.5-10 kts	700
Akademic Ioffe	Cruise ship, 3.3-5.5 kts	800
Nordic Odyssey	Ore carrier, loaded, 5.1-5.6 kts	800
	Ore carrier, unloaded, 7.6-9.3 kts	1000

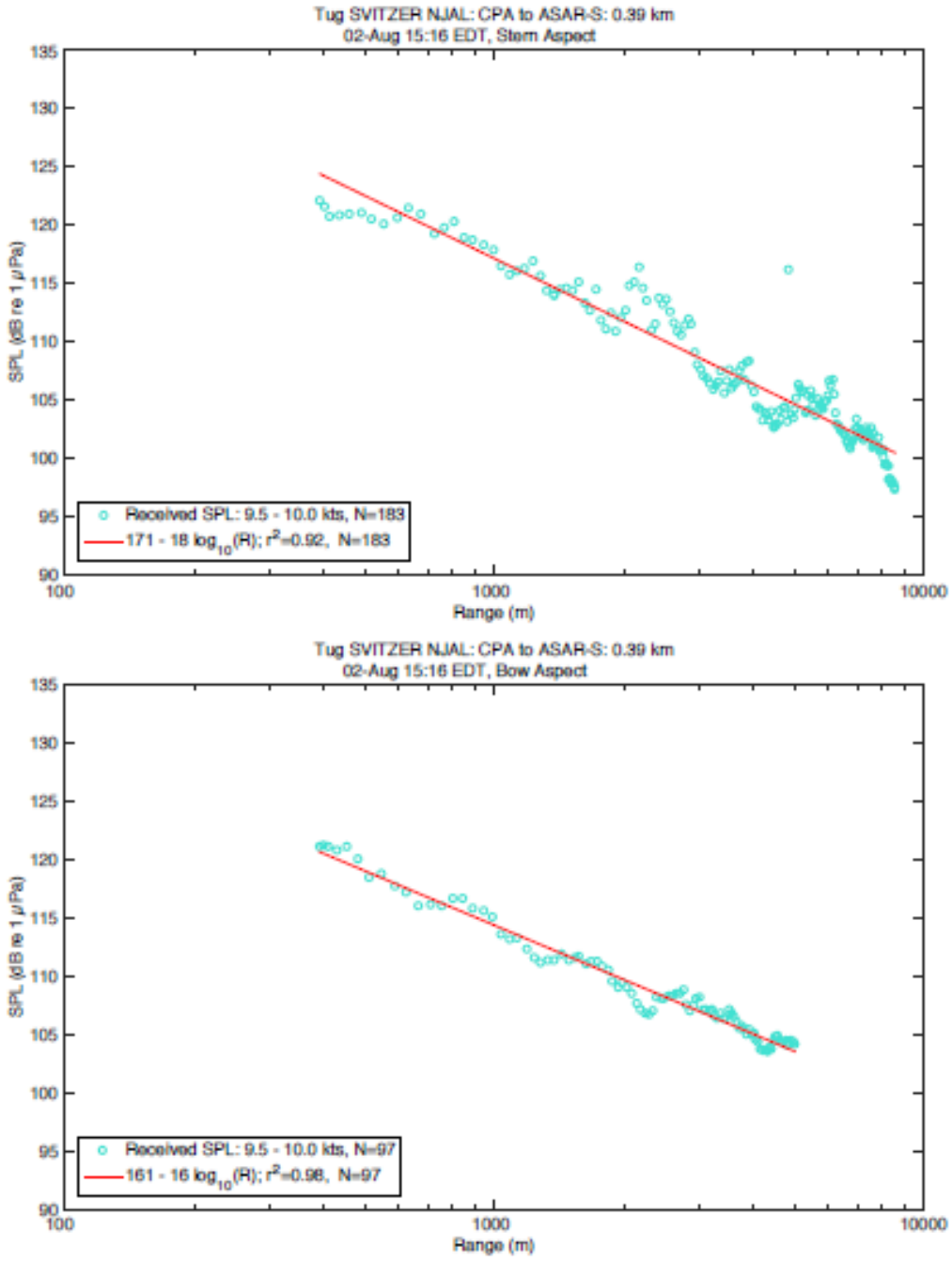

Figure 37: Received sound pressure levels (SPL) at passive acoustic monitoring location from the tug Svitzer Njal as a function of distance (range) from its bow and stern aspects while travelling toward Milne Port. Source: Greeneridge (2015)

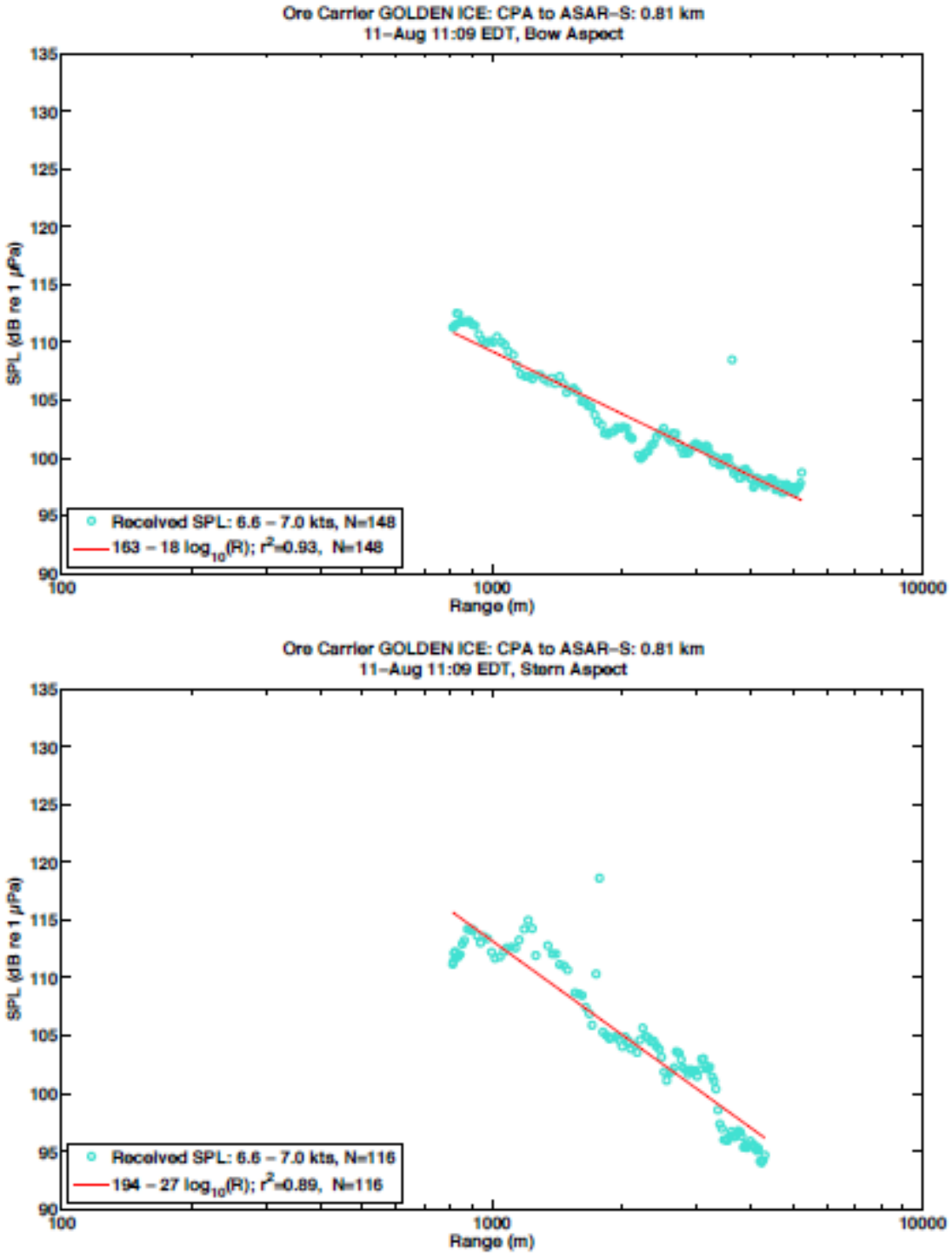

Figure 38: Received sound pressure levels (SPL) at passive acoustic monitoring location from the ore carrier Golden Ice as a function of distance (range) from its bow and stern aspects while travelling toward Milne Port. Source: Greeneridge (2015)

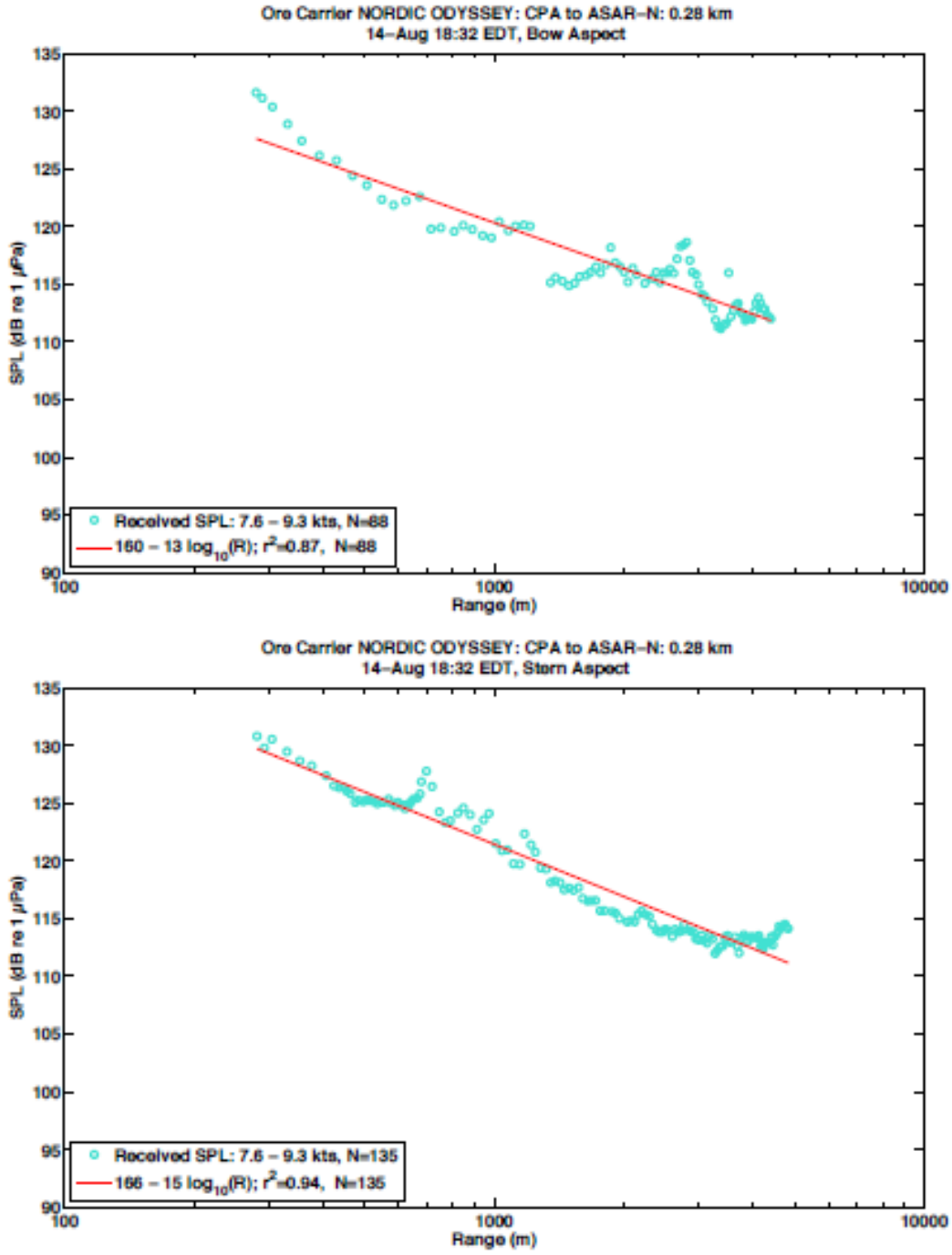

Figure 39: Received sound pressure levels (SPL) at passive acoustic monitoring location from the ore carrier Nordic Odyssey as a function of distance (range) from its bow and stern aspects while travelling toward Milne Port. Source: Greeneridge (2015)

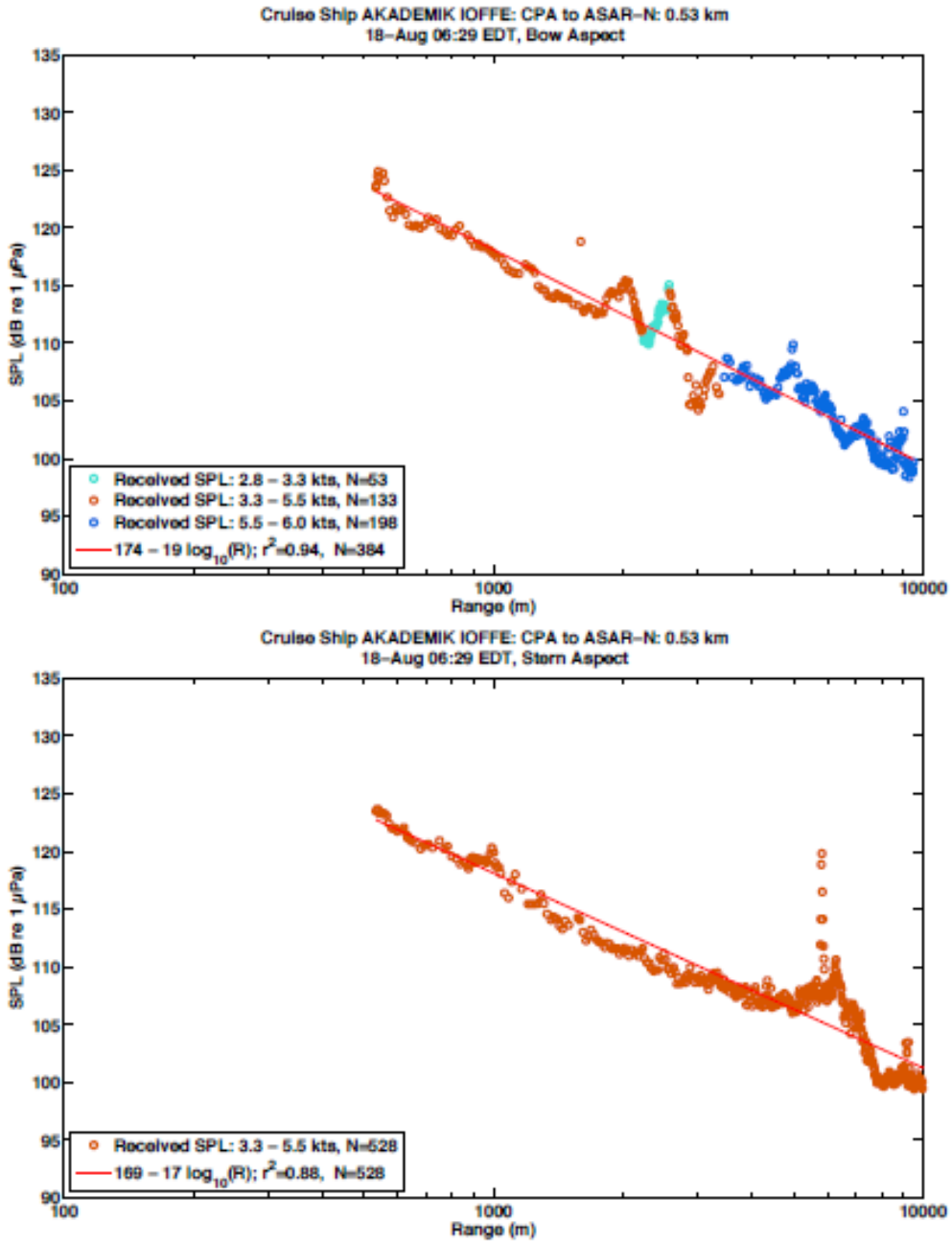

Figure 40: Received sound pressure levels (SPL) at passive acoustic monitoring location from the cruise ship Akademik Ioffe as a function of distance (range) from its bow and stern aspects while travelling near Bruce Head. Source: Greeneridge (2015)

