TECHNICAL SUPPORTING DOCUMENT

Mary River Project | Phase 2 Proposal | FEIS Addendum | August 2018

TSD 24

Marine Mammal Effects Assessment





MARINE MAMMAL TECHNICAL SUPPORTING DOCUMENT SUMMARY

The Marine Mammal Technical Supporting Document provides an assessment of the Phase 2 Proposal's effects on marine mammals and includes new information collected or published since submission of materials for the Approved Project. The Phase 2 Proposal builds on the extensive baseline studies and assessments carried out since 2011 for the larger Approved Project and is thus closely linked to the FEIS and previous addendums.

Project effects carried forward in the assessment include loss of habitat due to port expansion, disturbance, hearing impairment, and auditory masking from underwater noise generated by shipping and port construction (i.e., pile driving), and potential injury or mortality to marine mammals from ship strikes along the shipping corridor.

The study area for Marine Mammals includes Milne Port and the Northern Shipping Route which encompasses Milne Inlet, Eclipse Sound, Pond Inlet, and adjacent water bodies. Ten marine mammal species are reported to occur in the study area and have been included in the assessment. These are bowhead whale, beluga whale, narwhal, killer whale, atlantic walrus, bearded seal, ringed seal, harp seal, hooded seal, and polar bear. Of these, the polar bear is the only species protected under the federal *Species at Risk Act (*SARA*)* where it is listed as Special Concern (Schedule 1). Six species (bowhead, beluga, narwhal and killer whale, walrus, and polar bear) are designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Mitigation measures have been incorporated into dock design to reduce loss and/or alteration of marine mammal habitat, including reducing the overall subtidal footprint of the dock. Disturbance effects from ship noise will be reduced through reductions in ship speed, which reduces the overall noise output generated by ship propulsion. Noise will also be reduced by requiring vessels to maintain a constant course and speed when in transit, and reduce idling when docked at Milne Port. These measures will also help reduce ship strikes.

Based on the present assessment and planned mitigation, Project activities proposed as part of the Phase 2 Proposal are not predicted to result in significant adverse residual effects on marine mammals.

RÉSUMÉ DU DOCUMENT D'ASSISTANCE TECHNIQUE SUR LES MAMMIFÈRES MARINS

Le document d'assistance technique sur les mammifères marins comporte une évaluation des effets de la proposition de la phase 2 sur les mammifères marins et comprend de nouveaux renseignements recueillis ou publiés depuis la soumission des documents pour le projet approuvé. La proposition de la phase 2 est fondée sur les études préliminaires et les évaluations complètes réalisées depuis 2011 pour l'ensemble du projet approuvé et est donc étroitement à l'énoncé des incidences environnementales (EIE) et aux addendas précédents.

Les effets du projet reportés dans l'évaluation comprennent la perte d'habitat due à l'expansion des installations portuaires, les perturbations, la déficience auditive et le masquage auditif du bruit sous-marin généré par la navigation et la construction portuaire (c.-à-d. battage de pieux) ainsi que les blessures ou la mortalité potentielles des mammifères marins causées par les collisions avec les navires le long du corridor de navigation.

La zone d'étude pour les mammifères marins comprend le port de Milne et la route de navigation du Nord, qui englobe Milne Inlet, Eclipse Sound, Pond Inlet et les plans d'eau adjacents. Dix espèces de mammifères marins ont été signalées dans la zone d'étude et ont été incluses dans l'évaluation. Il s'agit de la baleine boréale, du béluga, du narval, de l'épaulard, du morse de l'Atlantique, du phoque barbu, du phoque annelé, du phoque du Groenland, du phoque à capuchon et de l'ours polaire. Parmi ces espèces, l'ours polaire est la seule qui est protégée en vertu de la *Loi sur les espèces en péril* où elle est classée comme espèce préoccupante (annexe 1). Six espèces (la baleine boréale, le béluga, le narval, l'épaulard, le morse et l'ours polaire) sont désignées comme espèces préoccupantes par le Comité sur la situation des espèces en péril au Canada (COSEPAC).

Des mesures d'atténuation ont été incorporées dans la conception des quais pour réduire la perte et/ou l'altération de l'habitat des mammifères marins, y compris la réduction de l'empreinte infratidale du quai. Les effets de perturbations causées par le bruit des navires seront réduits grâce à la réduction de la vitesse du navire, ce qui réduit le bruit global produit par la propulsion du navire. Le bruit sera également réduit en obligeant les navires à maintenir un cap et une vitesse constants lorsqu'ils sont en transit et à réduire la marche au ralenti lorsqu'ils sont amarrés au port de Milne. Ces mesures aideront également à réduire les collisions avec les navires.

Selon la présente évaluation et les mesures d'atténuation prévues, les activités du projet proposées dans le cadre de la proposition de la phase 2 ne devraient pas entraîner d'effets résiduels négatifs importants sur les mammifères marins.

ᐳᐃᔩᑦ ᐱᔭᓇᐊᑐᔪᑦ ᐃᑲᔪᐃᔾᔪᑎᑦ ᑎᑎᖅᑲᑦ ᐅᓂᒃᑳᓕᐊᑦ

ᐅᓇ ᐳᐃᔩᑦ ᐱᔭᓇᐊᑐᔪᑦ ᐃᑲᔪᐃᔾᔪᑎᑦ ᑎᑎᖅᑲᖓ ᐱᑕᖅᑲᖅᑎᑦᑎᔪᖅ ᖃᐅᔨᓴᐃᓂᓕᒃ ᑖᓯᒥᖓ ᐱᓕᕆᐊᒃ ᒪᑯᕆᓕᖅᑕᖓ ᐅᒃᑑᑎᖓᑕ ᐊᒃᑐᐃᓂᖃᕐᓂᖏᑕ ᐳᐃᔨᖏᓐᓄᑦ ᐊᒻᒪᓗ ᐃᓚᖃᖅᑲᖅᑐᓂᓗ ᓄᑖᓂᒃ ᑐᑭᓯᐅᒪᔾᔪᑎᒃᓴᓂᒃ ᑲᑎᖅᓱᒐᑦ ᑎᑎᕋᐅᓯᐅᔪᓪᓗᓐᓃᑦ ᑕᐃᑲᙵᓂᑦ ᑎᑎᕋᐅᓯᑦ ᓯᕗᓪᓕᖅᐹᑦ ᑐᓐᓂᖅᓴᖅᑕᐅᖅᑎᓪᓗᒋᑦ ᐊᕐᖅᓯᒪᔭᒍᑦ ᐅᔾᕋᕐᓂᐊᕐᓂᕐᒍᑦ. ᐱᓕᕆᐊᒃ ᒪᑯᕆᓕᖅᑕᖓ ᐅᒃᑑᑎᖓ ᐃᓚᒋᐊᕐᓂᖅᑲᖅᑐᖅ ᖄᖓᒍᑦ ᐊᕆᕗᔪᑦ ᑐᙵᕕᑦ ᖃᐅᔮᓴᕕᓐᑦ ᐊᕙᑖᓄᑦ ᑕᒪᓇᓗ ᖃᐅᔨᓴᐃᓂᖅ ᑕᐃᑲᖓᑦ 2011–ᒥ ᑖᓯᒧᖓ ᐃᓗᐃᑦᑑᔪᒧᑦ ᐊᕆᖅᓯᒪᔭᒧᑦ ᐅᔾᕋᕐᓂᐊᕐᓂᕐᒧᑦ ᑕᐃᓖᓪᓗ ᓂᒃᓯᒃᓯᒪᓂᖅᑲᖅᐳᖅ ᑭᖑᓪᓕᖅᐸᑉ ᐅᓂᒃᑳᕆᓄᑦ FEIS ᓯᕗᓂᐊᒍᓪᓗ ᐅᐃᒍᒋᐊᖅᑕᐅᓂᑰᔪᒃᑯᑦ.

ᐅᔾᕋᕐᓂᐊᖅᑐᑦ ᐊᒃᑐᐃᓂᕆᑦ ᑲᔪᓯᑎᑕᐅᖃᓯᐅᔪᖅ ᖃᐅᔨᓴᐃᓂᖏᑦ ᐃᓚᖅᑲᖅᑐᑦ ᐊᓯᐅᕈᓂᕆᑦ ᓇᔪᕐᕆᓐᓂᒃ ᐅᒥᐊᕐᔪᐊᓕᓇᖓᕝᕕᒃ ᐊᕆᓕᒋᐊᕐᓂᖓᓄᑦ, ᐸᖓᓵᖅᑲᕐᓂᐊᓄᑦ, ᑐᓵᑎᐊᕈᓐᓃᖅᑎᑦᑎᓂᖏᑦ, ᐊᒻᒪᓗ ᓈᓚᖓᕆᓂᒃ ᑐᓴᕐᕆᑎᑦᑎᓂᖅ ᐃᒪᖓᓂ ᓂᐱᖅᑲᕐᓂᐊᓄᑦ ᓵᖅᑭᓯᒪᔪᑦ ᐅᒥᐊᕐᔪᐊᑦ ᓂᐱᕆᓄᑦ ᐅᒥᐊᕐᔪᐊᓕᓇᖓᕝᕕᒧ ᓴᓇᔭᐅᓂᐊᓄᑦ (ᓲᖅᑐ, ᐃᖅᑲᖓᓄᑦ ᑐᖓᕕᒃᓴᑦ ᑲᓱᐊᖅᑕᐅᓂᕆᑦ), ᐃᑭᓕᖅᑕᐅᓂᕆᑦ ᑐᑯᑕᐅᓂᕆᓐᓄᑦ ᐳᐃᔩᑦ ᐅᒥᐊᕐᔪᐊᓄᑦ ᑐᑐᖅᑕᐅᑐᑎᒃ ᐃᕆᖃᑎᓪᓗᒋᑦ ᐊᖅᑯᑎᒥᒍᑦ.

ᖃᐅᔨᓴᖅᑐᑦ ᐳᐃᔨᓄᑦ ᐃᓚᖅᑲᖅᑐᖅ ᖁᕝᕙᐊᑕ ᐅᒥᐊᕐᔪᐊᓕᓇᖓᕝᕕᖓ ᐊᒻᒪᓗ ᐅᐊᖓᓈᑕ ᐅᒥᐊᕐᔪᐊᑦ ᐊᖅᑯᑖ ᐃᓚᖅᑲᖅᑐᓂ ᖁᕝᕙᐊᓂᒃ, ᑕᓯᐅᔭᕐᒥᒃ, ᑐᖅᓯᒃᑕᖅᒥᑦ, ᐊᕙᑖᒍᓪᓗ ᑕᓇᐅᕝᕙᔪᑦ. ᖁᓖᑦ ᑕᓇᐅᖅᒥ ᐳᐃᔩᑦ ᐅᖅᑲᐅᓯᐅᓯᒪᕗᑦ ᓇᔪᕐᓯᑦ ᐃᒪᕆᓐᓂᒃ ᖃᐅᔨᓵᕝᕙᔪᒥᒃ ᐃᓚᓕᐅᑎᔭᐅᓯᒪᕗᑦ ᖃᐅᔨᓴᐃᓂᖅᒥᒃ. ᑖᒃᑯᐊ ᐊᕐᕕᑦ, ᖃᐅᓪᓗᖅᑖᑦ ᕿᓚᓗᒐᑦ, ᑑᒑᓕᑦ ᕿᓚᓗᒐᑦ, ᐋᕐᓗᐃᑦ, ᐊᐃᕖᑦ, ᐅᒡᔫᑦ, ᓇᑦᑏᑦ, ᖃᐃᕈᓖᑦ, ᐊᐸᐃᑦ, ᐊᒻᒪᓗ ᓇᓄᐃᑦ. ᑖᒃᑯᓇᙵᑦ, ᓇᓄᐃᑦ ᑎᑎᖅᓯᒪᔪᑐᐊᑦ ᐆᒪᔪᓂᒃ ᓴᐳᒻᒥᔭᐅᔪᖅ ᒐᕙᒪᑐᖅᑲᑯᑦ *ᓂᕈᐊᑦ ᐅᑐᓇᐊᓇᖅᑐᒦᑦᑐᓄᑦ ᐱᖁᔭᖅ (SARA)* ᑕᐃᒍᖅᓯᒪᓪᓗᓂ ᐃᓱᒫᓘᓇᖅᑐᒦᑦᑐᖅ ᓂᕈᐊᑎ (ᐅᐃᒍᖓ 1). ᐊᕕᓂᓛᑦ ᐳᐃᔩᑦ (ᐊᕚᑦ, ᖃᐅᓪᓗᖅᑖᑦ, ᕿᓚᓗᒐᑦ ᐊᒻᒪ ᐋᕐᓗᐃᑦ, ᐊᐃᕖᑦ ᐊᒻᒪᓗ ᓇᓄᐃᑦ) ᑎᑎᖅᑕᐅᓯᒪᔪᑦ ᐃᓱᒫᓘᓇᖅᑐᒦᑦᑐᑦ ᓂᕈᐊᑎᑦ ᑲᑎᒪᔨᕋᓛᑦ ᐃᓕᖅᑯᓯᐊᓄᑦ ᓄᖑᓕᖅᑐᑦ ᓂᕈᐊᑎᑦ ᑲᓇᑕᒥ (COSEWIC).