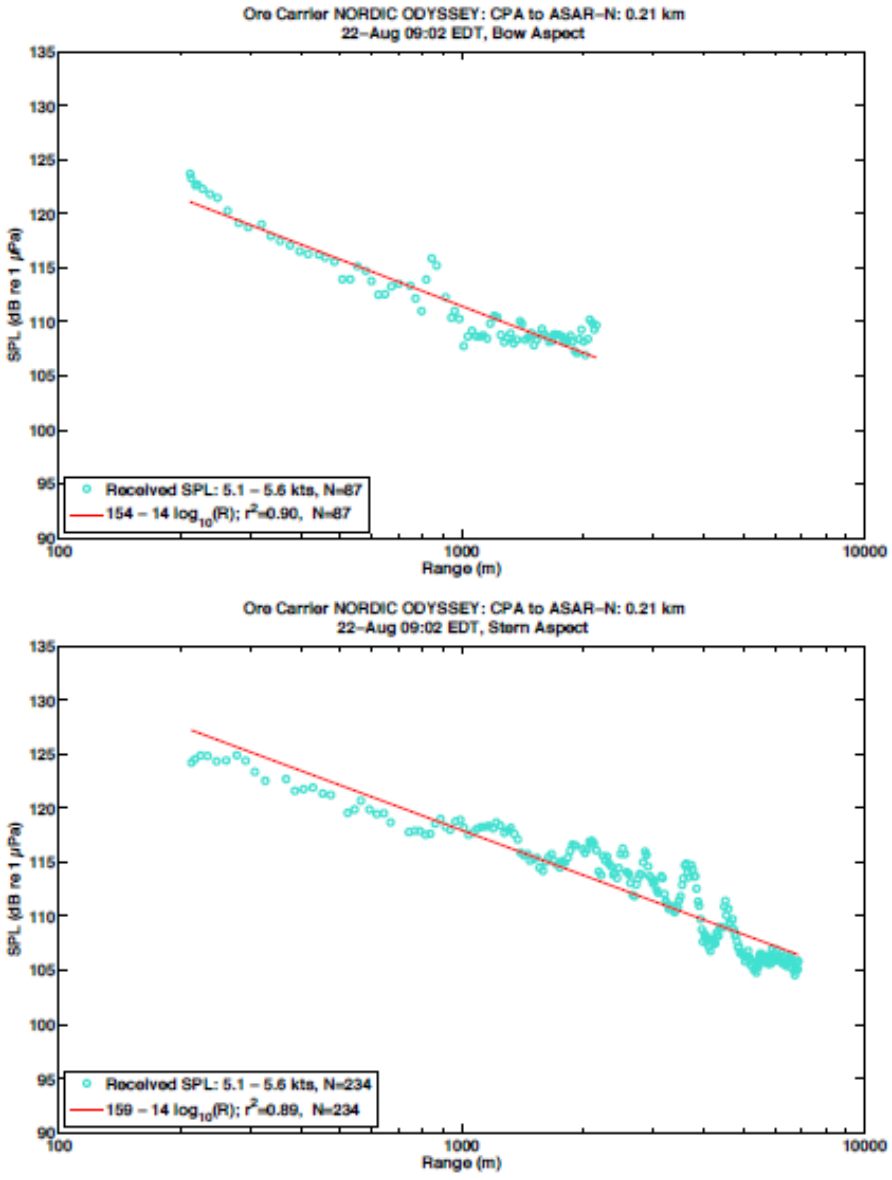

Figure 41: Received sound pressure levels (SPL) at passive acoustic monitoring location from the ore carrier Nordic Odyssey as a function of distance (range) from its bow and stern aspects while leaving Milne Port carrying 73,710 mt of iron ore. Source: Greeneridge (2015)

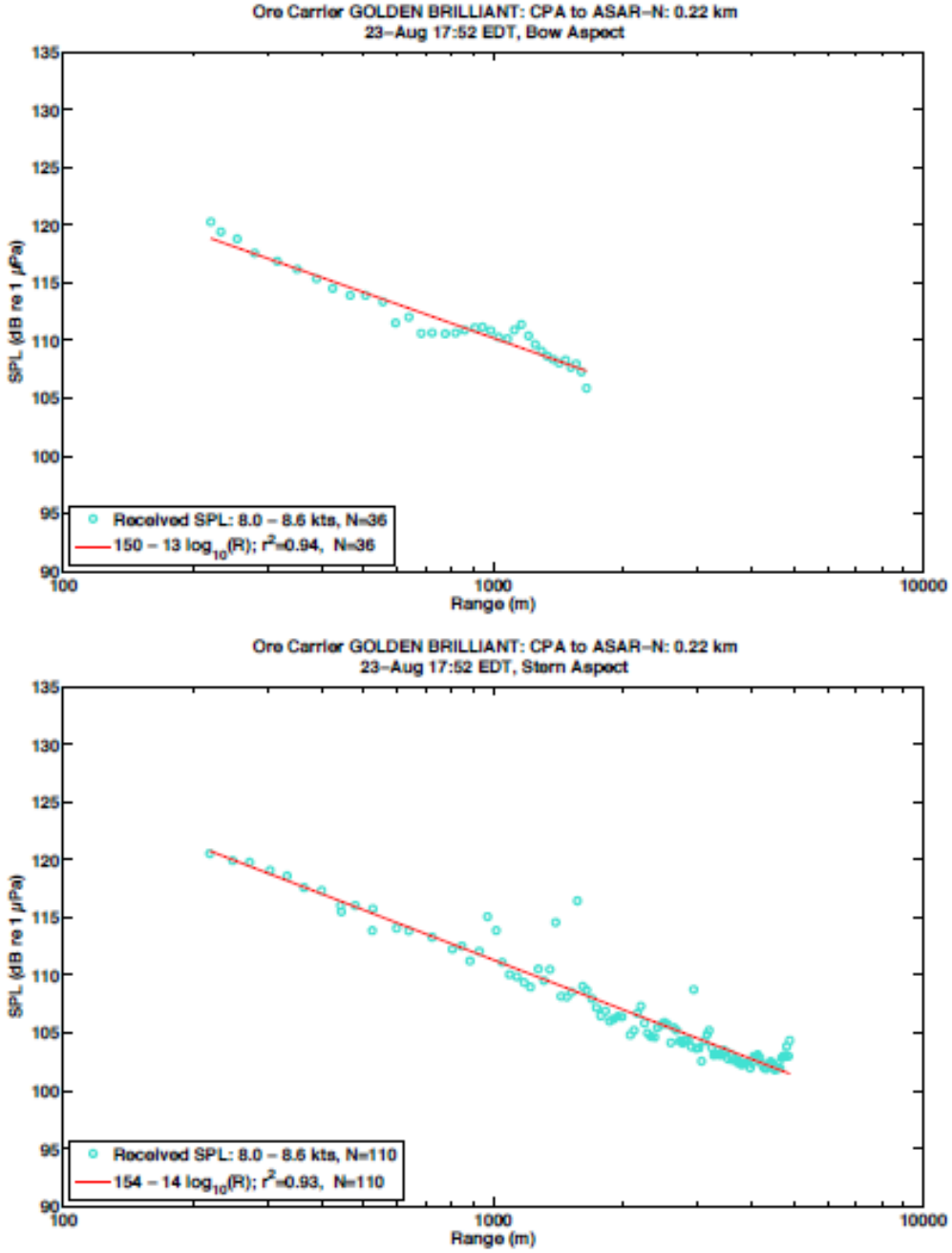

Figure 42: Received sound pressure levels (SPL) at passive acoustic monitoring location from the ore carrier Golden Brilliant as a function of distance (range) from its bow and stern aspects while travelling toward Milne Port. Source: Greeneridge (2015)

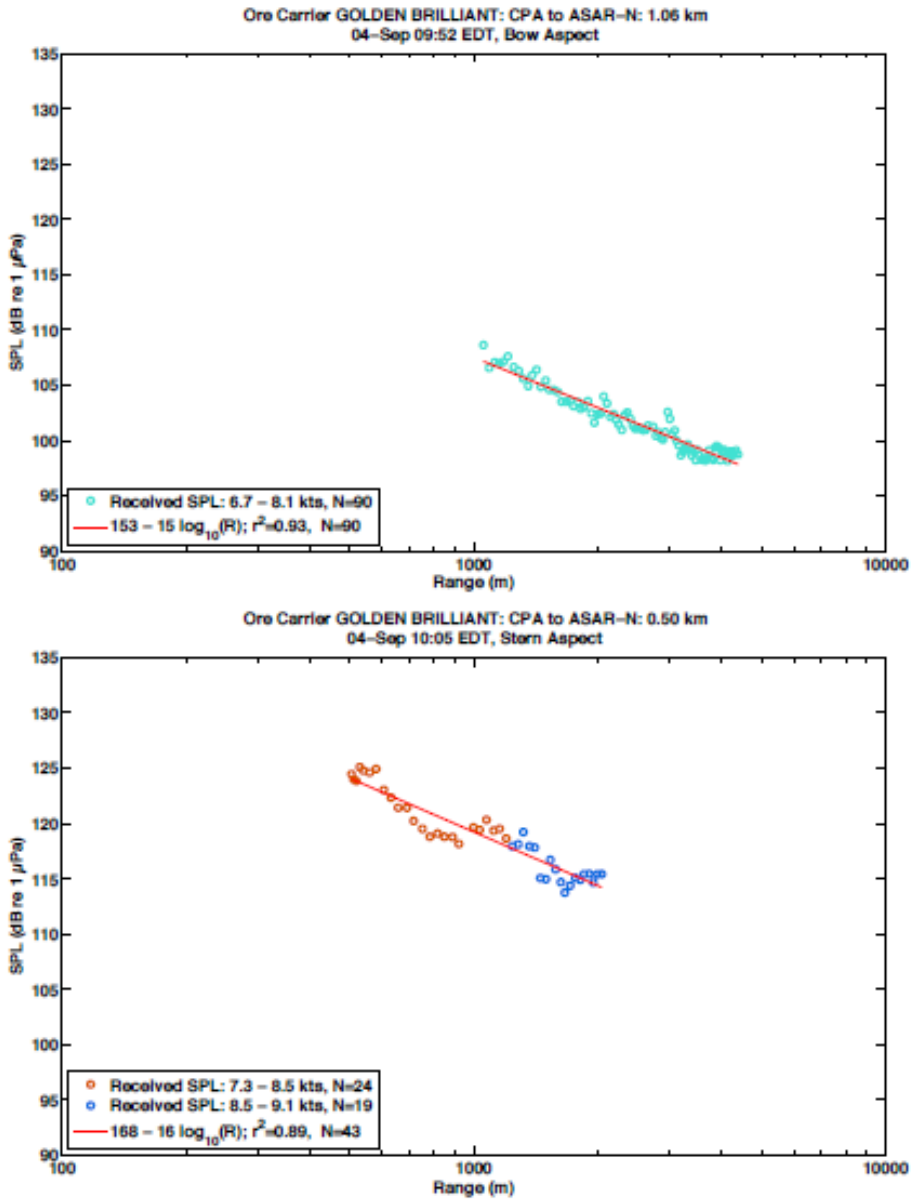

Figure 43: Received sound pressure levels (SPL) at passive acoustic monitoring location from the ore carrier Golden Brilliant as a function of distance (range) from its bow and stern aspects while leaving Milne Port carrying 73,053 mt of iron ore. Source: Greeneridge (2015)

3.2.1.5 Will marine mammals habituate to frequent and regular ship passages?

It is not possible to determine if habituation has taken place. Evaluation of habituation on the part of individual animals would require information on the movements of individual animals in relation to ship positions.

Participants in the community workshops shared the following IQ (see Appendix A for details):

- *The marine mammals, they get used to shipping noise. In the past, when the ships started coming to our area in the 1960s, wildlife would move somewhere else. Nowadays, seals are no longer going to different areas. Sometimes they go not far away, but this is temporary and then they return.*
- *When the ships start entering the area, the narwhals listen to the noise. After the ship continues on, the narwhal return. That's how they behave. It's not like they are scared. Narwhals tend to move faster from cruise ships and merchant vessels. Iron ore vessels move a lot slower, so the narwhal seem to tolerate them more. Seals know when the ships are coming before the narwhals do. When the ships are travelling, you see more seals on the shoreline. That is something that we can clearly see… One thing that was evident two years ago, when they were building a dock at Milne Port, is that they would swim away when there were no ships in the area and also when there were no hunters in the area. They seem to tolerate the ships. I don't want to say bad things about hunters, but narwhals move away from hunters when they hear shooting. When the iron ore carriers move through here, the narwhals always return.*
- *Ships don't bother narwhal much anymore. When a ship is louder and starts its engine, the narwhals run away. They are more afraid when it's leaving than when it's coming in. That's how we see them from Bruce Head. When the work started on the dock, the narwhal would run away because they were putting boulders in the water. The narwhals would come back in the evening. They are more afraid of rocks than ships. I guess they are used to ships now. Seals are braver than narwhal as long as they have distance between them. They will go underwater when the ship comes and then rise up again when it leaves. Narwhals take the newborn calf between them and force it to dive. As they grow they get left alone.*
- *Narwhals get used to the ship sounds. Marine mammals not being hunted don't get scared. Once population numbers increase, they are not afraid of anything. You won't be able to block the route of narwhals, regardless.*

3.2.1.6 If habituation occurs, how long will it take marine mammals to habituate?

It is not possible to determine if habituation has taken place. Evaluation of habituation on the part of individual animals would require information on the movements of individual animals in relation to ship positions.

3.2.1.7 What natural factors influence narwhal distribution and abundance, independent of shipping?

3.2.1.7.1 Predation by killer whales

Narwhal distribution and abundance is known to be influenced by killer whales. Killer whales have been observed in Milne Inlet in the vicinity of Koluktoo Bay in August in years before the Baffinland monitoring studies commenced (Campbell et al. 1988; Marcoux et al. 2009) and seven killer whales were observed by an experienced marine mammal observer as he departed Bruce Head by helicopter on 12 August 2015 (LGL 2016b). These were the only killer whales reported in the vicinity of the Bruce Head shore-based observation post during the years of monitoring by Baffinland. The killer whales observed on 12 August 2015 were in two groups: one group of two adults and one group of five smaller whales. The whales were on the western side of Milne Inlet, between Koluktoo Bay and the entrance to Milne Port, in an area not visible from Bruce Head. All killer whales were headed towards Milne Port, and the group of smaller killer whales was observed pursuing narwhals. According to counts recorded from Bruce Head, very few narwhals were present in Milne Inlet on 12 August although a count>400 was recorded early in the morning of 11 August.

IQ from local communities, shared with Ferguson et al. (2012), described the response of narwhals and their movement into shallow waters to avoid killer whales. An Arctic Bay hunter observed narwhal stay in the shallows long enough for the killer whales to give up and leave, and a Pond Inlet interviewee also observed this in the 1970s in Milne Inlet. Many killer whales came near, and were there for four days, but could not get the narwhal that were hiding in shallow waters and then left. One interviewee in Pond Inlet described seeing narwhal half-beached and one in Arctic Bay said there were once so many narwhal on shore that people could touch them. Another Arctic Bay interviewee described an event in 2008 when so many narwhal fled into shallow water that it “looked like waves on shore”.

A killer whale attack on narwhals that had been fitted with satellite-linked transmitters was documented at Kakiak Point in Admiralty Inlet, Nunavut, Canada, in August 2005 (Laidre et al. 2006). Narwhal movement patterns (e.g., dispersal and clumping) were compared for five days before the attack, during the attack, and five days after killer whales left the area. At least four narwhals were killed by 12 to 15 killer whales in a period of 6 hours.

Narwhal behaviour changed in the presence of killer whales. Behaviours included slow, quiet movements, travel close to the beach (<2 m from shore), use of very shallow water, and formation of tight groups at the surface. These behavioural changes are consistent with the IQ descriptions documented by Ferguson et al. (2012). When the killer whales were within 2 to 4 km, narwhals suddenly moved closer to the shore and into shallow water (<2 m). Some narwhals formed tight groups and others moved slowly or lay very still at the surface. One narwhal beached itself on a flat gravel beach in less than 0.5 m of water thrashing its tail for >30 seconds, either as a warning signal or in an attempt to remove itself from the beach (Laidre et al. 2006).

Narwhals resumed their normal swimming behavior and distance from the coast within an hour after the killer whales left the locality. Longer-term tagging data indicated that narwhals did not alter their site fidelity to the summering grounds or depart early from the summering grounds in response to the presence of killer whales (Laidre et al. 2006).

3.2.1.7.2 Climate Change

Climate change could be a factor affecting the year to year abundance of narwhals.