ᓄᖅᑲᖓᔾᔪᑏᑦ ᐱᓕᕆᔾᔪᑎᖏᑦ ᐃᓚᔭᐅᓯᒪᕙᑦ ᐅᒥᐊᕐᔪᐊᓕᓇᖓᕝᕕᐅᑉ ᐃᐱᖅᓯᒪᕝᕕᐊᑕ ᓴᓇᔭᐅᓯᒪᓂᐊᓄᑦ ᒥᑭᓛᒥᒃ ᐊᓯᐅᕈᓂᕐᒥᒃ ᐊᒻᒪ/ᐅᕝᕗᓗ ᐊᓯᔾᔨᕆᓂᖅ ᑕᓇᐅᑉ ᐳᐃᔩᑦ ᓇᔪᕐᕆᓐᓂᒃ, ᐃᓚᖅᑲᖅᑐᓂ ᒥᑭᓕᖓᓇᓱᖓᓂᕐᒥᒃ ᐃᓗᐃᑦᑑᔪᒥᒃ ᐅᓕᑦᑕᖅᑑᑉ ᐊᑐᕐᓂᐊ ᑕᓇᐅᑉ ᐃᖅᑲᖓᓂᒃ ᐅᒥᐊᕐᔪᐊᓕᓇᖓᕝᕕᖓᓄᑦ. ᐸᕝᕙᓯᖅᑲᕐᓂᕆᑦ ᐅᒥᐊᕐᔪᐊᑦ ᓂᐱᖅᑲᕐᓂᐊᓄᑦ ᐊᖅᐸᓯᓚᓯᓪᓗᒋᑦ ᓱᒃᑲᐃᓭᕐᑯᔭᐅᓂᐊᓄᑦ, ᓂᐱᖅᑲᓗᐊᕆᓐᓂᖅᓴᐅᓚᔭᖅᑲᓗᓂ ᐃᕆᖃᑎᐊᓂᖓ. ᓂᐱᖅᑲᕐᓂᖓ ᐊᖅᐸᓯᒋᐊᖃᓱᒃᑭᕗᑦ ᓴᖑᐃᑲᑕᕆᓪᓗᑎᒃ ᓱᒃᑲᓵᓪᓚᑲᑕᕆᓪᓗᑎᒃ ᐃᕆᖃᑎᒥᒍᑦ, ᐊᐅᓚᐅᑎᕆᓪᓗ ᓄᖅᑲᖅᑎᑕᐅᕝᓗᑎᒃ ᐃᐱᖅᓯᒪᓕᕚᖓᒥᒃ ᖁᕝᕙᐊᓂ. ᑖᒃᑯᐊ ᑲᒪᒋᔾᔪᑏᑦ ᑐᑐᖅᓯᒻᒥᒋᑦᑎᓪᓗᓴᓇᕗᑦ ᐅᒥᐊᕐᔪᐊᓂᒃ ᓱᒃᑲᐃᓐᓂᖅᓴᐅᒍᑎᒃ.

ᑐᙵᕕᒋᓪᓗᒍ ᒫᓇ ᖃᐅᔨᓴᐅᓂᖓ ᐸᕐᓈᖑᓯᒪᔪᓪᓗ ᓄᖅᑲᖓᔾᔪᑏᑦ, ᐅᔾᕋᕐᓂᐊᖅᑐᑦ ᐱᓕᕆᐊᕆᑦ ᐊᑐᖅᑕᐅᔪᒪᔪᑦ ᐃᓚᒋᔭᕆᑦ ᐱᓕᕆᐊᒃ ᒪᑯᕆᓕᖅᑕᖓ ᐅᒃᑑᑎᖓᓄᑦ ᓇᓚᐅᑦᑖᕆᔭᐅᕆᑦᑐᑦ ᓵᖅᑮᖓᔭᖓᓂᖓᓂᒃ ᐊᕆᔪᒥᒃ ᐱᐅᕆᑦᑐᒥᒃ ᖃᐅᒪᐃᔪᒥᒃ ᐊᒃᑐᐃᓂᖅᑲᕐᓂᒥᒃ ᐳᐃᔨᕆᓄᑦ.

REPORT

Baffinland Iron Mines Corporation
Mary River Project - Phase 2 Proposal

Technical Supporting Document No.24
Marine Mammal Effects Assessment

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1 August 2018

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TABLES

FIGURES

APPENDICES

Abbreviation and Acronym list

Baffinland	Baffinland Iron Mines Corporation
BB	Baffin Bay
BWMP	Ballast Water Management Plan
CCG	Canadian Coast Guard
CCME	Canadian Council of Ministers of the Environment
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSAS	Canadian Science Advisory Secretariat
dB	decibel
DD	data deficient
DFO	Fisheries and Oceans Canada
EBSA	Ecologically and Biologically Significant Area
EIS	environmental impact statement
EPCM	engineering, procurement and construction management
ERP	Early Revenue Phase
EN	endangered
FEIS	Final Environmental Impact Statement
Golder	Golder Associates Ltd.
HF	high-frequency
HTO	Hunters and Trappers Organization
IQ	Inuit Qaujimajatuqangit
IWC	International Whaling Commission
LF	low-frequency
Lpk	peak sound pressure
LSA	Local Study Area
µPa	micropascal
Mary River Project	the Project
MEEMP	Marine Environmental Effect Monitoring Program
MEWG	Marine Environment Working Group
MF	mid-frequency
MHTO	Mittimatalik Hunters and Trappers Organization
MMPA	Marine Mammal Protection Act
MMO	marine mammal observer

Mtpa	million tonne per annum
NAMMCO	North Atlantic Marine Mammal Commission
NIRB	Nunavut Impact Review Board
NITS	noise-induced threshold shift
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSA	Nunavut Settlement Area
OW	pinnipeds (Otariids) in-water
Pa	Pascal
PDA	Potential Development Area
PTS	permanent threshold shifts
PW	pinnipeds (Phocids) in-water
QIA	Qikiqtani Inuit Association
RSA	Regional Study Area
SARA	*Species at Risk Act*
SC	special concern
SEL	sound exposure level
SMWMP	Shipping and Marine Wildlife Management Plan
SPL	sound pressure level
SPLpeak	peak sound pressure level
SPLrms	root-mean-square sound pressure level
TTS	temporary threshold shifts
TH	threatened
TOR	Terms of Reference
VECs	Valued Ecosystem Components
VU	vulnerable

1.0 INTRODUCTION

The Mary River Project (the Project) is an operating iron ore mine located in the Qikiqtani Region of Nunavut (Figure 1.1). Baffinland Iron Mines Corporation (Baffinland; the Proponent) is the owner and operator of the Project. As part of the regulatory approval process, Baffinland submitted a Final Environmental Impact Statement (FEIS) to the Nunavut Impact Review Board (NIRB), which presented in-depth analyses and evaluation of potential environmental and socioeconomic effects associated with the Project.

In 2012, NIRB issued Project Certificate No 005 which provided approval for Baffinland to mine 18 million tonnes per annum (Mtpa) of iron ore, construct a railway to transport the ore south to a port at Steensby Inlet which operates year-round, and to ship the ore to market. The Project Certificate was subsequently amended to include the mining of an additional 4.2 Mtpa of ore, trucking this amount of ore by an existing road (the Tote Road) north to an existing port at Milne Inlet, and shipping the ore to market during the open water season. The total approved iron ore production was increased to 22.2 Mtpa (4.2 Mtpa transported by road to Milne Port, and 18 Mtpa transported by rail to Steensby Port). This is now considered the Approved Project. The 18 Mtpa Steensby rail project has not yet been constructed, however 4.2 Mtpa of iron ore is being transported north by road to Milne Port currently. Baffinland recently submitted a request for a second amendment to Project Certificate No.005 to allow for a short-term increase in production and transport of ore via road through Milne Port from the current 4.2 Mtpa to 6.0 Mtpa.