The effect of climate change on 11 Arctic and subarctic marine mammals was investigated by Laidre et al. (2008). Based on its reliance on sea ice and specialized feeding areas, narwhal is one of the most sensitive marine mammals to climate change, along with polar bear and a subarctic species, the hooded seal; bearded seal and ringed seal were considered the least sensitive due to their widespread distribution and more flexible habitat requirements. It was suggested that the wintering grounds might be the most critically important habitat for narwhals and that climate-related changes in ice cover or food availability could affect narwhals. Very little feeding has been documented in summering areas and the major portion of the annual energy intake appears to be obtained during intense feeding that takes place in Baffin Bay in winter (Laidre et al. 2004, Laidre and Heide-Jørgensen 2005). The dependency of narwhal (and beluga) on sea ice is most likely because their prey are associated with ice (either directly from living in association with sea ice, or indirectly by receiving nutrients that fall through the water column from sea ice) (Kovacs et al. 2011). Protection from killer whales might also play a role in their use of ice-covered waters (Kovacs et al. 2011). In the context of the present discussion of narwhals that summer in waters of northern Baffin Island, it is important to note that the estuaries, fiords and lagoons occupied by narwhals in summer were also identified as critical habitat (Laidre et al. 2008).

Shrinking ice cover could also mean that narwhals will not have this refuge from turbulent water during storm activity. This could indirectly increase energetic costs and may possibly directly increase calf mortality (Kovacs et al. 2011).

Climate change could also affect narwhals by altering the distribution or abundance of predators such as killer whales. Killer whales appear to be extending their season of Arctic occupation which may increase their predation rate on their preferred prey - narwhal, beluga and bowhead (Higdon et al. 2011).

3.2.2 Will narwhal behaviour change during and after a project vessel passage?

3.2.2.1 What is narwhal behaviour in Milne Inlet before Project shipping? [Supplemental information: group composition will also be described]

Behavioural observations were conducted from Bruce Head by tracking “focal groups” of narwhals and recording their behaviour.

Observations from 2013 (LGL 2014a) are the basis for this review. Most focal group observations occurred at times when there was no anthropogenic activity in the area (67%). There was some form of vessel activity during 9.1 hours of behavioural observations (9.3% of observational effort). Large and small vessel activity accounted for 23.3% (2.1 h) and 77.7% (7.0 h), respectively, of all behavioural observations conducted during periods of vessel activity. Thus, the behaviour described in this section includes all 2013 observations.

In 2013, 169 narwhal focal groups totalling 628 individuals (mean: 3.7 narwhals/group; range: 1 to 19 narwhals/group) were recorded during 6 to 26 August. Individual narwhals were most common (27.8%), while narwhal groups of >1 individual account for 72.2% of all of the focal groups. Almost 80% of the focal groups were of pods of five or fewer narwhals.

Adults were the most commonly recorded age class (69.3%) from narwhals that could be identified to a specific age class, followed by juveniles (24.1%) and calves (6.6%). Calves were always seen closely associated with an adult female. Males and females rarely grouped together.

Groups without calves travelled faster than groups with calves (5.0 and 3.7 km/h respectively). However, this difference was not statistically significant. Swimming speeds ranged from 0.3 to 10.2 km/h for lone narwhals, 1.0 to 7.3 km/h for groups with calves, and 1.0 to 23.8 km/h for groups without calves.

During periods when narwhals were classified as travelling, mean swim speed was 5.1 km/h. When narwhals were observed foraging and resting, mean swim speeds were relatively slower (1.0 and 1.6 km/h, respectively).

Travelling narwhals moved in the most linear fashion (0.99 linearity; where 0 indicates the least and 1 the most resemblance to a straight line trajectory). Foraging and socializing were relatively non-linear behaviours (mean 0.44 and 0.58, respectively), as would be expected with activities involving turning to capture prey and to interact with conspecifics.

3.2.2.2 Does relative abundance and distribution of narwhals change during and after a ship passage?

Section 3.2.1.2.1 addresses this question.

3.2.2.3 Is narwhal group composition affected?

Seven large vessel transits went through the study area during the 2013 field season (LGL 2014a). Narwhals were only present in the study area and close enough for behavioural observations during three of the seven transits. The three large vessels that transited when narwhal focal group observations were made were: the *Qamutik* on 12 August; the cruise ship *Sea Adventurer* on 14 August; and the *Avataq* on 26 August.

Narwhal composition was not recorded during large vessel transits in 2013.

Mean group size was significantly smaller when groups were observed in the presence of large vessels compared to groups observed in the absence of anthropogenic activity. Mean group size in the presence of medium and small vessels was similar to mean group size in the absence of anthropogenic activity.

Table 14: Narwhal group size data observed from Bruce Head in 2013 relative to vessel presence.

Narwhal group size (mean ± SD)			
Large vessels present (a)	**Small and medium vessels present (b)**	**No anthropogenic activity (c)**	**Statistical significance**
1.6 ± 1.3	3.8 ± 2.6	4.4 ± 3.4	a<c, b=c

No group composition or group size data were collected in the presence of large vessels in 2014 (LGL 2015c).

In 2015 (LGL 2016a), group composition was described relative to large, small to medium, and no vessel presence in combination with a determination of the spread of the group (Table 15). This information provides some

inference as to whether narwhals reacted to vessels as they do to the presence of killer whales, i.e., by forming tight groups as mentioned in Section 3.2.1.7.1. The difference in group spread was not statistically significant.

Table 15: Narwhal group composition and group spread observed from Bruce Head in 2015 relative to vessel presence. Source: LGL (2016a)

Group composition		Group spread (Loose = narwhals>1 body width apart, Tight = narwhals<1 body width apart)					
Tusks	Calves	No vessels		Small Vessels		Large Vessels	
		Loose	Tight	Loose	Tight	Loose	Tight
Mixed yes/no	No	10	15	0	1	0	2
Mixed yes/no	Yes	11	7	0	1	3	5
No	No	7	16	2	0	0	1
No	Yes	8	39	4	3	2	6
Yes	No	9	12	0	0	3	0
Yes	Yes	0	2	0	0	0	0
% of total by category of vessel presence		33.1	66.9	54.5	45.5	36.4	63.6

3.2.2.4 Does narwhal behaviour change during and after a ship passage?

In 2013, no significant differences were detected for any of the “general” behaviour categories across the three types of anthropogenic activity (LGL 2014a). Visual inspection of the data (Figure 44) does not suggest a clear pattern of changes in group behaviour when vessels were present. However, there was some indication that diving was observed more frequently during periods when vessels were present versus absent.

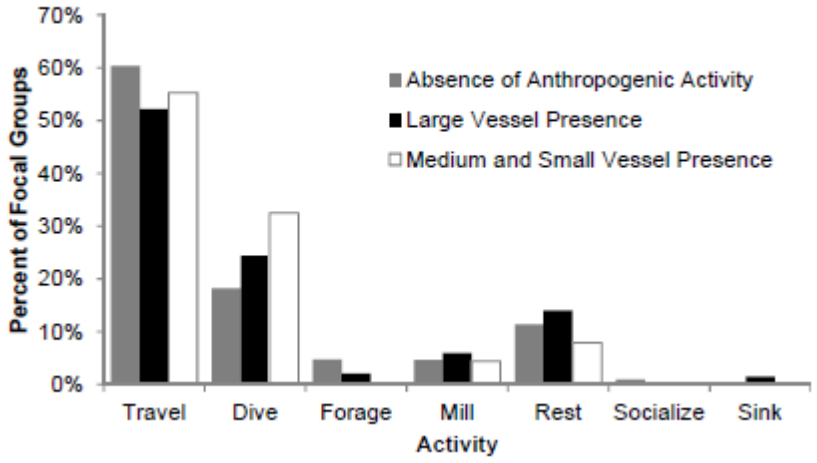

Figure 44: Narwhal behaviour during focal group observations from Bruce Head in 2013 relative to vessel presence. Source: LGL (2014a)

More than half of the narwhals exhibited no observable response to the presence of large vessels (~58% of focal groups) (Figure 33). Of the responses recorded in the presence of large vessels, the most common was an increase in swimming velocity away from the vessel. On one occasion a narwhal approached a vessel: it swam toward the vessel head on, stopped, turned perpendicular to the vessel (twice), and then at a distance of 3.3 km from the vessel it swam perpendicularly away from the vessel. No observable response was documented for narwhals in the presence of medium and small vessels.

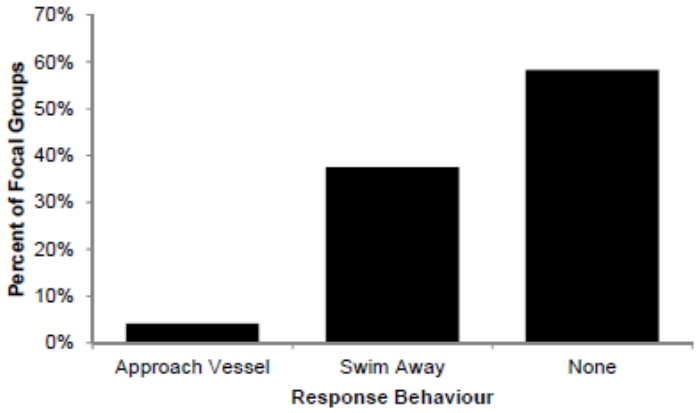

Figure 45: Narwhal behaviour observed from Bruce Head in 2013 relative to large vessel presence. Source: LGL (2014a)

Swimming speed of narwhals was determined by calculating "leg speed", defined as the travel time divided by distance measured between a pair of theodolite fixes. Mean swimming speed of narwhals tracked in the absence of anthropogenic activity was 3.6 km/h (range: 0.3–16.5 km/h), compared to 4.1 km/h (range: 1.0 to 17.9 km/h) for narwhals tracked in the presence of large vessels, but the difference was not statistically significant. Mean swimming speed of narwhals tracked in the presence of medium and small vessels was 5.6 km/h. Sample sizes were too small to test for differences with medium and small vessel presence. For easier comparison with 2014 values which were measured in kts, the 2013 speeds were converted to kts (Table 16).

Table 16: Narwhal swimming speeds observed from Bruce Head in 2013 in relation to vessel presence

Swimming speed	No vessels (n=48)	Small or medium vessels present (n=9)	Large vessels present (n=21)
Mean (kts)	1.9	3.023.8	2.2
Minimum (kts)	0.16	Not reported	1.1
Maximum (kts)	8.9	12.9	9.7

LGL (2014a) indicated that the fastest leg speed observed in 2013 (23.8 km/h) was exhibited by a group of seven adult narwhals that were travelling through the area approximately ten minutes after a local hunting boat went through the area. This group had a short burst of high speed swimming over a short period of time, possibly in response to the hunting boat. The second fastest leg speed (17.9 km/h) was exhibited by a pair of narwhals that were moving away from an approaching ship that was 883 m away. The ship was travelling at a speed of 25.8 km/h (13.9 kts) at the time of the observation. LGL (2014a) did not identify the ship.

In the 2014 Bruce Head survey (LGL 2015c), no behavioural data were collected in the presence of large vessels, and data available for small to medium vessels were limited to the measurements summarized in Table 17. No statistical comparison was conducted due to small sample size. For most observations, swimming speed was characterised as slow, medium or fast, but for a subset of samples speed was quantified (Table 17). Due to small sample size, no statistical analysis was conducted.

Table 17: Narwhal swimming behaviour observed from Bruce Head in 2014 relative to vessel presence. Data were not collected during large vessel transits

Parameter	No vessels (n=22)	Small or medium vessels present (n=7)
Linearity	0.84 (0.35-1.00)	0.97 (0.87-1.00)
Average speed (kts)	1.8 (0.4-4.0)	2.3 (1.2-2.9)
Minimum leg speed (kts)	0.0	0.6
Maximum leg speed (kts)	4.9	4.3

Focal group behaviours in 2015 were not quantified as was done in 2013, and were not statistically compared in the presence and absence of ships (LGL 2016a). In the presence of large vessels, narwhals were observed conducting primary (travelling, milling, and resting with backs exposed), and secondary (diving, bubble rings) behaviours. In the presence of small vessels, primary behaviours observed were travelling and milling, and the only secondary behaviour was diving. All primary and secondary behaviours observed in the presence of vessels were also observed when vessels were absent. Other secondary behaviours observed only when vessels were absent included: side swimming, back swimming, rubbing, tusking, and nursing. However, the difference in diversity of behaviours observed may be at least partly due to the difference in the number of observations made for different situations: 80 observations with no vessels, 12 observations with small vessels present, and 5 observations with large vessels present.

Ad libetum observations made during large vessel transits northwards through Milne Inlet suggest that narwhals generally do not respond to the large vessel presence by fleeing the area. During large vessel transits on 18 and 22 August, groups of narwhals were observed briefly resting while oriented toward the large vessel, before then swimming away and diving. Some narwhals were observed in relative close proximity (i.e., hundreds of metres) to the vessel, and many were observed swimming to the south. During these two large vessel transits, many narwhals were observed to remain nearby. LGL (2016a) indicated that these narwhals changed behaviour, but no further details were provided on what the change was.

Narwhals in the presence of small vessels were observed to display a very limited range of group behaviours: travelling and milling were the only primary behaviours observed, and diving was the only secondary behaviour observed. As well, swim speeds were faster for focal groups in the presence of small vessels vs. those in the absence of vessels. Small sample sizes precluded rigorous statistical testing, thus caution must be exercised before generalizing narwhal response to small vessels based on these observations.

Swim speed was recorded qualitatively as small, medium or fast, but was not statistically tested due to small sample size (Table 19).

Table 18: Narwhal swimming speed observed from Bruce Head in 2015, relative to vessel presence. Groups observed during shooting events or group sizes of 1 were excluded. Source: LGL (2016a)

Group composition		Swimming speed								
Tusks	Calves	No vessels (n=163)			Small Vessels (n=10)			Large Vessels (n=23)		
		Slow	Medium	Fast	Slow	Medium	Fast	Slow	Medium	Fast
Mixed yes/no	No	10	12	3	1	0	0	0	0	2
Mixed yes/no	Yes	0	12	6	0	1	0	0	0	8
No	No	19	22	3	0	16	0	0	0	2
No	Yes	13	23	11	1	0	0	0	0	8
Yes	No	14	12	1	0	0	0	0	2	1
Yes	Yes	1	0	1	0	8	0	0	0	0
% of total by category of vessel presence		35.0	49.7	15.3	20.0	80.0	0.0	0.0	8.7	91.3

Swimming speed and linearity were determined, but were not statistically tested due to small sample size (Table 19).

Table 19: Narwhal swimming behaviour observed from Bruce Head in 2015 relative to vessel presence

Parameter	No vessels (n=71)	Small to medium vessels (n=7)	Large vessels (n=2)
Linearity (mean, minimum-maximum)	0.92 (0.22-1)	0.89 (0.46-1)	0.93 (0.88-0.98)
Average speed (kts) (mean, minimum-maximum)	2.2 (0.6-4.4)	2.5 (0.6-4.2)	2.1 (1.6-2.5)
Minimum leg speed (kts)	0.0	0.0	0.5
Maximum leg speed (kts)	7.6	5.9	3.1

3.2.2.5 How does subsistence hunting affect narwhal behaviour?

The Bruce Head observation platform was located directly above a hunting camp used by local Inuit for hunting marine mammals, but the camp is out of sight of the observers on the platform. Relatively few observations were made at Bruce Head relating hunting to narwhal behaviour in 2013 (LGL 2014a). Hunting activity was observed on a single day (10 August) when both seals and narwhals were targeted. On two occasions, a group of narwhals close to shore was shot at by local hunters onshore. The immediate response of the narwhals was to dive. The narwhals were not observed to surface again. These hunting events were not recorded as focal groups because the narwhals were too close to the shore to be viewed with either the theodolite or Big Eye binoculars.

There was more hunting activity in 2014 than in 2013 (LGL 2015c). Much of the small vessel traffic in the study area occurred when hunters arrived and departed the hunting camp. Hunting activity was observed on six separate days from 23 August to 4 September, and comprised 18+ shooting events. A shooting event was defined as one or multiple shots fired at the same target species in a short period of time; hunting events were generally only

several seconds in length. In nine of the recorded shooting events, the target species was narwhal. Seals were the target species in five of the shooting events. More than three shooting events took place over the course of a walrus hunt on 1 September. During this hunting event, the walrus was initially shot (at 12:51h) by hunters stationed on shore at the base of Bruce Head. Hunters launched their boat and approached the walrus after it had been fatally wounded so that it appeared that it could not dive. Additional shots were fired by the hunters from their boat in order to kill it; the walrus was brought back to shore shortly after 16:00h. Target species was not determined for one additional recorded shooting event.