1.1 Phase 2 Proposal Overview

The Phase 2 Proposal (the third project certificate amendment request) involves increasing the quantity of ore shipped through Milne Port to 12 Mtpa, via the construction of a new railway running parallel to the existing Tote Road (called the North Railway). The total mine production will increase to 30 Mtpa with 12 Mtpa being transported via the North Railway to Milne Port and 18 Mtpa transported via the South Railway to Steensby Port. Construction on the North Railway is planned to begin in late 2019. Completion of construction of the North Railway is expected by 2020 with transportation of ore to Milne Port by trucks and railway ramping up as mine production increases to 12 Mtpa by 2020. Shipping from Milne Port will also increase to 12 Mtpa by 2020. Construction of the South Railway and Steensby Port will commence in 2021 with commissioning and a gradual increase in mine production to 30 Mtpa by 2024. Shipping of 18 Mtpa from Steensby Port will begin in 2025.

Phase 2 also involves the development of additional infrastructure at Milne Port, including a second ore dock (Figure 1.2). Shipping at Milne Port will continue to occur during the open water season, and may extend into the shoulder periods when the landfast ice is not being used to support travel and harvesting by Inuit. Various upgrades and additional infrastructure will also be required at the Mine Site and along both the north and south transportation corridors to support the increase in production and construction of the two rail lines.

In order to account for the increased tonnage of ore being transported under the Phase 2 Proposal, an increase in total vessel traffic serving Milne Port is proposed. Vessels ranging in size from Supramax to Cape Size will be retained by Baffinland depending on availability. An estimated 176 ore carrier round trips (upper range) will occur per season, with an average voyage time per vessel of 26 days. Shipping will occur seasonally over a period of approximately 90 days between July 01 and November 15, with each chartered vessel making one to three round trips per season.

LEGEND

- PROJECT SITE
- COMMUNITY
- FUTURE SOUTH RAILWAY
- MILNE INLET TOTE ROAD
- NUNAVUT SETTLEMENT AREA
- SHIPPING ROUTE
- SIRMILIK NATIONAL PARK
- WATER

0 125 250

1:5,000,000 KILOMETRES

REFERENCE(S)

BASE MAP: © ESRI DATA AND MAPS (ONLINE) (2016). REDLANDS, CA: ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE. ALL RIGHTS RESERVED.

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
PROJECT LOCATION

CONSULTANT

GOLDER

YYYY-MM-DD	2018-06-21
DESIGNED	DC
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	1.1

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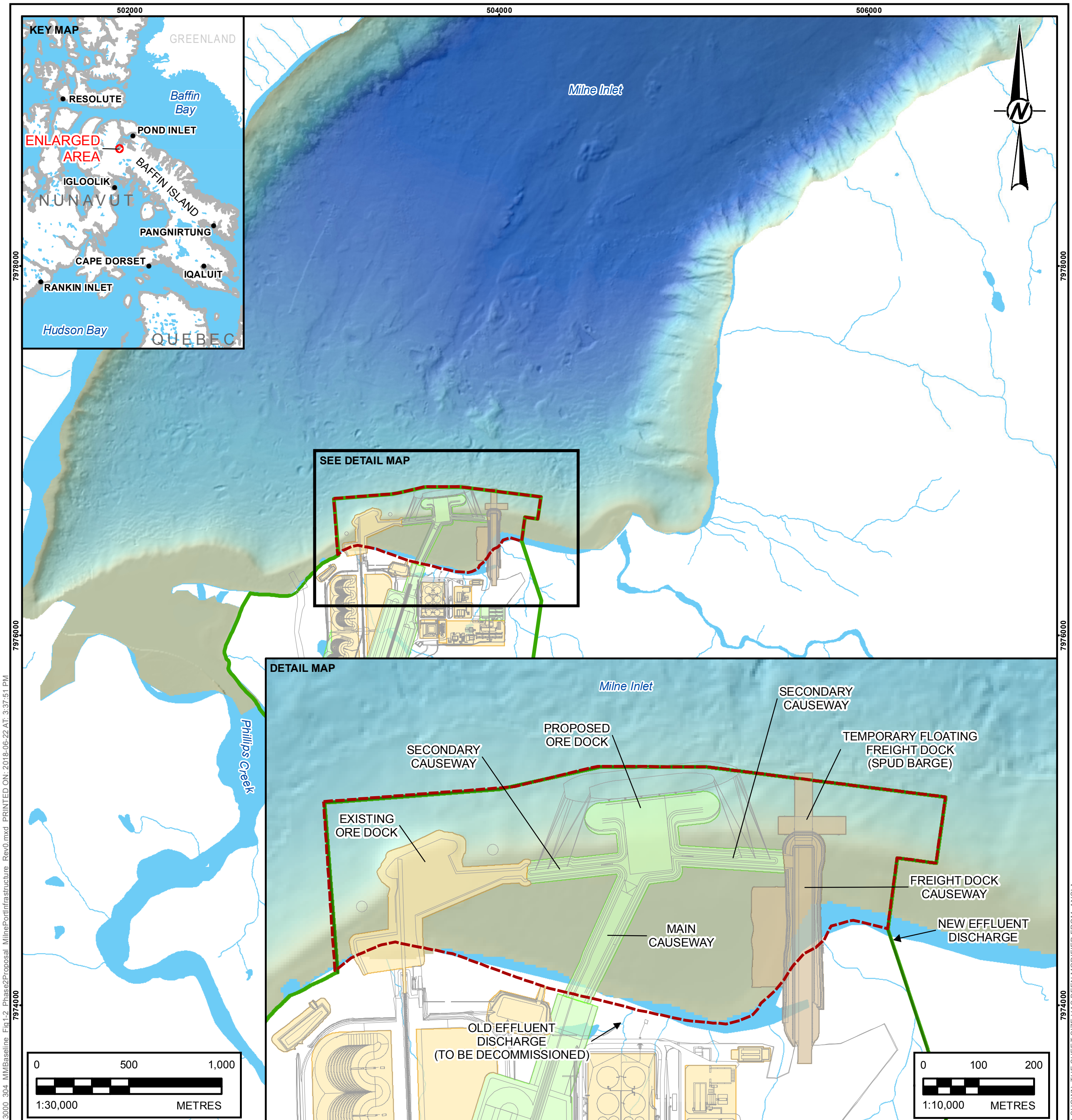


LEGEND

- PDA / QIA COMMERCIAL LEASE
- SITE LAYOUT
- WATERCOURSE
- INAC FORESHORE LEASE
- EXISTING ORE DOCK
- NEW ORE DOCK AND CAUSEWAYS
- EXISTING FREIGHT DOCK AND CAUSEWAY
- WATERBODY

ELEVATION (masl)
High : 25
Low : -225

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA OBTAINED FROM CLIENT, MAY 28, 2108, AND BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. BATHYMETRY CREATED BY GOLDER FROM MULTIPLE DATA SOURCES.. HYDROGRAPHY DATA BY EAGLE MAPPING (2005), RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE, MAY 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
MILNE PORT MARINE INFRASTRUCTURE

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	PR
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	1.2

1.2 Scope of the Assessment

1.2.1 Valued Ecosystem Components

Marine mammals were identified as a Valued Ecosystem Component (VEC) based on the following rationale:

- High potential to interact with the Project;
- Commercial, social, cultural, and ecological importance in Project area;
- Biological indicators for marine ecosystem health;
- Includes listed or protected species and/or sensitive habitat areas; and
- Identified as important during Inuit Qaujimajatuqangit (IQ) studies and stakeholder meetings.

1.2.2 Spatial and Temporal Boundaries

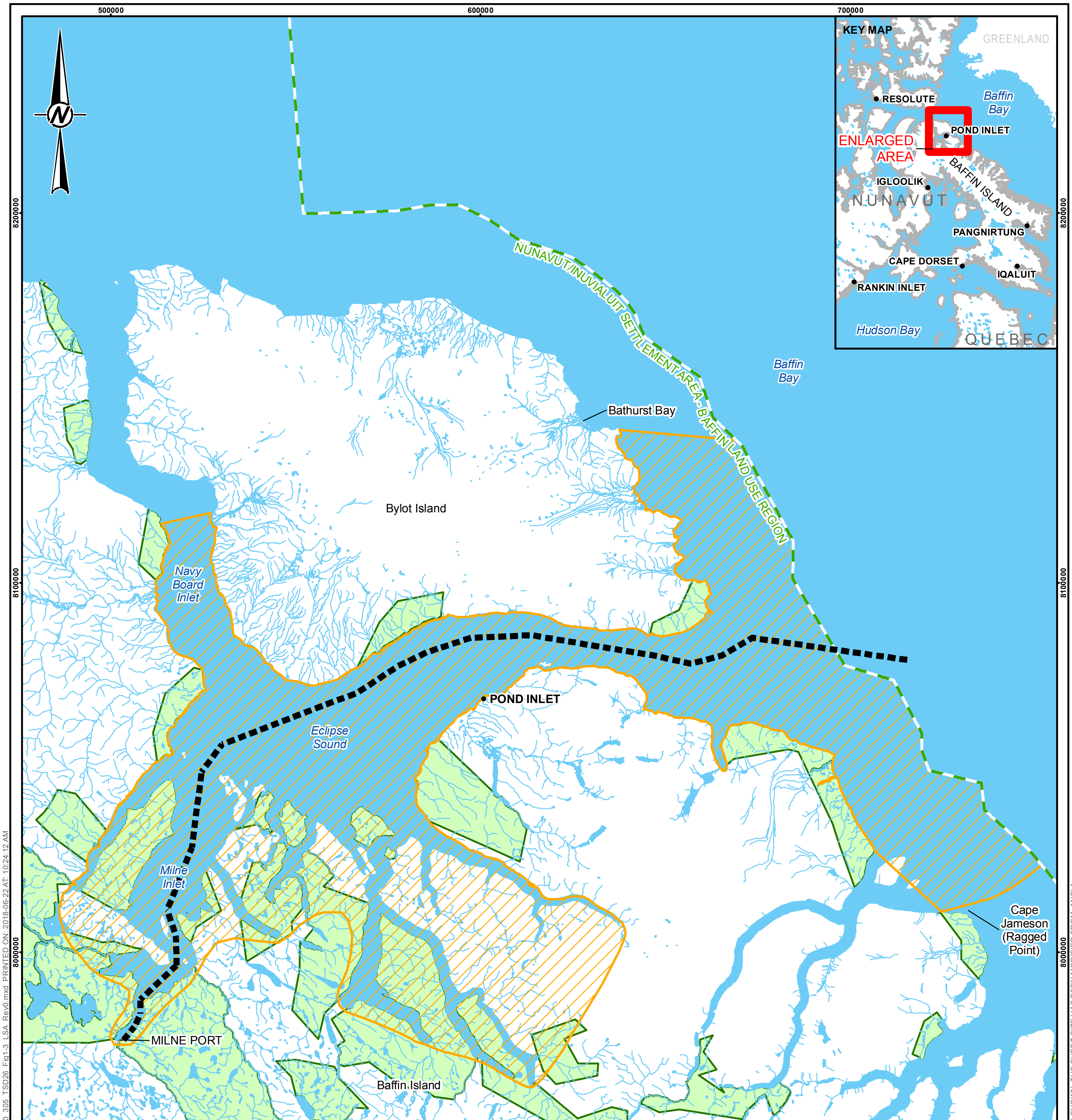
The study area for Marine Mammals includes Milne Port and the Northern Shipping Route, which encompasses Milne Inlet, Eclipse Sound, Pond Inlet, and adjacent water bodies. Milne Port is located at the head of Milne Inlet at the north end of Baffin Island. Milne Inlet is a narrow fjord characterized by high surrounding headlands and deep water that is covered by landfast ice for much of the year. Eclipse Sound separates Baffin Island from Bylot Island, and extends from Milne Inlet to the South-west, Navy Board Inlet to the North-west, and Baffin Bay to the east via Pond Inlet.

Two spatial boundaries were used for the assessment of effects on Marine Mammals in the Project area: a Local Study Area (LSA) (Figure 1.3) and a Regional Study Area (RSA) (Figure 1.4). The LSA allows an assessment of Project-related effects at a local, operational scale. The RSA represents marine mammals and their habitats at a regional, ecologically relevant scale on northern Baffin Island.

The Marine Mammal LSA represents the area where there exists a reasonable potential for direct measurable effects from routine Project activities on marine mammals, including shipping. This includes marine waters of Milne Port and the Northern Shipping Route, and includes a buffer extending up to 50 km on either side of the shipping route (where applicable).

The Marine Mammal RSA encompasses the area where there is potential for direct and indirect incremental effects from Project shipping on marine mammals, in addition to potential cumulative effects from the Project in conjunction with existing, historical, and reasonably foreseeable developments in the Project area. The RSA encompasses all waters of Milne Inlet, Navy Board Inlet, Tremblay Sound, Eclipse Sound and Pond Inlet extending to the entrance of Baffin Bay, consistent with the Nunavut Settlement Area Boundary. This regional area is considered sufficient to encompass the full range of direct and indirect effects (incremental and cumulative) resulting from routine Project shipping activities, including those related to shipping noise.

The temporal boundaries for the assessment of effects on marine mammals includes the construction, operations, and closure phases of the Phase 2 Proposal, which will occur over a total period of 17 years (2019-2035).