Additional hunting activity was known to occur when observers were not at the observation site: narwhal and seal carcasses were observed onshore on several occasions, and study team members received news of a successful narwhal hunt from a group of hunters camped out on a point below the observation site.

When hunting was observed in 2014, narwhals in the immediate vicinity of the shooting responded by increasing swimming speed, diving, and spending more time swimming while submerged. There were 36 observations of small motorized vessels with outboard engines (two observations comprised groups of two small vessels each) during the 2014 field season. The majority of these small motorized vessels appeared to be operated by Inuit. Observations of small motorized vessels were made on 13 separate days, and all small motorized vessels were observed after 17 August (Appendix B). Many of these small vessels spent time anchored at the shoreline immediately below the observation site.

Much more hunting activity was observed at Bruce Head in 2015 than in either 2013 or 2014. The hunting camp was observed to be occupied on 16 days over the course of the 2015 study period (LGL 2016a). Hunting activity was observed on 12 days from 8 to 30 August, and comprised 72+ shooting events. The target species was narwhal in 59 of the observed shooting events. Seals were the target species in five of the shooting events, and target species was not determined for the remaining shooting events.

Most of the hunting (i.e., shooting) activity observed from Bruce Head was conducted from the shore, though shooting was also occasionally observed from small vessels in 2015. Narwhals were observed to respond to shooting by diving and increasing their swim speed.

Much of the small vessel traffic in the study area occurred when hunters arrived and departed the hunting camp. This boat-based hunting occurred in the southern portion of the Bruce Head study area, as well as further south between the entrance to Assomption Harbour and Koluktoo Bay. Inuit study team members also relayed news of hunting activity in the area: hunting was reported to have occurred in Koluktoo Bay, and narwhal set nets were deployed on at least one occasion near the mouth of Assomption Harbour.

3.2.2.6 Do the number and characteristics of narwhal calls change in the presence of shipping?

Greeneridge monitored narwhal and other marine mammal calls, along with the presence of vessels and other detectable anthropogenic activity, from passive acoustic monitoring stations in southern Milne Inlet in 2014 and 2015 (Greeneridge 2015, 2016). The data did not identify a close relationship between the number of narwhals determined visually and the number of calls determined acoustically (Greeneridge 2015). A comparison of the Bruce Head visual narwhal count data and the acoustic narwhal detections showed that narwhal calls were rarely detected at times when no narwhals were visually observed (Figure 46 and Figure 47). However, the semi-quantitative category of narwhal call detections did not appear to have a strong relationship with the number of narwhals counted visually, and was generally categorized as “Many” or “Many+” calls on most dates that narwhals were observed from Bruce Head. The same lack of relationship was observed at both acoustic mooring locations, and in both years of study (Greeneridge 2015, 2016). The relationship was not tested statistically.

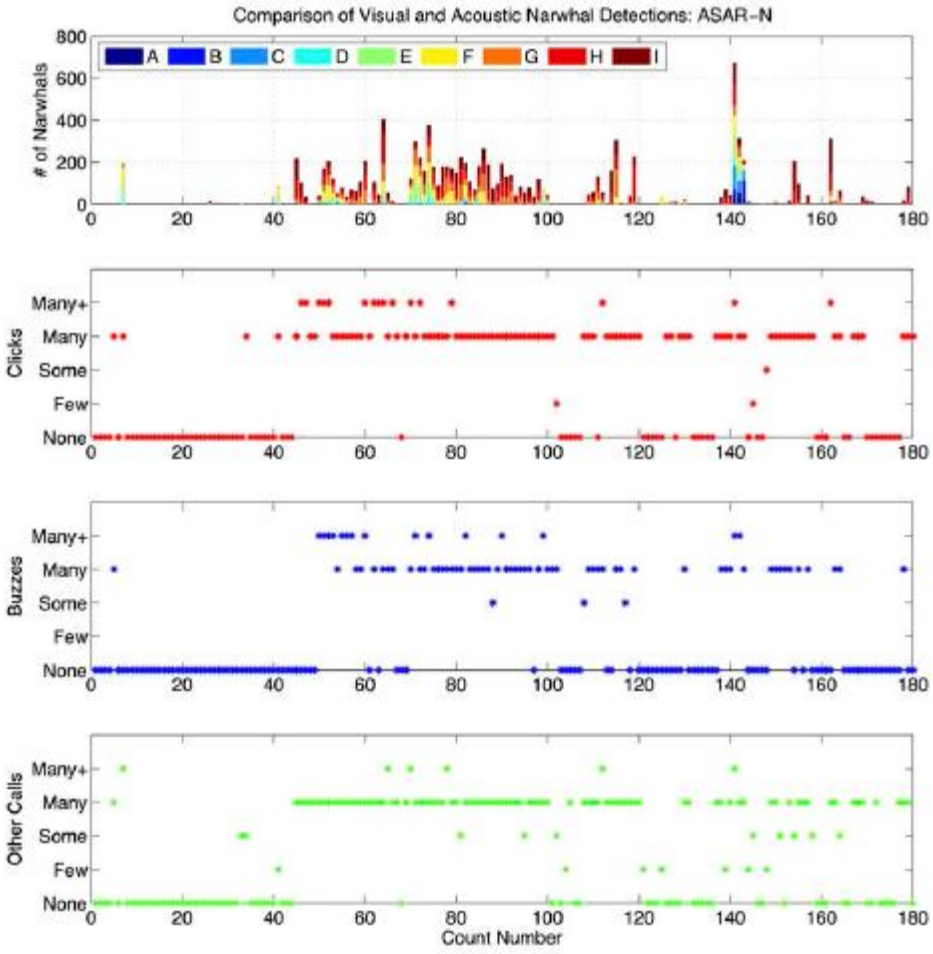

Figure 46: Comparison of visual sightings of narwhals at Bruce Head and acoustic detections of narwhals recorded by passive acoustic monitoring station ASAR-N, 3 August-5 September 2014. Source: Greeneridge (2015)

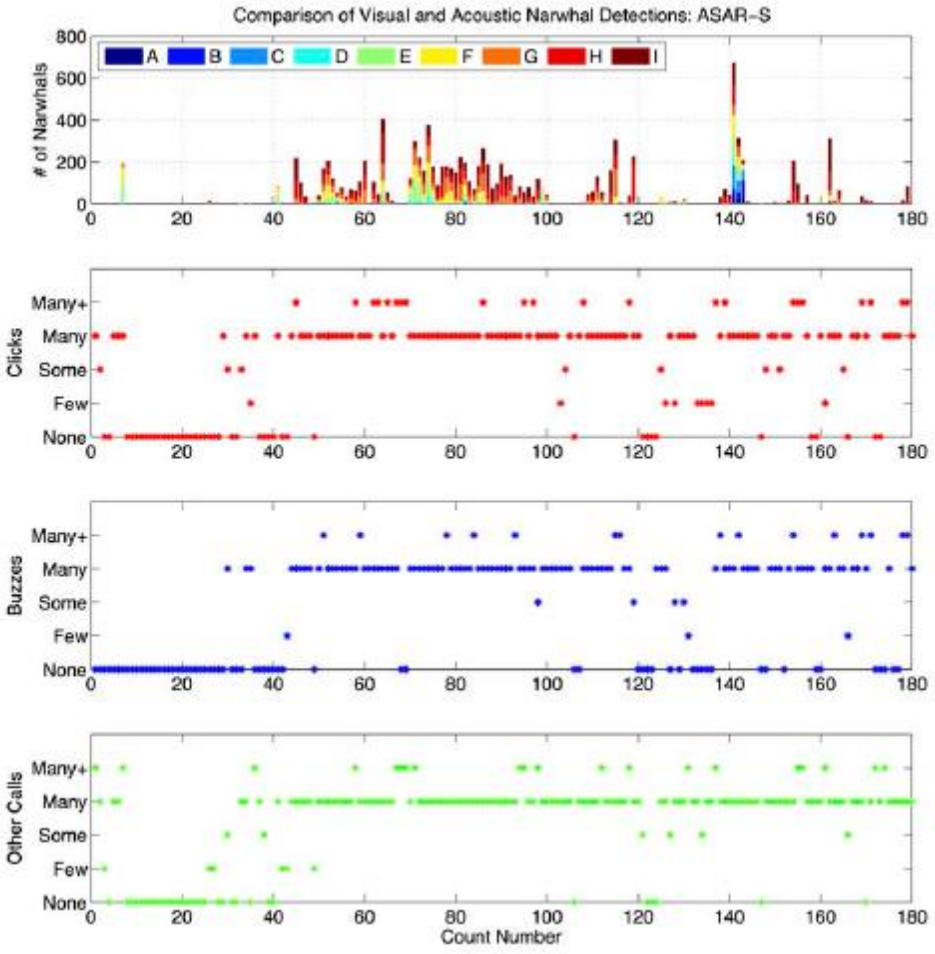

Figure 47: Comparison of visual sightings of narwhals at Bruce Head and acoustic detections of narwhals recorded by passive acoustic monitoring station ASAR-S. Source: Greeneridge (2015)

The relationship between narwhal calls and detection of acoustic signals from vessels was also not investigated statistically by Greeneridge (2015, 2016). Visual inspection of the 2014 data (Figure 48 and Figure 49) does not show a strong relationship between the presence of vessels and narwhal calls. All vessel sizes were combined irrespective of size. Similar results were observed in 2015 data, and will not be presented here.

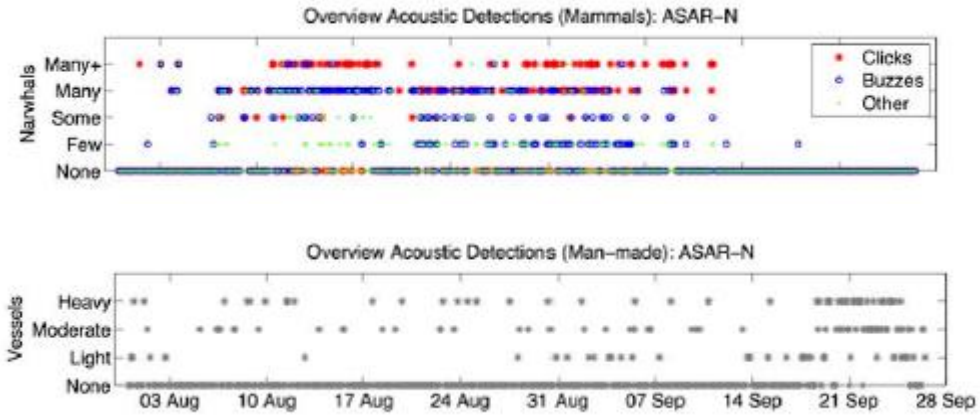

Figure 48: Comparison of narwhal vs. vessel acoustic detections recorded by passive acoustic monitoring station ASAR-N (off Bruce Head) in 2014. Source: Greeneridge 2015.

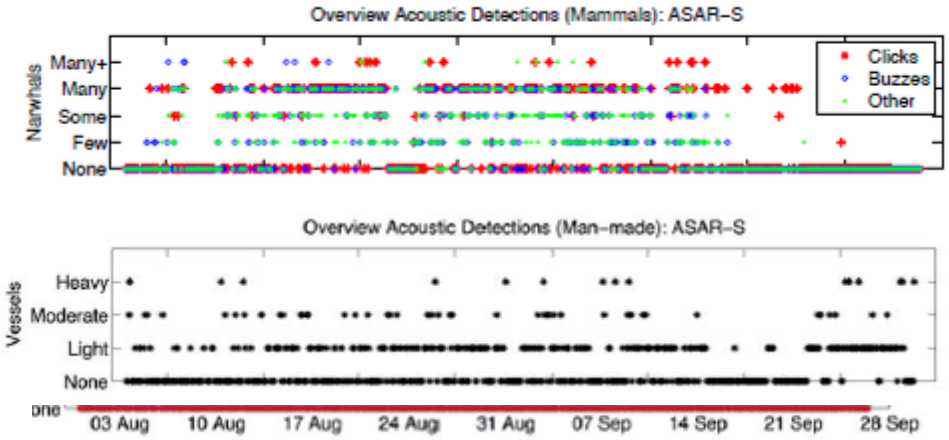

Figure 49: Comparison of narwhal vs. vessel acoustic detections recorded by passive acoustic monitoring station ASAR-S (off Koluktoo Bay) in 2014.

Broadband (10–23,500 Hz) received sound levels were similar for the two recorders in 2014 (Greeneridge 2015). Minimum broadband levels were 78.0 and 78.5 dB re 1 µPa for ASAR-N and ASAR-S, respectively. Maximum broadband received levels reached 144.4 and 151.4 dB re 1 µPa for ASAR-N and ASAR-S, respectively. However, the maximum levels were dominated by vessel traffic and the most prominent characteristic of the broadband pressure time series is the presence of numerous spikes representing high-level transients (i.e., short-duration sound sources). Except during such transients, broadband received sound levels were usually between approximately 90 and 115 dB re 1 µPa (Figure 50).

Broadband (10–23,500 Hz) received sound levels were also similar for the two recorders in 2015 (Greeneridge 2016). Minimum broadband levels were 80.6 and 81.5 dB re 1 µPa for ASAR-N and ASAR-S, respectively. Maximum broadband received levels reached 140.6 and 132.4 dB re 1 µPa for ASAR-N and ASAR-S, respectively. The high density of high-level transients observed in 2014 was again present in 2015. The highest levels were mainly attributable to vessel traffic, in the case of components below a few hundred hertz, and to narwhal calls above ~15 kHz, although narwhal calls also contained significant energy below ~7 kHz. Except during such transients, broadband received sound levels were usually between roughly 90 and 115 dB re 1 µPa, as they were the previous year. Baseline broadband levels typically fluctuate with wind speed, and, with improved wind speed measurements in 2015, the relationship between ambient sound and wind was demonstrated. At frequencies most closely associated with wind-generated noise (<1 kHz), moderate winds (~6 m/s) typical of the study site contributed to average ambient sound levels of ~94 dB re 1 µPa. In the same <1 kHz band, vessels contributed the greatest sound energy to the local soundscape, increasing received sound levels to ~119 dB re 1 µPa, or 12.0 to 26.8 dB above average wind-generated sound levels at high and low sea states, respectively. Thus, wind was identified as a major source of sound in the local soundscape, but the soundscape was dominated by various types of transitory vessels, whose sound energy was well above natural sources of ambient sound like wind. Other frequent and high-level transients in the sound records included bouts of narwhal calls and narwhal hunters' shots (Figure 51).

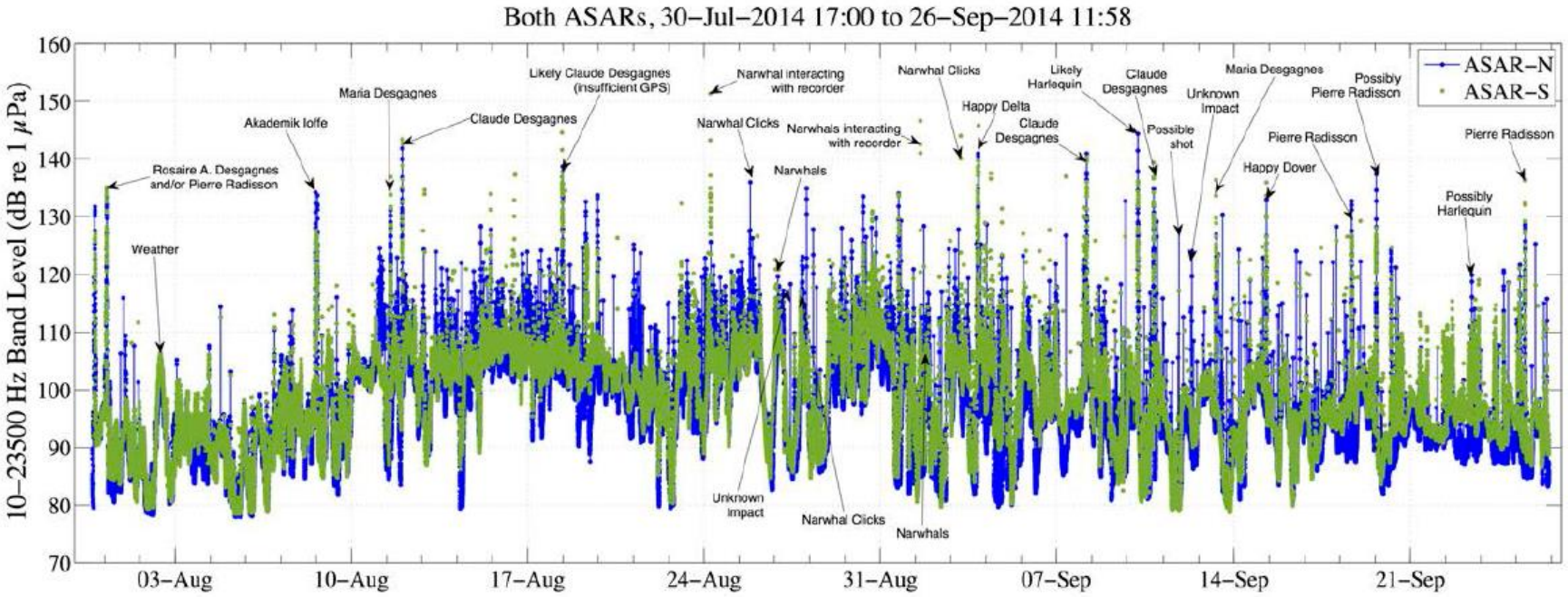

Figure 50: Identification of selected transient sound sources detected in Milne Inlet by passive acoustic monitoring stations in 2014. Source: Greeneridge (2015)

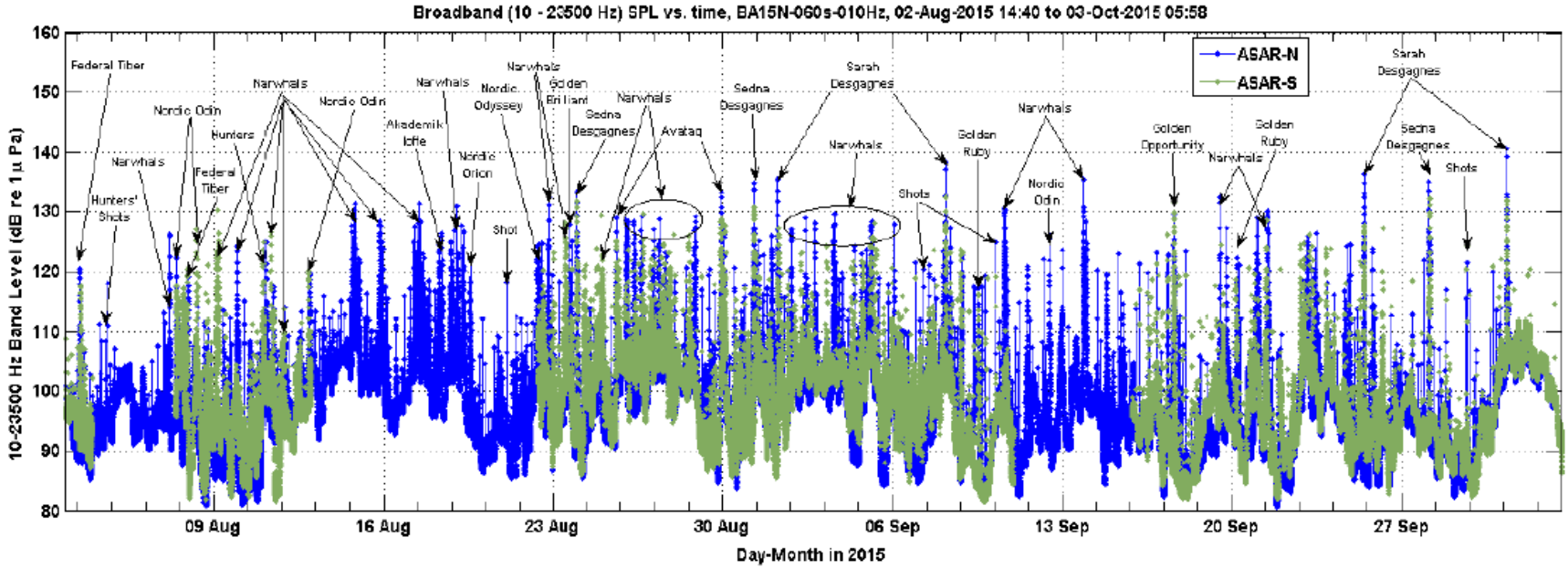

Figure 51: Identification of selected transient sound sources detected in Milne Inlet by passive acoustic monitoring stations in 2015.
Source: Greeneridge (2016)

Previous studies on narwhal calls in Koluktoo Bay reported that narwhals' calls ranged from 300 Hz to 24,000 Hz (Ford and Fisher 1978; Marcoux et al. 2011; Marcoux et al. 2012). In Figure 52, high-frequency components of narwhal calls, in one case, were detectable above shipping noise, while low-frequency components of narwhal calls were not evident and were likely masked by vessel noise. Lower-frequency components of narwhal calls may be those associated with echolocation.

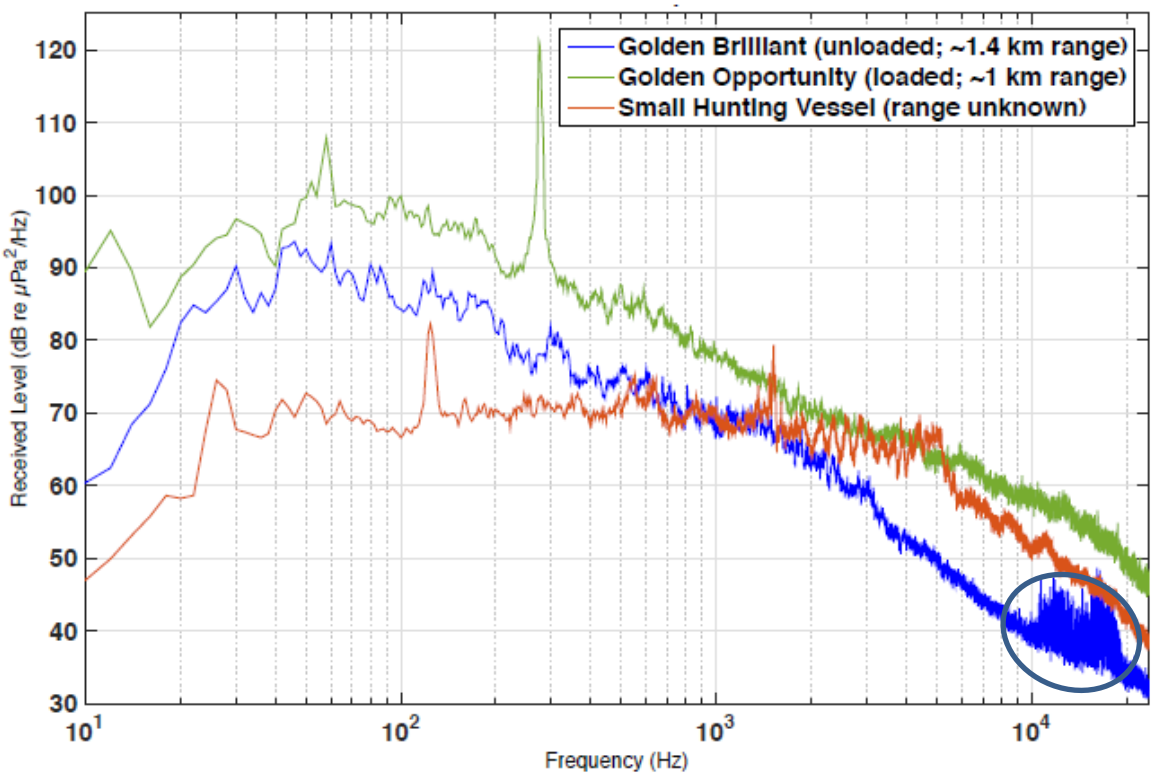

Figure 52: Comparison of acoustic signatures of two ore carriers and a small narwhal hunting vessel recorded by passive acoustic monitoring stations in 2016. The 10-20 kHz high energy present in the Golden Brilliant recording indicates a bout of narwhal buzzes (circled at right of figure). The green spike is the "tonal" that appeared in the Golden Opportunity's acoustic signature when loaded. Modified from Greeneridge (2016)

3.2.3 What are short-term, long-term, and cumulative effects of shipping and underwater noise on marine mammals?

At this time, the data do not clearly indicate whether there are any effects of shipping in Milne Inlet and thus short-term, long-term and cumulative effects of shipping, if any, have not been identified.

4.0 GAP ANALYSIS AND OPTIONS

4.1 State of Knowledge Relative to Hypotheses

The hypotheses that are to be examined in the MEEMP (Baffinland 2016) were evaluated with respect to the monitoring results presented in Section 3.0. An evaluation of the state of knowledge for each hypothesis is presented in Table 20.

Table 20: Summary of conclusions for each set of hypotheses in the marine mammal monitoring/management program.

Hypothesis Number	Null and Alternate Hypotheses	State of Knowledge
Shore-based Narwhal Monitoring		
1	H_0: Narwhal distribution and relative abundance does not significantly change in response to a large vessel transit H_A: Narwhals move away from a vessel and narwhal numbers decrease in response to a large vessel transit	Results are inconclusive because of the high spatial and temporal variability in abundance and distribution of narwhal. Some of the highest abundances of narwhals were observed in conjunction with some large vessel transits. At other times the narwhals appear to have left Milne Inlet, but the causal link to vessel transits is unclear.
2	H_0: Narwhal group characteristics do not significantly change in the presence of a vessel H_A: Narwhal group characteristics do significantly change in the presence of a vessel	Results are inconclusive because of small sample sizes and also because the data collected have changed from year to year.
3	H_0: Narwhal behaviour does not significantly change in the presence of a vessel H_A: Narwhal behaviour does significantly change in the presence of a vessel	Results are inconclusive because of small sample sizes and also because the data collected have changed from year to year. Qualitative descriptions of several narwhal responses to shipping indicate that in some large vessel transits more than half the narwhals remained in the vicinity.
4	H_0: Narwhals do not habituate to large vessel shipping H_A: Narwhals habituate to large vessel shipping	Unable to determine at this time.
Aerial Survey		
1	H_0: Narwhal regional distribution and relative abundance does not significantly change in response to a large vessel transit H_A: Narwhals move away from a vessel and narwhal numbers decrease in response to a large vessel transit	Results are inconclusive because of the high spatial and temporal variability in abundance and distribution of narwhal and because of inability to collect sufficient data from Before/During/After photographic surveys in Milne Inlet and Tremblay Sound. Golder's third party review of the 2015 aerial survey report found the survey design and statistical analysis to be flawed.
2	H_0: Narwhals do not habituate to large vessel shipping H_A: Narwhals habituate to large vessel shipping	Unable to determine at this time.

Hypothesis Number	Null and Alternate Hypotheses	State of Knowledge
Acoustic study		
1	H_0: Presence of narwhal calls does not significantly change relative to a large vessel transit H_A: Presence of narwhal calls does significantly change relative to a large vessel transit	The 2014 and 2015 acoustic reports did not test for a relationship but suggest from visual inspection of the data that the numbers of narwhal calls were reduced during large vessel transits. Examination of the data in an integrated manner does not support this conclusion.
2	H_0: Narwhal call types and frequency of calls do not significantly change in response to large vessel transits H_A: Narwhal call types and frequency of calls do significantly change in response to large vessel transits	This hypothesis was not tested in the acoustic reports. Visual inspection of the data does not appear to support a change in call types and frequency of calls during large vessel transits.

Overall, the results of the monitoring studies have been inconclusive in assigning a causal relationship between the distribution of marine mammals, specifically narwhals, and shipping. Even if there were no other anthropogenic impacts in the Project area, confirming a causal relationship between narwhal distribution and shipping from observational data would be extremely challenging given the high level of variability in narwhal distributions in space and time within their summer range. Developing an understanding of the relationship between narwhals and shipping, with the monitoring methods that were in use between 2013 and 2015, may simply not be possible because of the confounding effect of narwhal hunting which takes place in the same area and at the same time as large shipping transits, even by integrating the information obtained from several monitoring methods.

According to literature estimates of received sound levels that are likely to elicit avoidance (135 dB) or disturbance-onset (120 dB) behaviours, the zone of influence around large vessels should be less than 1 km and may be less than 200 m for the vessels analysed in 2015. If the narwhals are more sensitive and respond to any shipping sound above the background level, the zone of influence would be larger. The indication from the data and observations presently available from Baffinland studies is that any avoidance that is occurring is a short-term effect only, but that is based primarily on IQ observations of narwhal behaviours. Whether these returnees are the same individual narwhals becoming habituated to shipping is unknown and cannot be addressed without analysis of individual movements which could most readily be obtained from satellite-tracked tagging studies. In an animal more predictable in its spatial and temporal distribution, it would be feasible to assume habituation had occurred if densities of the animal were initially lower in the vicinity of the shipping track but then recovered over time so that there was no longer a gradient of abundance relative to shipping activity. With the high variability in narwhal density, it is unlikely that such an analysis will provide any clarity on the question of habituation.

One option for further study is the use of satellite-based tags which would provide information on the spatial position of individual narwhals. If used in conjunction with acoustic monitoring tags and data on ship position, such a study would address other issues related to determination of effects:

- Do narwhals move away from ships? What is the distance between individual narwhals and ships?
- What is the received sound level from ships, measured at the position of the narwhal? This can be measured by placing an acoustic tag on the narwhal as well as the tracking tag.
- If narwhals swim away from ships, and given the large range occupied by individual narwhals on the summering grounds, does avoidance of ships cause them to swim farther or faster than they would in the absence of ships? If this occurs, what are the physiological consequences? Does it mean that narwhals use extra energy that is not easily replaced (since the fiords do not seem to be used as feeding habitat)?
- Do individual narwhals habituate to ships, and if so, how long does it take for habituation to occur?

4.2 The Marine Mammal Program Relative to Terms and Conditions of Project Certificate

An objective of this report was to determine whether the marine mammal monitoring, mitigation and adaptive management program was meeting the Terms and Conditions of NIRB Certificate No. 5 (Amendment #1), and to review what other options might exist for meeting these conditions. In assessing these options and comparing the value of monitoring methods, it is important to consider whether the value provided by new options outweighs the value of continuing a time series that has been established by the existing monitoring plan. It will be apparent, however, from review of the two to three years of monitoring that has been conducted for the programs discussed in Section 3.2 that there has already been considerable year-to-year change in the methods and data collected by the different programs. This is not an ideal situation as it unnecessarily complicates the task of determining what change has occurred over time.

The status of each NIRB Term and Condition relevant to marine mammals has been assessed along with options for the future marine mammal program (Table 21).