LEGEND

- • COMMUNITY
- SHIPPING ROUTE (APPROXIMATE)
- WATERCOURSE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- MARINE MAMMAL LOCAL STUDY AREA
- NUNAVUT LAND CLAIMS AGREEMENT – POND INLET INUIT OWNED LAND
- WATERBODY

0 25 50
1:1,500,000 KILOMETRES

REFERENCE(S)

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PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
MARINE MAMMAL LOCAL STUDY AREA

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-305	0	1.3

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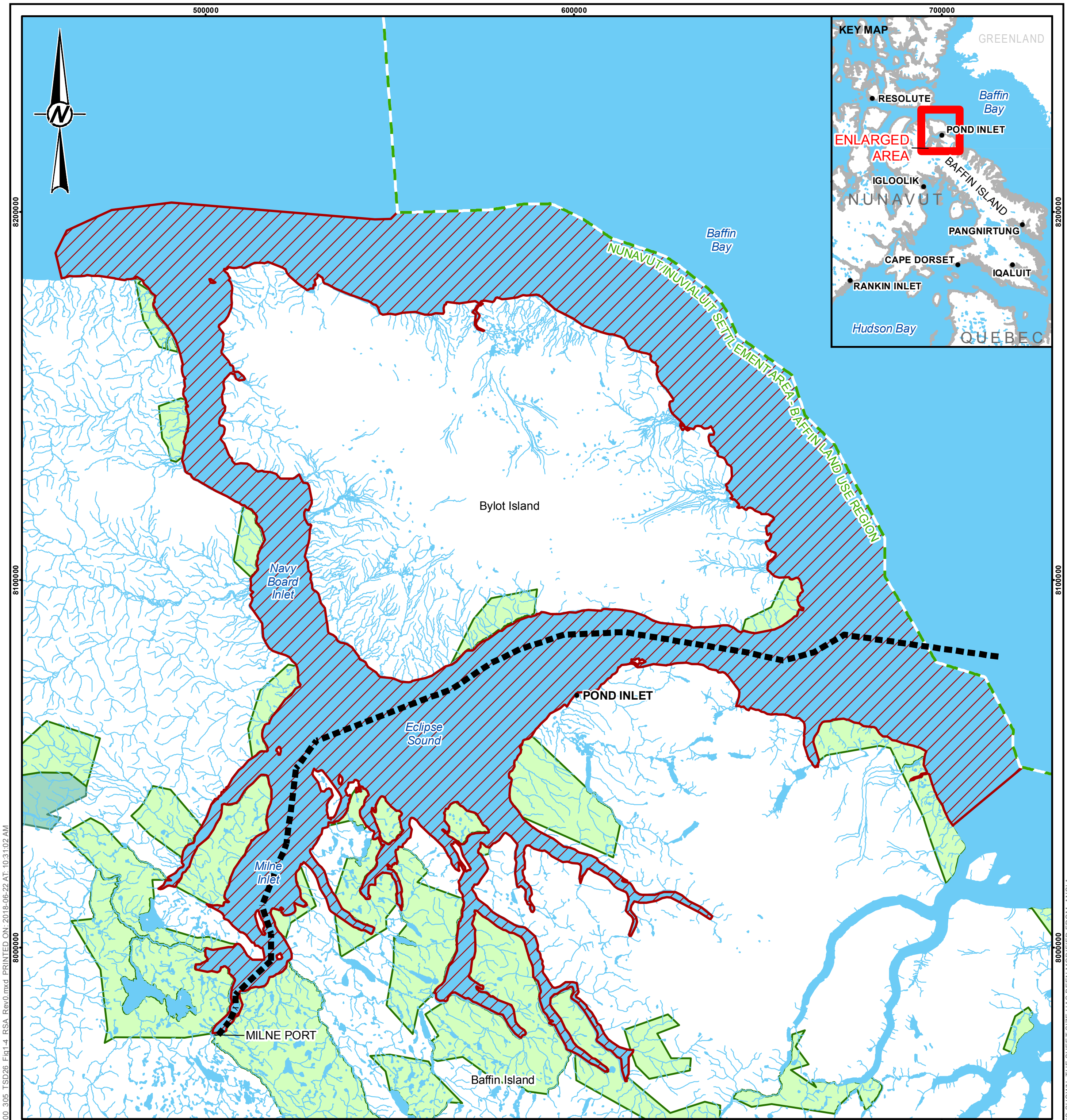

LEGEND

- COMMUNITY
- SHIPPING ROUTE (APPROXIMATE)
- WATERCOURSE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- MARINE MAMMAL REGIONAL STUDY AREA
- NUNAVUT LAND CLAIMS AGREEMENT – ARCTIC BAY INUIT OWNED LAND
- NUNAVUT LAND CLAIMS AGREEMENT – POND INLET INUIT OWNED LAND
- WATERBODY

0 25 50

1:1,500,000 KILOMETRES

REFERENCE(S)

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PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT

BAFFINLAND IRON MINES CORPORATION

PROJECT

MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE

MARINE MAMMAL REGIONAL STUDY AREA

CONSULTANT

GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-305	0	1.4

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1.3 Existing Environment

A detailed summary of marine mammal baseline conditions is provided in Appendix A and includes new information collected or published since the submission of materials for the Approved Project. A brief overview is provided below.

At least ten species of marine mammal have the potential to occur in the RSA at different times of the year (Table 1.1), including four species of cetaceans (three toothed whales and one baleen whale), five species of pinnipeds (four seal species and walrus), and polar bear. Polar bear are the only species in the RSA protected under the federal *Species at Risk Act* (SARA) where they are listed as Special Concern (Schedule 1). Six of the ten species are designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), including all four cetacean species (bowhead, beluga, narwhal and killer whale), walrus and polar bear.

Table 1.1: Marine Mammal Species with Potential to Occur in RSA

Species common name	Population or subspecies (if subdivided)	SARA[1]	COSEWIC[2]
Bowhead Whale	Eastern Canada-West Greenland (EC-WG) population	NS	SC
Beluga Whale	Eastern High Arctic-Baffin Bay (EHA-BB) population	NS	SC
Narwhal	Baffin Bay (BB) population	NS	SC
Killer Whale	Northwest Atlantic / Eastern Arctic population	NS	SC
Atlantic Walrus	Baffin Bay (High Arctic) population	NS	SC
Bearded Seal	N/A – subspecies not delineated	NS	DD
Ringed Seal	N/A – subspecies not delineated	NS	NAR
Harp Seal	Northwest Atlantic population	NS	NS
Hooded Seal	Western North Atlantic stock	NS	NAR
Polar Bear	N/A – subspecies not delineated	Sc1:SC	SC

Notes:
[1] SARA (GoC 2009): EN=Endangered; T=Threatened; SC=Special concern; UC=Under consideration; NS=No status; Sc1=Schedule 1; Sc2=Schedule 2
[2] COSEWIC (COSEWIC 2010): EN=Endangered; T=Threatened; SC=Special concern; DD=Data deficient; NAR=Not at risk; NS=No status.