Table 21: Summary of Terms and Conditions of NIRB Certificate, activities conducted to meet the Condition, and options for future marine mammal program

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
101	The Proponent shall incorporate into the appropriate monitoring plans the following items: ■ A monitoring program that focuses on walrus use of Steensby Inlet and their reaction to disturbance from construction activities, aircraft, and vessels	Not required at present time; not using Steensby Inlet	---

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
	Efforts to involve Inuit in monitoring studies at all levels	Involved as field observers in shore-based program 2013-2016, shipboard observers 2013-2015, aerial survey 2013-2015.	Continued involvement in shore-based and aerial survey programs. Consider further training, e.g., of Nunavut Arctic College students including data analysis.
	Monitoring protocols that are responsive to Inuit concerns	Has been the goal of all protocols	Continue to keep this a priority
	Marine monitoring protocols are to consider the use of additional detecting devices to ensure adequate monitoring through changing seasonal conditions and daylight	Used acoustic monitoring in 2014-2015	Passive acoustic monitoring can differentiate presence/absence but not very quantitative and not informative as to narwhal's received sound levels. Consider tagging study with sufficient number of tagged narwhals.
	Schedule for periodic aerial surveys as recommended by the Marine Environment Working Group	Aerial survey conducted by Baffinland 2013-2015, data sharing with DFO 2016.	Continue to conduct aerial surveys or to partner as opportunities arise.
	Periodic aerial surveys for basking ringed seals throughout the landfast ice of Steensby Inlet, and a suitable control location. Surveys shall be conducted at an appropriate frequency to detect change inter-annual variability	Not required at present time	---
	Shore-based observations of pre-Project narwhal behavior in Milne Inlet, that continues at an appropriate frequency throughout the Early Revenue Phase (not less than three years)	Bruce Head shore-based monitoring, 2013-2015	Continue program. Consider cameras for data collection in "blind spots" missed from Bruce Head
	Monitoring strategy focused on assessing and mitigating interaction between humans and wildlife at the port site(s).	Not discussed in the present report	----

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
105	The Proponent shall ensure that measures to reduce the potential for interaction with marine mammals, particularly in Hudson Strait and Milne Inlet, are identified and implemented prior to commencement of shipping operations. These measures could include, but are not limited to: a. Changes in the frequency and timing (including periodic suspensions) of shipping during winter months in Hudson Strait and during the open water season in Milne Inlet , i.e., when interactions with marine mammals are likely to be the most problematic b. Reduced shipping speeds where ship-marine mammal interactions are most likely c. Identification of alternate shipping routes through Hudson Strait for use when conflicts between the proposed routes and marine mammals could arise. Repeated winter aerial survey results showing marine mammal distribution and densities in Hudson Strait would greatly assist in this task.	As provided in Shipping and Marine Wildlife Management Plan. Community consultations identified winter shipping as more problematic in Eclipse Sound than summer (Appendix A, Sections 2-3). Ship speeds are already reduced. Hudson Strait routes are not in use.	No additional options proposed at this time
106	The Proponent shall ensure that shipboard observers are employed during seasons where shipping occurs and provided with the means to effectively carry out assigned duties. The role of shipboard observers in shipping operations should be taken into consideration during the design of any ore carriers purpose-built for the Project, with climate controlled stations and shipboard lighting incorporated to permit visual sightings by shipboard observers during all seasons and conditions. Any shipboard lighting incorporated should be in accordance with the *Canada Shipping Act, 2001's Collision Regulations*, and should not interfere with safe navigation of the vessel. .	Marine mammal observers saw very few mammals; safety hazard of vessel transfers at Pond Inlet. Program currently discontinued	Ship's officers required to report collisions

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
107	The Proponent shall revise the proposed "surveillance monitoring" to improve the likelihood of detecting strong marine mammal, seabird or seaduck responses occurring too far ahead of the ship to be detectable by observers aboard the ore carriers. A baseline study early in the shipping operations could employ additional surveillance to detect potential changes in distribution patterns and behavior. At an ambitious scope, this might be achieved using unmanned aircraft flown ahead of ships, or over known areas of importance for seabirds or haul-out sites in the case of walruses, in accordance with the requirements of their Special Flight Operations Certificate.	Experimental use of UAV in 2014 had limited success and was discontinued	No other options identified at this time.
108	The Proponent shall ensure that data produced by the surveillance monitoring program is analysed rigorously by experienced analysts (in addition to being discussed as proposed in the FEIS) to maximize their effectiveness in providing baseline information, and for detecting potential effects of the Project on marine mammals in the Regional Study Area. It is expected that data from the long-term monitoring program be treated with the same rigor.	All data have been analysed by experienced consultants	Ongoing.
109	The Proponent shall conduct a monitoring program to confirm the predictions in the FEIS with respect to disturbance effects from ships noise on the distribution and occurrence of marine mammals. The survey shall be designed to address effects during the shipping seasons, and include locations in Hudson Strait and Foxe Basin, Milne Inlet, Eclipse Sound and Pond Inlet. The survey shall continue over a sufficiently lengthy period to determine the extent to which habituation occurs for narwhal, beluga, bowhead and walrus.	Shore-based, aerial, acoustic and shipboard observer programs are intended to assess disturbance. Differentiating effects of large vessels vs. smaller vessels and hunting is problematic. Monitoring studies conducted to date focus on narwhal; limited information on beluga, bowhead and walrus	Aerial surveys provide information on disturbance effects at regional scale or population decline (may not require fortnightly program; consider focus on peak narwhal period). Shore-based program provides information on smaller-scale reactions of narwhal. Both have limited ability to detect habituation. Consider narwhal tagging studies. May be opportunity for collaboration with DFO/WWF tagging study

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
110	The Proponent shall immediately develop a monitoring protocol that includes, but is not limited to, acoustical monitoring, to facilitate assessment of the potential short term, long term, and cumulative effects of vessel noise on marine mammals and marine mammal populations. The Proponent is expected to work with the Marine Environment Working Group to determine appropriate early warning indicator(s) that will ensure rapid identification of negative impacts along the southern and northern shipping routes.	Passive acoustic monitoring conducted near Bruce Head 2014-2015. No direct measures of received sound by narwhals. Early warning indicator(s) have not been developed	Consider acoustic tags on narwhals along with spatial position tags
111	The Proponent shall develop clear thresholds for determining if negative impacts as a result of vessel noise are occurring. Mitigation and adaptive management practices shall be developed to restrict negative impacts as a result of vessel noise. This shall include, but not be limited to: a. Identifications of zones where cumulative noise could be mitigated due to biophysical features (e.g., water depth, distance from migration routes, distance from overwintering areas etc.) b. Vessel transit planning, for all seasons, to determine the degree to which cumulative sound impacts can be mitigated through the seasonal use of different zones.	Thresholds have not been identified. Evidence for negative impacts is equivocal. Mitigation measures developed in Shipping and Marine Wildlife Management Plan	If sound impacts are considered the key potential stressor, measurement of received sound by narwhal in conjunction with tracking of their movements with respect to ships is likely the best option for identification of negative impacts
112	Prior to commercial shipping of iron ore, the Proponent, in conjunction with the Marine Environment Working Group, shall develop a monitoring protocol that includes, but is not limited to, acoustical monitoring that provides an assessment of the negative effects (short and long term cumulative) of vessel noise on marine mammals. Monitoring protocols will need to carefully consider the early warning indicator(s) that will be best examined to ensure rapid identification of negative impacts. Thresholds shall be developed to determine if negative impacts as a result of vessel noise are occurring. Mitigation and adaptive management practices shall be developed to restrict negative impacts as a result of vessel noise. This shall include, but not be limited to: d. Identification of zones where noise could be mitigated due to biophysical features (e.g., water depth, distance from migration routes, distance from overwintering areas etc.)	Passive acoustic monitoring was conducted 2014-2015 but does not provide direct assessment of negative effects of noise on marine mammals. Early warning indicator(s) and thresholds still under consideration. Mitigation and adaptive management as described in in Shipping and Marine Wildlife Management Plan	See options for #111.

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
	e. Vessel transit planning, for all seasons f. A monitoring and mitigation plan is to be developed, and approved by Fisheries and Oceans Canada prior to the commencement of blasting in marine areas		
119	The Proponent shall, in conjunction with the Marine Environment Working Group, monitor ringed seal birth lair abundance and distribution for at least two years prior to the start of icebreaking to develop a baseline, with continued monitoring over the life of the project as necessary to test the accuracy of the impact predict ions and determine if mitigation is needed. Monitoring shall also include a control sit e outside of the Project's zone of influence.	Not applicable until 2 years before icebreaking	If required, consider potential collaboration with DFO/EC/WWF on polar bear/seal survey on ice, using infrared video and photographic aerial survey
120	The Proponent shall ensure that, subject to vessel and human safety considerations, all project shipping adhere to the following mitigation procedures while in the vicinity of marine mammals: a. Wildlife will be given right of way. b. Ships will when possible, maintain a straight course and constant speed, avoiding erratic behavior. c. When marine mammals appear to be trapped or disturbed by vessel movements, the vessel will implement appropriate measures to mitigate disturbance, including stoppage of movement until wildlife have moved away from the immediate area.	Mitigations as described in in Shipping and Marine Wildlife Management Plan	No other options identified at this time
121	The Proponent shall immediately report any accidental contact by project vessels with marine mammals or seabird colonies to Fisheries and Oceans Canada and Environment Canada respectively, by notifying the appropriate regional office of the: g. Date, time and location of the incident h. Species of marine mammal or seabird involved i. Circumstances of the incident j. Weather and sea conditions at the time k. Observed state of the marine mammal or sea bird colony after the incident l. Direction of travel of the marine mammal after the incident, to the extent that it can be determined	See #106	See #106

NIRB Condition #	NIRB Term and Condition	Status	Options and commentary
122	The Proponent shall summarize and report annually to the NIRB regarding accidental contact by project vessels with marine mammals or seabird colonies through the applicable monitoring report.	See #106	See #106
123	The Proponent shall provide sufficient marine mammal observer coverage on project vessels to ensure that collisions with marine mammals and seabird colonies are observed and reported through the life of the Project. The marine wildlife observer protocol shall include, but not be limited to, protocols for marine mammals, seabirds, and environmental conditions and immediate reporting of significant observations to the ship masters of other vessels along the shipping route, as part of the adaptive management program to address any items that require immediate action.	See #106	See #106
126	The Proponent shall design monitoring programs to ensure that local users of the marine area in communities along the shipping route have opportunity to be engaged throughout the life of the Project in assisting with monitoring and evaluating potential project-induced impacts and changes in marine mammal distributions.	Through community consultations and activities listed in #101	See #101

4.3 Community Suggestions for Marine Mammal Program Development

At the community workshops conducted by Baffinland in 2016 (Appendix A), participants were asked for suggestions on marine mammal monitoring programs, and on mitigation and adaptive management. With respect to monitoring, the community workshop participants would like to see:

- Greater community participation in monitoring programs, including development of a community-based environmental monitoring program
  - Involvement of the HTO to develop a monitoring program involving hunters.
  - Regular sharing of monitoring results with the community of Pond Inlet.
  - Use of a local contractor to conduct environmental monitoring.
- Monitoring throughout Eclipse Sound and Milne Inlet, including the selected trans-shipping location.
- Monitoring earlier in the season, starting in June and July when narwhals start entering Eclipse Sound.
- Continuation of the Bruce Head marine mammal monitoring program.

Community members also made suggestions for mitigation and adaptive management of marine mammals (Appendix A):

- Concerns were focused on the shipping through ice activity.
  - Avoid shipping in March, as seal pups are born in this month. Also avoid shipping in April and May.
  - Avoid shipping in June as this is the peak period for hunters to go out on the ice.

5.0 CONCLUSIONS

The marine mammal program developed for Baffinland Iron Mines Corporation has gathered a considerable amount of data on marine mammal distribution and abundance and behaviour as well as data on the acoustic environment of the Project area. These data are meant to test a series of hypotheses to guide marine mammal management, but due to high natural spatial and temporal variability in the distribution and abundance of narwhals, the confounding effect of hunting and other vessel activity occurring at the same time as Project-related large vessel transits, and small sample sizes that do not allow for statistical testing, the results are inconclusive. The elements of the marine mammal program that have addressed the Project Certificate's Terms and Conditions were identified, and options for the program, moving forward, were provided. Local residents provided their views on Baffinland's marine mammal program at community workshops held in 2016, and major themes included their interest in greater involvement in the program (e.g., community-based monitoring) as well as their concerns about shipping through ice.

6.0 CLOSURE

We trust the information contained in this report is sufficient for your present needs. Should you have any additional questions regarding the project, please do not hesitate to contact the undersigned.

Yours truly,

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APPENDIX A

Summary of Marine Mammal IQ from Community Workshops

BIM conducted a series of workshops in the local communities to learn about contemporary Inuit land use in Eclipse Sound and Navy Board Inlet areas. This information is Inuit Quajimajatuqangit (IQ), defined as ‘‘the combining of the traditional knowledge, experience and values of Inuit society, along with the present Inuit knowledge, experience and values that prepare the way for future knowledge, experience and values’’ (Dale and Armitage 2010).

The following summaries related to marine mammals are excerpted from the report by Jason Prno Consulting Services (2017).

1.0 SEASONAL ACTIVITIES

1.1 Ukiaksaaq (October to Mid-November)

Narwhal hunting occurs in Ukiaksaaq and October was noted as the main harvesting period for this season. Up to 20 boats a week may be out hunting narwhal during peak narwhal availability periods. The highest numbers of hunters will be out when the narwhal numbers are the highest. The areas closest to Pond Inlet were said to be the most actively hunted, as this is where the most narwhal will be present in this season. Milne Inlet and Navy Board Inlet are not very actively hunted for narwhal at this time of year.

Ukiaksaaq is also a period when seal hunting takes place, which can occur all over the ocean (and also occurs throughout the year). Ringed seals are the most popular to hunt, although bearded, harp, and hooded seals may also be caught in lesser quantities. Seal hunting in Ukiaksaaq can occur at winter ice cracks in Eclipse Sound from October to May.

1.2 Ukiuq (Mid-November to February)

Hunting at the Pond Inlet floe edge was noted to occur during Ukiuq. This is the most actively used floe edge (rather than the Navy Board Inlet floe edge), with most people travelling to Button Point first, then north or south along the floe edge. To get to Button Point, people will often travel from Pond Inlet to Bylot Island and then along the coast. Seal hunting is the most popular activity that occurs during this season. Ringed seals are the most popular seals to harvest, but harp, bearded, and hooded seals may also be caught (although hooded seals are rarely caught). The smaller and tastier seals were noted to come from the floe edge and January was said to be the best seal hunting month in Ukiuq. Polar bear and occasional walrus hunting will also occur at the Pond Inlet floe edge.

Hunting at the Navy Board Inlet floe edge may also occur during Ukiuq, although this area is not very actively used (it was used more in the past). Some polar bear, seal, and walrus hunting may occur, with ringed seal being the most popular seal species harvested. However, some bearded and harp seal may also be harvested. The Navy Board Inlet floe edge was noted to have many more walrus present than at the floe edge in the Button Point area.

Seal hunting throughout Eclipse Sound (i.e., not confined to the floe edge) will occur during Ukiuq. Hunting occurs in different ways, including at cracks in the ice. Seal hunting at winter ice cracks will occur from October to May, with ringed seals being the primary focus (although bearded seals may be harvested occasionally). No particularly busy month for seal hunting during Ukiuq was identified, as hunting was said to be fairly constant throughout this season. Once seal hunting cracks freeze over in Eclipse Sound in December or early January, more people travel

to the Button Point area to hunt. Hunting at seal breathing holes may also occur. This activity will take place throughout Eclipse Sound (and throughout the year), although in some years seals will use breathing holes more than others. Seal nets may also be used as a harvesting method, although they are generally only used by individuals with dog teams (currently, fewer than 10 people). It was additionally noted that seals will start to make their dens in February, while seal pupping will begin in February and March.

1.3 Upirngaksaaq (March to May)

Workshop participants noted the same land use activities occurring in Ukiuq also occur in Upirngaksaaq. However, a number of differences were discussed, including the fact that narwhals start arriving in April and May. Seal hunting also continues in Ukiuq and seal pupping will last into March. Ringed seal pups were preferred by local Inuit and are harvested throughout Eclipse Sound. The only areas noted that were not good for hunting them are where polar bears are also hunting them. However, snow and ice conditions will dictate exactly where seal pups are found. More generally, seal hunting can occur at winter ice cracks in Eclipse Sound from October to May.

Pond Inlet floe edge activities continue in Upirngaksaaq, including the hunting of ringed and bearded seal, narwhal, polar bear, and walrus (although walrus is not often hunted here). A number of people will be at the floe edge in May because of narwhal hunting opportunities. Hunting at the floe edge, generally, is very popular from April to June, with June being the most popular month. There are approximately the same number of people at the floe edge during Upirngaksaaq as in Ukiuq; however, many more people use Eclipse Sound for hunting seal pups at this time. It was estimated there will be 20+ groups/individuals out per week hunting during this time. May and June were also noted to be a popular time for outfitters and other tourists (like photographers) to visit the floe edge.

In May, leads (which are different than ice cracks) will start forming in the ice. Leads will usually form in the same place each year. Upirngaksaaq also sees some narwhal hunting occur at the Navy Board Inlet floe edge in April and May. More generally, April and May were noted to be very popular for sport hunting, with April being the main month for sport hunting. The Nunavut Quest dog team race may also occur in Upirngaksaaq.

1.4 Upirngaaq (Late May to July)

While all of Upirngaaq was described as a busy period for land use activities, June was the busiest month, as long as there is ice to travel on and hunt from. People will be spread throughout Eclipse Sound during this time of year; however, Pond Inlet floe edge activities continue to be important during Upirngaaq. Seal and narwhal hunting at the floe edge occur, and bowhead whales may be found at this time of year. However, bowhead whales will not be regularly harvested because they are under a harvesting quota system. Porpoises may also be seen at the floe edge, but will not be harvested. The floe edge will remain busy until the Pond Inlet HTO informs the community it should no longer be used for the season because of safety concerns (e.g., due to thin or melting ice).

Seal harvesting occurs throughout Eclipse Sound at breathing holes, while seals are basking on the ice, and in leads (although not regularly) during Upirngaaq. Spring was the most popular seal hunting period of the year, with young seals primarily being harvested at this time. Upirngaaq was when seal pups become young seals, who are then often harvested for their skins. Adult seals are not regularly harvested because they sink once shot at this time of year and are difficult to retrieve. Only dog team owners will typically hunt adult seals at this time.

Narwhal harvesting is another land use activity that occurs in Upirngaaq. Narwhal will enter the leads in Eclipse Sound in July. Narwhal migrate into Eclipse Sound from both Navy Board Inlet and Pond Inlet, although large male narwhals will be the first ones to enter the leads, ahead of the females and calves.

1.5 Aujaq (End of July to September)

Harvesting of marine mammals will occur in locations throughout Eclipse Sound during Aujaq. Hunting seals and narwhal was very popular during this time of year and it was estimated that more than 50 boats per week could be out hunting during this time. While ringed seals are harvested everywhere in Eclipse Sound during Aujaq, the harvesting of young seals is preferred. Harp seals and the occasional bearded seal may also be harvested. Likewise, most narwhal in the area are found from the end of July to the middle of August. Narwhal calving was noted to occur in the southwestern inlets/fjords of Eclipse Sound (e.g., Milne Inlet). August and September are the busiest narwhal harvesting periods in the year. Polar bears are present in the area but are not harvested, as their hunting season is over at the end of May.

Some walrus may be harvested to the east of the community of Pond Inlet; however, there generally are few walrus present in this location because the water is too deep for them. Walrus may also be harvested in northern Navy Board Inlet during Aujaq, but not regularly (however, walrus were noted to be present there year round). Workshop participants noted walrus harvesting isn't an activity that is typically focused on by local hunters from Pond Inlet. Likewise, killer whales can be seen in Eclipse Sound at this time of year but will not be hunted. Bowhead whales also migrate through the area with their calves in Aujaq, but are not actively harvested by Inuit due to the quotas that are in place. Fin or sperm whales may also be seen, but are not harvested. Workshop participants additionally noted more porpoises are being seen in the area; however, these won't be harvested.

2.0 NARWHAL DISTRIBUTION

In addition to discussing contemporary Inuit land use activities, key narwhal migration and lifecycle activities in the Eclipse Sound and Navy Board Inlet areas were discussed in Workshop #1. (*Note: a map of key migration and lifecycle activities is in production as Fig. 8 of the Prno report but was not included in the draft version provided to Golder. This should be included in later versions of this marine mammal integration report*.)

Workshop participants generally noted that in April, May, and June narwhal will migrate in from Baffin Bay and be found in the areas offshore of the Pond Inlet floe edge, northern coast of Bylot Island, Navy Board Inlet floe edge, and eastern Lancaster Sound. The main narwhal migration is from the south and begins in March each year. Once the ice starts to break up in July, narwhal begin migrating into Eclipse Sound through Pond Inlet and Navy Board Inlet. Narwhal first begin coming into the leads closest to the Pond Inlet floe edge in July. It was noted that large male narwhals are the first ones to enter the leads, ahead of the females and calves. In August, September, and October, narwhal are found in the Milne Inlet area; this is where calving activities occur. In October and November, narwhal migrate back out to Baffin Bay through Eclipse Sound and Pond Inlet to overwinter. However, it was noted the periods mentioned here are approximate and may change from year to year (e.g. due to ice conditions).

3.0 SHIPPING

3.1 Shipping Through Ice

Using the seasonal land use maps developed through community consultation (i.e., material summarized in sections 1 and 2 of this Appendix), Baffinland identified a number of potential Project-land use interactions for each season when shipping through ice would occur. These seasons include Ukiaksaaq (October to mid-November; however, ice only forms in the latter part of this season), Ukiuq (mid-November to February), Upirngaksaaq (March to May; however, Baffinland is not proposing to ship in April and May), and Upirngaaq (late May to July). Aujaq (end of July to September) was not reviewed at the workshop on shipping through ice as this season was discussed in the workshop on open water shipping.

Of particular concern to workshop participants was the potential for marine mammals in the Eclipse Sound area to be negatively affected by shipping. Workshop participants also expressed concerns that shipping through ice would interfere with their hunting of marine mammals in Eclipse Sound and reduce their ability to fully participate in Pond Inlet floe edge activities.

Workshop participants noted shipping through ice is not an activity that regularly occurs in Eclipse Sound. As such, the residents of Pond Inlet lack experience with shipping through ice and are unfamiliar with all of its potential effects. A number of workshop participants also had concerns about the use of Eclipse Sound as a shipping route and questioned whether Baffinland would consider using Navy Board Inlet instead. It was suggested that Navy Board Inlet could result in fewer negative effects on marine wildlife, Inuit harvesting, and Inuit travel.

Some experiences with shipping through ice at the Nanisivik Mine near Arctic Bay were shared during the Phase 2 community workshops. For example, one individual recalled that seals would act afraid of ships moving through rough ice. It was also noted that while seals would initially flee from shipping activities, they would generally return to the area a day after a ship had passed through. Some hunters from Arctic Bay were also said to have benefited from Nanisivik's shipping activities, as they could hunt narwhal in the ship track after the ship had passed.

Shipping during March, April, and May was also a concern for some individuals due to various land use and environmental considerations (e.g. seal pups are born in March and could be affected by shipping activities).

Discussion with Arctic Bay residents, who have experience with shipping through ice, identified that some of the concerns Arctic Bay residents initially had about shipping through ice never materialized. One individual described concerns the community had about the impacts of ice breaking on narwhal but noted that rather than scaring narwhal away, ice breaking created access for narwhal and ended up benefiting local hunters. However, some minor and/or temporary effects associated with shipping through ice were noted. For example, one individual mentioned narwhal would at first flee when an ice breaker came near, but would eventually return to the area. Another individual added that overall changes (e.g., year to year abundance) to the narwhal population did not occur as a result of Nanisivik's shipping activities. In another instance, a small number of dead seals were noted near where a Nanisivik ship had passed and there were reports of seals losing their hearing as a result of shipping activities. However, another individual described how seals will likely adapt to the noise and disturbance caused by shipping, simply by avoiding areas where shipping activity occurs.

Specific comments by workshop participants included:

- *The ship track was used by narwhal to migrate in because the ship was opening up the ice. But when the ice breaker came in the narwhals would scatter. After the ice breaker came in and things calmed down, the narwhal came back in. It had a very temporary impact.*
- *We didn't see any decrease year to year. We didn't notice any changes in the population or abundance of narwhal. There were no drastic changes to the numbers.*
- *I noticed dead seals near the ship and they lost hearing too, so they gave us reports on that. Not too many though. We heard of reports of seals losing hearing. We report it to the conservation officer, who might have the reports. The seal was taken for testing. There were only 1-2 dead seals. Afterwards, there was a scientist working on seals and he was doing a study, but there were no real concerns.*
- *Let's say if the ship came in the fall, the seals might avoid breeding in the space where they heard this noise. They might breed somewhere else. They can adapt to the conditions that are being brought to them. The seals already know there is too much activity, so they will go elsewhere to breed. If the ship is moving in the same place, the animals will know, they will only stick to the places where the ships aren't. They'll go a certain distance from the noise. The seals will avoid the area of activity. They are already prepared when the ice is frozen to give birth.*

3.2 Open Water Shipping

Seasons when open water shipping would occur include Upirngaaq (late May to July; however, open water only occurs in the latter part of this season), Aujaq (end of July to September), and Ukiaksaaq (October to mid-November; however, ice forms in the latter part of this season). Ukiuq (mid-November to February) and Upirngaksaaq (March to May) were not reviewed as these seasons were discussed in the workshop on shipping through ice.

Open water shipping was generally noted to raise much fewer concerns than shipping through ice. Open water shipping was said to be less concerning because Pond Inlet residents have past experience with this type of shipping and because similar open water shipping activities have already been approved by regulators (e.g. for Baffinland's Early Revenue Phase). Likewise, Eclipse Sound was often seen as an acceptable location for open water shipping to occur. However, some concerns over the increased number of open water shipping transits required for Baffinland's Phase 2 were raised.

While some workshop participants expressed concern marine mammals could be impacted by shipping activities, a number of others commented on the ability of marine mammals to adapt and the lack of long-term effects that would result from open water shipping. For example, it was noted that marine mammals may initially flee from shipping activities but will tend to return to an area shortly after a ship has passed. Likewise, marine mammals can become accustomed to shipping-related noise and disturbance if it poses no immediate threat to their safety. It was also noted that marine wildlife population numbers can naturally fluctuate over time.

The following statements were made by workshop participants:

- *The marine mammals, they get used to shipping noise. In the past, when the ships started coming to our area in the 1960s, wildlife would move somewhere else. Nowadays, seals are no longer going to different areas. Sometimes they go not far away, but this is temporary and then they return. We see ore carriers passing through Eclipse Sound. Calving areas for narwhal are near Bruce Head and Tremblay Sound. I'm not talking about winter shipping. We have monitors stationed at the Bruce Head.*
- *When the ships start entering the area, the narwhals listen to the noise. After the ship continues on, the narwhal return. That's how they behave. It's not like they are scared. Narwhals tend to move faster from cruise ships and merchant vessels. Iron ore vessels move a lot slower, so the narwhal seem to tolerate them more. Seals know when the ships are coming before the narwhals do. When the ships are travelling, you see more seals on the shoreline. That is something that we can clearly see… One thing that was evident two years ago, when they were building a dock at Milne Port, is that they would swim away when there were no ships in the area and also when there were no hunters in the area. They seem to tolerate the ships. I don't want to say bad things about hunters, but narwhals move away from hunters when they hear shooting. When the iron ore carriers move through here, the narwhals always return.*
- *Ships don't bother narwhal much anymore. When a ship is louder and starts its engine, the narwhals run away. They are more afraid when it's leaving than when it's coming in. That's how we see them from Bruce Head. When the work started on the dock, the narwhal would run away because they were putting boulders in the water. The narwhals would come back in the evening. They are more afraid of rocks than ships. I guess they are used to ships now. Seals are braver than narwhal as long as they have distance between them. They will go underwater when the ship comes and then rise up again when it leaves. Narwhals take the newborn calf between them and force it to dive. As they grow they get left alone.*
- *Narwhals will still have access, even if there is shipping. When we went to Labrador, someone harvested narwhal in the ship track… Narwhals get used to the ship sounds. Marine mammals not being hunted don't get scared. Once population numbers increase, they are not afraid of anything. You won't be able to block the route of narwhals, regardless.*
- *Narwhals are coming, and the ship shows up, and before the narwhals reach the hunters' area they stopped and went back. Hunters were frustrated because they lost their chance to hunt.*

Some local residents have questioned whether Baffinland activities including shipping and use of "underwater acoustic devices" *[Note added by Golder: there is no information on what kind of underwater acoustic device is meant here]* have been responsible for recently observed changes to marine wildlife. These changes have included fewer narwhal being observed and an increase in harp seals in Eclipse Sound. More generally, workshop participants commented on the lack of communication they perceived to be occurring between Baffinland and the community of Pond Inlet, specifically with regards to the results of existing monitoring programs. Other comments by workshop participants included:

- *The hunters and elders had some concerns during the past summer. We only saw harp seals in our area. Only later in the fall were we able to get seals and narwhals, so there was some speculation that there may be some devices in the water. We did not see narwhals here in July, August, September.*

- *We have that narwhal monitoring at Bruce Head and [unrecorded comments]. We know that in Milne Inlet, before Baffinland, we had a baseline of how mammals lived. Some of these animals that go up into the area have stopped going there or up to Koluktoo Bay. This summer we had the least amount of narwhal go up into those bays, according to our study. It is seals too. It is visible now.*

Residents of Arctic Bay made the following statements about open water shipping:

- *We had a tanker anchored here. We had killer whales come in close to the tanker. I don't think it's a big concern to the marine mammals. Maybe they're attracted to the ship more than they are scared of it.*
- *I think over time the marine mammals can get used to it. In the early days of the ships, animals used to go right to shore. We see seals behaving normally. It actually benefitted hunters because it herded narwhal close to shore.*
- *We know as HTO members that in the summer the marine mammals move at their own discretion wherever they feel like. They are like you and me. We don't want to be rammed by a ship, so we move out of the way. I'm worried about spill clean ups, but ramming will never happen.*
- *In the summer, this [shipping] is the only way to do it. Today there are seals and narwhal moving about normally, they're used to it. They're not threatened. If they hear something they don't like, they're going to go away from it. In open water, they can go anywhere. Summer is not a problem to me.*

3.3 Trans-shipping Locations

Three potential trans-shipping locations for Baffinland's Phase 2 (Figure 1) were reviewed with workshop participants. Workshop participants were asked to comment on the acceptability of each site and whether one site was preferable over others. Anchorage #1 (Ragged Island, the area used in 2015 as an anchorage for vessels awaiting transit to Milne Port) was noted by many individuals to be the preferred trans-shipping location compared to Anchorages #2 and #3. This is because Anchorage #1 is in an area that has few marine mammals, where hunting does not regularly take place, and where people generally don't camp. Anchorage #2, on the other hand, is located in an area that has many marine mammals and where people camp. There does not appear to have been any specific information recorded on any social or biological importance of Anchorage #3.

Figure 1: Locations of anchorages discussed at community workshops in 2016.

4.0 COMMUNITY INPUT ON MARINE MAMMAL MONITORING AND MITIGATION

The community workshop participants provided suggestions on requirements for marine mammal monitoring, and for mitigation/adaptive management for marine mammals.

4.1 Monitoring Suggestions

Community members made the following suggestions for marine mammal monitoring:

- Further research and monitoring of marine mammals (e.g. seals, whales) will need to occur.
- The existing Bruce Head marine mammal monitoring program should continue to operate.
- Marine mammal (especially narwhal) monitoring and research should occur throughout Eclipse Sound and Milne Inlet, rather than focusing only on Bruce Head, and include the selected trans-shipping location.
- Marine mammal monitoring programs should occur throughout the life of the Project.
- Monitoring results should be shared with the community of Pond Inlet on a regular basis.
- A community-based environmental monitoring program should be developed, in order to make greater use of community monitors and input.
- Work with the HTO to develop a monitoring program involving hunters.
- The existing ship-based observer monitoring program has issues primarily due to the viewing/sightline limitations faced by observers while transiting Eclipse Sound.

- The use of acoustic devices and underwater monitoring devices were noted to have negative effects on marine wildlife and were discouraged. (*Comment added by Golder: it is unclear what is meant by these devices and what specific negative effects were believed to be associated with them)*.
- Start monitoring in June and July.
- The community of Pond Inlet would benefit from an environmental monitoring business being run by a local contractor. It was also suggested Baffinland communicate all potential contracting opportunities (e.g., for monitoring) to the community of Pond Inlet in the future.