1.3.1 Marine Mammals and Underwater Noise

The potential effects of Project-related underwater noise on marine mammals are assessed in Section 2.5. In support of this part of the assessment, background information is provided below on marine mammals and underwater noise, including existing acoustic thresholds for marine mammal injury and disturbance.

Underwater sound can be described through a source-path-receiver model. An acoustic source emits sound energy that radiates outward and travels through the water and the seafloor as pressure waves. The sound level decreases with increasing distance from the acoustic source as the sound pressure waves spread out under the influence of the surrounding environment. The amount by which the sound levels decrease between a source and receiver is called transmission loss. The amount of transmission loss that occurs depends on the source receiver separation, the frequency of the sound, the properties of the water column and the properties of the seafloor layers. Underwater sound levels are expressed in decibels (dB) which is a logarithmic ratio relative to a fixed reference pressure of 1 µPa (equal to 10-6 Pa or 10-11 bar).

An animal senses the sound at a level that is dependent on the amount of transmission loss between the source and the receiver (Richardson et al. 1995). The efficiency of underwater sound propagation allows marine mammals to use underwater sound as a primary method of communication, navigation, and prey detection. Underwater noise created by pile driving, ship traffic, and other human activities often can be detected by marine mammals many kilometers from the source. Underwater anthropogenic noise has gained recognition as an important stressor for marine mammals because of their reliance on underwater hearing for maintenance of these critical biological functions (Richardson et al. 1995a; Ketten 1998). The potential zone of effect of anthropogenic sound is also influenced strongly by the properties of natural background (ambient) sound present in the area of exposure (Richardson et al. 1995a) and local sound transmission properties which are determined by site-specific environmental factors such as seafloor bathymetry, substrate composition and water column characteristics.

Potential effects on marine mammals range from subtle changes in behaviour at low received levels to strong disturbance effects or physical injury at high received levels. New technical guidance has replaced previous acoustic thresholds for assessing auditory impacts to marine mammals (Finneran 2016; NOAA 2016). Anthropogenic noise sources can be categorized generally as impulsive (e.g., impact pile driving) or non-impulsive/ continuous (e.g., vibratory pile-driving, vessel noise). Sounds from moving sources such as ships are considered to be continuous noise sources, although transient relative to the receivers. Impulsive noise is characterized by broad frequency, fast rise-time, short duration and a high peak sound pressure (Finneran 2016) such as in impact pile-driving. Non-impulsive (i.e., continuous) noise is the steady-state noise characteristic of vibratory pile-driving or vessel activities. Sound reaching the receiver with ample duration and sound pressure level (SPL) may result in a loss of hearing sensitivity termed noise-induced threshold shift (NITS). When the sound is eliminated, a temporary threshold shift (TTS) has occurred; however, if the sound is persistent and remains elevated, a permanent threshold shift (PTS) may occur (Finneran 2016).

Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. The importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998; Nedwell et al. 2007). Regulatory thresholds used for the purpose of predicting the extent of potential noise impacts on marine mammals and subsequent management of these impacts, have recently been revised to account for duration of exposure and differences in hearing acuity amongst different marine mammal hearing groups, as described further below.

1.3.1.1 Acoustic Impact Criteria

Assessment of the potential effects of underwater noise on marine mammals requires acoustic thresholds against which received sound levels can be compared. Auditory injury thresholds from underwater noise are expressed using two common metrics: sound pressure level (SPL), measured in dB re: 1 µPa[1], and sound exposure level (SEL), a measure of energy in dB re: 1 uPa^{2}s. SPL is an instantaneous value represented as either root-mean-square (SPLrms) or peak sound pressure level (SPLpeak), whereas SEL is the total noise energy to which an organism is exposed over a given time period, typically one second for pulse sources. As such, the cumulative SEL metric is appropriate when assessing effects to marine mammals from cumulative exposure to multiple pulses.

[1] Underwater sound levels are expressed in decibel (dB) which is a logarithmic ratio relative to a fixed reference pressure of 1 µPa (re 1 µPa) (equal to 10-6 Pa or 10-11 bar).

Injury

The U.S. National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) adopted a set of interim thresholds for assessing injury due to both impulsive and non-impulsive types of noise sources. These NMFS SPL criteria for acoustic exposure injury to marine mammals were set according to recommendations for cautionary estimates of sound levels leading to onset of permanent hearing threshold shift (PTS). These criteria prescribed injury thresholds of 190 dB re 1 µPa SPL for pinnipeds and 180 dB re 1 µPa SPL for cetaceans (NMFS 2013) for most noise sources. These injury thresholds are applied to individual noise pulses and do not consider the overall duration of the noise or its acoustic frequency distribution to account for species dependant hearing acuity.

Criteria that do not consider exposure duration or noise spectra are generally insufficient for assessing hearing injury. In recognition of shortcomings of the SPL-only based injury criteria, NMFS sponsored the Noise Criteria Group in 2015 to undertake a comprehensive literature review on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual acoustic injury criteria for impulsive sounds that included peak pressure level (L_{peak}) thresholds and SEL_{24h} thresholds, where the subscripted $_{24h}$ refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted, whereas the SEL_{24h} is frequency weighted according to one of four marine mammal species hearing groups: Low-, Mid- and High-Frequency Cetaceans (LFC, MFC, and HFC respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for humans). Recommendations in Southall et al. (2007) do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure.

In August 2016, NMFS finalized technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NOAA 2016). The guidance provides updated frequency weighting functions for five hearing groups based on audiogram studies (behavioural and electrophysiological measurements) and predictions based on modeling, taxonomy, and vocalizations (Table 1.2), and identifies injury criteria for onset of PTS (Table 1.3) which considers both duration of exposure and species dependant hearing acuity. The injury thresholds are higher for continuous sounds such as shipping and vibratory pile driving than for impulsive sounds such as impact pile driving because the mammalian ear can temporarily reduce its sensitivity when exposed to continuous noise.

The present assessment used NFMS (2016), Wood et al. (2012), and Southall et al. (2007) criteria to assess for the potential effects of hearing impairment on marine mammals in the LSA due to Phase 2 activities.