4.2 Mitigation and Adaptive Management Suggestions

Community members made the following suggestions for mitigation and adaptive management of marine mammals:

- Avoid shipping in June. June is the peak period for Inuit hunters and families going out on the ice to hunt, travel, and camp.
- Shipping during March is a concern as seal pups are born in this month. Shipping may need to be avoided in this month. Some individuals also suggested shipping in April and May should be avoided.
- The use of Navy Board Inlet is preferred over Eclipse Sound for shipping through ice activities.
- Some re-routing of ship traffic may be useful to avoid Inuit hunting areas, marine wildlife, and shallow areas that are hazardous for ships
- A shipping through ice 'pilot project' in Eclipse Sound could be useful. It would allow local residents to directly experience shipping activities and effects.
- Some way of dispersing seal pups located in front of the ships should be considered

Specific comments by community members include:

- *In the months of June and July, narwhals start entering Eclipse Sound, so I would prefer there be monitoring in June and July. It's not only narwhals that are entering; other marine mammals also enter this area and sometimes they enter through Navy Board Inlet. Under Phase 2, there should be additional monitoring outside of Bruce Head, which only occurs in summer.*
- *There needs to be an improvement on monitoring. People on the ships [shipboard observers] see nothing because everything is moving away from them. You could work with the HTO to set up a monitoring program, like using a form for hunters to fill out.*

APPENDIX B

Vessel Activity in the Project Area

2013
During Aerial Surveys

Table B-1: Summary of vessels detected by AIS and that were active in the survey area on survey dates in 2013

Survey Period	Survey Date	Active Vessels (and stratum where they were active, if reported)
1	31 Aug	Cruise ship *M/V Akademik Ioffe* Cruise ship *Hanse Explorer* Cruise ship *Le Boreal* CCGS *Henry Larsen* M/V *Claude A. Desgagnés* (Milne Port, Milne Inlet)
	1 Sept	Cruise ship M/V *Akademik Ioffe* Cruise ship *Hanse Explorer* Cruise ship *Le Boreal* CCGS *Henry Larsen*
2	14 Sept	Cargo ship *Avataq* Cargo ship *Qamutik* (Milne Inlet South, Milne Inlet North)
	15 Sept	Cargo ship *Avataq* Cargo ship *Qamutik*
3	29 Sept	CCGS *Amundsen* (Eclipse Sound)
	30 Sept	M/V *Claude A. Desgagnés* (Milne Inlet)
4	14-18 Oct	No vessels

Bruce Head Shore-based Survey

Table B-2. Vessels observed from Bruce Head in August 2013

Date	Time	Name	Type	Size	Direction
6 Aug	11:28	Kayaks (x3)	Recreational	Small	South
	11:38	*Arctic Tern*	Sailboat	Small	South
7 Aug	5:08	M/V *Jana Desgagnés*	Fuel tanker	Large	South
	11:29	None	Motorized Skiff	Small	West
	13:23	None	Motorized Skiff	Small	East
	13:50	*Arctic Tern*	Sailboat	Small	South
	14:45	Kayaks	Recreational	Small	N/A
	16:03	*M/V Claude A. Desgagnés*	Cargo	Large	South
	16:08	None	Motorized Skiff	Small	West
8 Aug	13:10	*Arctic Tern*	Sailboat	Small	North
9 Aug	16:15	None	Motorized Skiff	Small	West
10 Aug	12:12	HMCS *Summerside*	Navy Ship	Medium	North
	14:01	None	Motorized Skiff	Small	West
	19:07	M/V *Claude A. Desgagnés*	Cargo	Large	North
11 Aug	15:50	None	Motorized Skiff	Small	West
	17:17	None	Motorized Skiff	Small	East
12 Aug	17:20	*Lady M II*	Luxury Yacht	Medium	North
	20:50	M/V *Qamutik*	Cargo	Large	South
13 Aug	16:47	None	Motorized Skiff	Small	West
	18:04	Research boats (x2)	Motorized Skiff	Small	North
14 Aug	14:04	*Sea Adventurer*	Cruise Ship	Large	North
	14:24	None	Motorized Skiff	Small	West
19 Aug	0:47	M/V *Qamutik*	Cargo	Large	North
21 Aug	16:16	None	Motorized Skiff	Small	West
25 Aug	16:09	None	Motorized Skiff	Small	East
26 Aug	18:55	M/V *Avataq*	Cargo	Large	South

2014
During Aerial Surveys

Table B-3: Summary of vessels detected by AIS and that were active in the survey area on survey dates in 2014

Survey Period	Survey Date	Active Vessels (and stratum where they were active, if reported)
1	1-2 Aug	No vessels
	3-4 Aug	No vessels
2	14-15 Aug	Cargo ship *Claude A. Desgagnés* (Milne Port) Fuel tanker M/T *Maria Desgagnés* (Milne Inlet) Two sailboats (Milne Inlet)
	16-17 Aug	Cruise ship *M/V Silver Explorer* Two sailboats (Milne Inlet) Two sailboats (Eastern Eclipse Sound)
3	30-31 Aug	Cargo ship M/V *Qamutik* Cargo ship M/V *Happy Delta* (Pond Inlet, Eclipse Sound) Navy vessel (north entrance Oliver Sound) Cruise ship M/V *Akademik Ioffe* (Pond Inlet)
	1-2 Sept	Cargo ship M/V *Happy Delta* (anchored at Milne Port) Navy ship (north entrance Oliver Sound) Cruise ship M/V *Austral* (Pond Inlet to Navy Board Inlet) Cruise ship M/V *Sea Explorer* (Pond Inlet)
4	14-15 Sept	Navy ship (Navy Board Inlet) Cargo ship M/V *Happy Dover* (Northern Milne Inlet to Pond Inlet) Cruise ship M/V *Akademik Ioffe* (Eclipse Sound) Cruise ship M/V *La Louise* (Eclipse Sound)
	16-17 Sept	Cargo ship M/V *Happy Dover* (Pond Inlet)
5	29-30 Sept	CCGS *Pierre Radisson* and its launch (Northern Milne Inlet, Western Eclipse Sound) Fuel tanker M/V *Havelstern* (Eastern Eclipse Sound, Pond Inlet) CCGS *Amundsen* (Navy Board Inlet)
	1-2 Oct	Cargo ship M/V *Anna Desgagnés* (Navy Board Inlet)
6	17-20 Oct	No vessels
	21-22 Oct	No vessels

Bruce Head Shore-based Survey

Table B-4. Vessels observed from Bruce Head, 2014

Date	Time First Observed	Name	Type	Size	Direction
5 Aug	14:07	*Bagheera* (7431)	Sailboat	Small	East
6 Aug	00:00	*Bagheera* (7431)	Sailboat	Small	N/A
	14:35	*Bagheera* (7431)	Sailboat	Small	North
8 Aug	15:34	M/V *Akademik Ioffe*	Cruise Ship	Large	North
	19:58	None	Skiff with outboard	Small	South
13 Aug	18:52	None	Skiff with outboard	Small	N/A
15 Aug	12:41	M/T *Maria Desgagnés*	Fuel Tanker	Large	North
	13:17	*Sedna IV*	Sailboat	Medium	South
16 Aug	15:56	*Sedna IV*	Sailboat	Medium	North
	21:53	None	Skiff with outboard	Small	South
17 Aug	06:26	None	Skiff with outboard	Small	N/A
	16:03	None	Skiff with outboard	Small	N/A
	16:06	None	Skiff with outboard	Small	N/A
18 Aug	08:54	M/V *Claude A. Desgagnés*	Cargo	Large	North
	17:34	None	Skiff with outboard	Small	N/A
22 Aug	14:34	None	Skiff with outboard	Small	West
	19:20	None	Skiff with outboard	Small	North
	20:15	None	Skiff with outboard	Small	West
23 Aug	13:22	None	Skiff with outboard	Small	South
	06:06	None	Skiff with outboard, 2	Small	South
	17:25	None	Skiff with outboard	Small	South
	17:26	None	Skiff with outboard	Small	South
	19:24	None	Skiff with outboard	Small	North
	19:47	None	Skiff with outboard	Small	North
28 Aug	18:58	None	Skiff with outboard	Small	N/A
31 Aug	15:00	None	Skiff with outboard	Small	North
	16:36	None	Skiff with outboard	Small	North
	17:08	M/V *Happy Delta*	Cargo	Large	South
	20:08	None	Skiff with outboard	Small	N/A
1 Sept	15:13	None	Skiff with outboard	Small	N/A
2 Sept	13:10	None	Skiff with outboard	Small	N/A
	13:41	None	Skiff with outboard	Small	North
	14:46	None	Skiff with outboard	Small	N/A
	16:04	None	Skiff with outboard	Small	North
3 Sept	17:31	None	Skiff with outboard	Small	N/A

Date	Time First Observed	Name	Type	Size	Direction
	20: 42	None	Skiff with outboard	Small	N/A
	20:44	M/V *Happy Delta*	Cargo	Large	North
5 Sept	13:48	None	Skiff with outboard, 2	Small	South
	14:15	None	Skiff with outboard	Small	East
	14:35	None	Skiff with outboard	Small	North
	14:54	None	Skiff with outboard	Small	West
	15:51	None	Skiff with outboard	Small	N/A
	17:45	None	Skiff with outboard	Small	N/A
	18:01	None	Skiff with outboard	Small	East
	18:26	None	Skiff with outboard	Small	North
	18:26	None	Skiff with outboard	Small	North

2015

During Aerial Surveys

Extensive Survey

Table B-5: Summary of vessels detected by AIS and that were active in the survey area on extensive survey dates in 2015

Survey Period	Survey Date	Active Vessels (and stratum where they were active, if reported)
1	1-2 Aug	Cargo ship M/V *Federal Tiber* (Eclipse Sound / Ragged Island anchorage) Tug M/V *Svitzer Nerthus* (Milne Inlet to Milne Port) Tug M/V *Svitzer Njal* (Milne Inlet to Milne Port)
2	16-17 Aug	Tug M/V *Svitzer Nerthus* (Milne Port) Ore carrier M/V *Golden Saguenay* (Pond Inlet to Milne Inlet) Cruise ship M/V *Hanseatic* (Pond Inlet to Navy Board Inlet) Cruise ship M/V *Akademik S. Vavilov* (Pond Inlet to Bylot Island) Cruise ship M/V *Akademic Ioffe* (Pond Inlet)
3	31 Aug	Ore carrier M/V *Nordic Olympic* (Ragged Island to Milne Port) Cargo ship M/V *Sedna Desgagnés* (Eclipse Sound, Pond Inlet) Ore carrier M/V *Golden Opportunity* (Pond Inlet to Ragged Island anchorage) Tug M/V *Svitzer Nerthus* (Assomption Harbour) Tug M/V *Svitzer Njal* (Assomption Harbour) Cruise ship M/V *Hanseatic* (Pond Inlet, Eclipse Sound)
4	15 and 17 Sept	Ore carrier M/V *Federal Tiber* (Ragged Island to Milne Port) Navy ship HMCS *Shawinigan* (Eclipse Sound, Pond Inlet) Navy ship HMCS *Moncton* (Eclipse Sound, Pond Inlet) CCGS *Pierre Radisson* (Eclipse Sound, Pond Inlet)

Photographic Survey

Table B-6: Active vessels in and near the Project area during the 2015 photographic survey

Survey Date	Active Vessels	Vessel Movements
18 Aug.	Ore carrier M/V *Golden Ice*	Departed Milne Port, transited northbound through Milne Inlet
	6 small boats; no hunting observed	Milne Inlet
	Tug M/V *Svitzer Nerthus*	Active in Assomption Harbour
	Tug M/V *Svitzer Njal*	Active in Assomption Harbour
	Sailboat	Active south of Ragged Island
	Cruise ship M/V *Academik Ioffe* Ore carrier M/V *Golden Saguenay* Sailboat *Aventura* Ore carrier M/V *Nordic Olympic*	In Eclipse Sound, Pond Inlet, and/or Navy Board Inlet
22 Aug.	Ore carrier M/V *Nordic Odyssey*	Transited northbound through Milne Inlet into Eclipse Sound (out of survey area approx. 1315h)
	1 small boat; no hunting observed	Milne Inlet
	Ore carrier M/V *Nordic Olympic*	Circling in Eclipse Sound waiting for anchorage at Ragged Island
30 Aug.	Ore carrier M/V *Golden Saguenay*	Southbound in Milne Inlet from Ragged Island
	Ore carrier M/V *Nordic Oshima*	Southbound in Milne Inlet to Ragged Island
	2 hunting boats	Milne Inlet
	Cruise ship M/V *Akademik Ioffe* Cruise ship M/V *Le Soleal* Cruise ship M/V *Sea Explorer I* Ore carrier M/V *Nordic Orion*	Outside of Milne Inlet
4 Sept.	Ore carrier M/V *Golden Brilliant*	Northbound through Milne Inlet into Eclipse Sound
	Ore carrier M/V *Nordic Oshima*	Southbound from Ragged Island anchorage through Milne Inlet
	Ore carrier M/V *Golden Ruby*	Southbound through Milne Inlet to Ragged Island anchorage
	19 sightings of small boats; 1 was close to the narwhal herd; 7 sightings of hunting vessels; narwhal carcass observed	
	Cargo ship M/V *Anna Desgagnés*	Westbound from Pond Inlet to southern Navy Board Inlet

Bruce Head Shore-based Survey

Table B-7: Vessels observed from Bruce Head, 2015

Date	Time	Vessel	Size
2 Aug	15:00	1 tug boat	Small
3 Aug	10:00	*Federal Tiber*	Large
	11:00	*Federal Tiber*	Large
	11:00	1 aluminum skiff with 2 outboards	Small
	12:00	*Federal Tiber*	Large
	15:00	1 skiff with 2 outboards	Small
6 Aug	15:00	1 skiff with 1 outboard	Small
	16:00	1 skiff with 1 outboard	Small
	17:00	1 skiff with 1 outboard	Small
7 Aug	10:00	*Nordic Odin*	Large
	11:00	*Nordic Odin*	Large
	13:00	2 skiffs with outboards	Small
	14:00	1 small skiff with outboard	Small
8 Aug	07:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
	08:00	1 small skiff with outboard	Small
	16:00	1 skiff with outboard	Small
	17:00	3 skiffs: at least1 with 2 outboards	Small
	18:00	4 skiffs with outboards	Small
	19:00	2 skiffs with outboards	Small
9 Aug	14:00	1 skiff with 1 outboard	Small
	15:00	1 skiff with 1 outboard	Small
	16:00	1 skiff with 1 outboard	Small
	17:00	1 skiff with 1 outboard	Small
	18:00	1 skiff with 1 outboard	Small
	19:00	1 skiff with 1 outboard	Small
	20:00	1 skiff with 1 outboard	Small
10 Aug	14:00	1 skiff with 1 outboard	Small
	15:00	1 skiff with 1 outboard	Small
	18:00	1 skiff with outboards	Small
	19:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
11 Aug	01:00	1 skiff with 1 outboard	Small
	18:00	1 skiff with 1 outboard	Small
	21:00	1 skiff with 1 outboard	Small
12 Aug	11:00	2 skiffs, at least 1 with 2 outboards	Small
	13:00	2 skiffs, each with 1 outboards	Small
	14:00	1 skiff with 1 outboard	Small

Date	Time	Vessel	Size
	15:00	1 skiff with 1 outboard	Small
	16:00	1 skiff with 1 outboard	Small
16 Aug	11:00	1 with 2 outboards	Small
	12:00	1 with 2 outboards	Small
18 Aug	05:00	*Akademik Ioffe*	Large
	06:00	*Akademik Ioffe*	Large
	09:00	*Akademik Ioffe*	Large
	19:00	*Golden Ice*	Large
19 Aug	12:00	Nordic Odin	Large
	13:00	Nordic Odin	Large
	15:00	1 with 2 outboards	Small
	16:00	1 with 2 outboards	Small
	17:00	1 with 2 outboards	Small
20 Aug	16:00	1 with 2 outboards	Small
	17:00	1 with 1 outboard	Small
	18:00	3 skiffs, at least 1 with 2 outboards	Small
	19:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
	20:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
21 Aug	7:00	1 skiff with 1 outboard	Small
	08:00	2 skiffs, at least 1 with 2 outboards	Small
	09:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
	10:00	1 skiff with 2 outboards	Small
	11:00	1 skiff with 2 outboards	Small
	18:00	1 skiff with 2 outboards	Small
	19:00	2 skiffs, each with 1 outboard	Small
	20:00	1 skiff with 2 outboards	Small
	21:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
22 Aug	08:00	*Nordic Odyssey*	Large
	09:00	*Nordic Odyssey*	Large
	09:00	1 skiff with 2 outboards	Small
	12:00	1 skiff with 1 outboard	Small
	13:00	1 skiff with 1 outboard	Small
	14:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
	16:00	1 skiff with 1 outboard	Small
	17:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
23 Aug	09:00	1 skiff with 1 outboard	Small
	10:00	1 skiff with 2 outboards	Small
	11:00	3 skiffs: 1 with 1 outboard, 2 with 2 outboards	Small

Date	Time	Vessel	Size
	17:00	*Golden Brilliant*	Large
	18:00	*Golden Brilliant*	Large
	18:00	3 skiffs: at least 2 with 1 outboard	Small
	19:00	2 skiffs, both with 2 outboards	Small
	20:00	3 skiffs: 1 with 1 outboard, 2 with 2 outboards	Small
	21:00	1 skiff with 1 outboard	Small
24 Aug	13:00	1 skiff with 2 outboards	Small
	15:00	1 skiff with 2 outboards	Small
29 Aug	11:00	1 skiff with 1 outboard	Small
	12:00	1 skiff with 1 outboard	Small
	13:00	1 skiff with 1 outboard	Small
	14:00	2 skiffs, each with 1 outboard	Small
	15:00	2 skiffs, each with 1 outboard	Small
	16:00	3 skiffs: 2 with 1 outboard, 1 with 2 outboards	Small
30 Aug	11:00	*Golden Saguenay*	Large
	12:00	*Golden Saguenay*	Large
	12:00	1 skiff with 2 outboards	Small
	13:00	2 skiffs, each with 2 outboards	Small
	16:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
	17:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
	18:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
31 Aug	11:00	*Nordic Olympic*	Large
	13:00	1 skiff with 1 outboard	Small
	17:00	1 skiff with 1 outboard	Small
1 Sept	13:00	1 skiff with 1 outboard	Small
	14:00	1 skiff with 1 outboard	Small
4 Sept	09:00	*Golden Brilliant*	Large
	10:00	*Golden Brilliant*	Large
	13:00	2 skiffs: 1 with 1 outboard, 1 with 2 outboards	Small
	16:00	*Nordic Oshima*	Large
	17:00	*Nordic Oshima*	Large
5 Sept	11:00	1 skiff with 1 outboard	Small

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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