Table 1.2: Marine Mammal Hearing Groups based on NMFS (NOAA 2016)

Functional Hearing Groups	Taxonomic Group	Hearing Range
Low-Frequency (LF) Cetaceans	Baleen whales (e.g. bowhead)	7 Hz to 35 kHz
Mid-Frequency (MF) Cetaceans	Toothed whales (e.g. narwhal, beluga)	150 Hz to 160 kHz
High-Frequency (HF) Cetaceans	Toothed whales (e.g. killer whale)	275 Hz to 160 kHz
Pinnipeds In-water (PW)	Phocid seals (e.g. ringed, bearded, harp seal)	50 Hz to 86 kHz
Pinnipeds In-water (OW) & other non-phocid marine carnivores	Non-phocid pinnipeds (e.g. walrus and polar bear)	60 Hz to 39 kHz

Notes: Modified from NOAA (2016); Includes select species pertaining to the current assessment criteria

Table 1.3: Marine Mammal Injury Thresholds based on NMFS (2016), Wood et al. (2012), and Southall et al. (2007) Criteria

Hearing Group	Impulsive Source				Non-Impulsive Source	
	NMFS (2016) Criteria		Wood et al. (2012) Criteria		NMFS (2016) Criteria	Southall et al. (2007) Criteria
	Peak	cSEL (24 h)	Peak	cSEL (24 h)	Weighted SEL	Weighted SEL
Low-Frequency Cetaceans (LFC) (bowhead)	219 dB	183 dB	230 dB	192 dB	199 dB	215 dB
Mid-Frequency Cetaceans (MFC) (e.g. narwhal,)	230 dB	185 dB	230 dB	198 dB	198 dB	215 dB
High-Frequency Cetaceans (HFC) (porpoise)	202 dB	155 dB	230 dB	179 dB	173 dB	215 dB
Phocid pinnipeds In-water (e.g. ringed seal)	218 dB	185 dB	218 dB	186 dB	201 dB	203 dB
Otariid Pinnipeds In-water	232 dB	203 dB	-	-	-	-

Notes: Modified from NOAA 2016 and Wood et al. (2012). Peak sound pressure (Peak) has a reference value of 1 µPa, and cumulative sound exposure level (cSEL) has a reference value of 1µPa^{2}s. The subscript associated with cumulative sound exposure level thresholds indicates that the recommended accumulation period is 24 hours. Thresholds for impulsive sound (e.g., impact pile-driving, airguns). Thresholds for non-impulsive sound (e.g., vibratory pile-driving, shipping).

Disturbance

The current NMFS disturbance (behavioral response) threshold for all marine mammal species is 160 dB re 1µPa (SPLrms) for impulsive noise (e.g., impact pile driving) and 120 dB re 1 µPa (SPLrms) for non-pulsive noise (e.g., vibratory pile driving, shipping) (NOAA 2014). These disturbance thresholds do not consider the overall duration of the noise or its acoustic frequency distribution to account for species dependant hearing acuity. The disturbance thresholds are much lower for continuous sounds than impulsive sounds, which is attributed to differences in the way the ear perceives loudness for these sound types. While elevated underwater noise could startle or displace animals, behavioural responses are not necessarily predictable from the sound source level (loudness) and may vary depending on factors such as age and status of the animal, type of activity it is engaged in, and social context (McCauley et al. 2003).

1.4 Inuit Community and Stakeholder Comments

In 2015, the Nunavut Impact Review Board (NIRB) developed updated EIS guidelines for the Project (NIRB 2015) that reflected Inuit community and stakeholder concerns associated with potential Project-related effects on marine mammals. Primary concerns identified for marine mammals along the Northern Shipping Route included potential loss or alteration of narwhal calving and nursing habitat due to port construction and shipping, potential injuries or mortality of marine mammals due to ship strikes, and potential acoustic disturbance effects on marine mammals from port construction and shipping that may lead to changes in animal distribution, abundance, migration patterns, and subsequent availability of these animals for harvesting.

Two years of community engagement meetings regarding the Phase 2 Proposal were carried out in Arctic Bay, Clyde River, Hall Beach, Igloolik, and Pond Inlet. Inuit communities and Stakeholders expressed concerns during these meetings related to marine wildlife and marine habitat (Table 2.2). Primary concerns identified by the communities with respect to potential Project effects on marine mammals included:

- Loss or alteration of narwhal habitat due to port construction and shipping;
- Injuries or mortality of marine mammals due to ship strikes; and
- Acoustic disturbance effects on marine mammals from port construction and shipping that may lead to changes in animal distribution, abundance, migration patterns, and subsequent availability of these animals for harvesting.

During the community engagement meetings, positive feedback was also provided, particularly with respect to on-going monitoring programs such as environmental monitoring at Milne Port and shore-based marine mammal monitoring at Bruce Head Peninsula.

Since 2012, potential Project effects on marine mammals have been discussed with the Marine Environmental Working Group (MEWG). This group was established to serve as an advisory group in connection with mitigation measures for the protection of the marine environment, and in connection with Baffinland's development and execution of the environmental effects monitoring program to address the Terms and Conditions of Project Certificate No. 005, as these pertain to the marine environment. In the context of the Phase 2 Proposal, the terms and conditions applicable to marine mammals focus primarily on monitoring requirements for evaluating potential physical and behavioral disturbance to marine mammals due to shipping that may result in changes in animal distribution, abundance, and migratory movements in the study area.

The present assessment focuses on issues of primary concern as identified through engagement with the MEWG, Project stakeholders and local Inuit communities to date, and is based on the latest information available from the ongoing monitoring programs, as outlined in Section 2.3.

2.0 EFFECTS ASSESSMENT

2.1 Background on Project Effects

The following section provides a summary of Project effects that were previously assessed for marine mammals as part of the Approved Project.

2.1.1 Change in Habitat

Potential loss and/or alteration of marine mammal habitat due to ore dock installation was considered in the previous assessment. Given the dock's relatively small footprint, the residual environmental effect of habitat change due to dock installation was predicted to be "Not Significant" for all marine mammals.

2.1.2 Acoustic Disturbance

Potential behavioral disturbance to marine mammals due to pile driving noise was evaluated in the previous assessment. Although pile driving was determined to be the loudest noise source during construction and operations, most of the noise was predicted to be confined to within 12 km of the piling site due to the configuration of Milne Inlet. Based on aerial survey records, narwhal and ringed seal were the only two species considered likely to occur within this limited area during the open-water season. Proposed mitigation measures included the use of a bubble curtain to reduce peak sound pressure levels emitted from the pile. With mitigation, the zones of avoidance and disturbance onset were estimated at 0.5 km and 2 km (respectively) for narwhal; and 0.3 km and 2 km for seals. Based on corrected aerial survey densities, 47 narwhal were predicted to occur within the disturbance zone (<2 km) at a given time in August (estimated four narwhal in September); potentially resulting in minor behavioral responses amongst these animals. Five narwhal were predicted to occur within the avoidance zone (<0.5 km) in August (estimated one narwhal in September), potentially resulting in localized and temporary avoidance behavior amongst these animals. There were no density estimates available for ringed seal in the RSA, although few seals were expected to occur in Milne Port. Seals potentially occurring near the Project site during construction were predicted to exhibit temporary and localized avoidance from pile driving activities. With the effective implementation of mitigation, the residual environmental effect of disturbance from pile driving noise was predicted to be "Not Significant" for all marine mammals.

Potential behavioral disturbance to marine mammals due to ship noise was evaluated in the previous assessment. Mitigation measures proposed to reduce disturbance effects from ship noise included reductions in ship speed (to between 7 and 10 knots), which reduces the overall noise output generated by ship propulsion. Other mitigation included the requirement for vessels to maintain a constant course and speed when in transit, and minimize idling when docked at Milne Port. It was anticipated that marine mammals will actively avoid ore carriers traveling along the Northern Shipping Route and any effect would be localized and short-term. With the effective implementation of mitigation, the residual environmental effect of disturbance from ship noise was predicted to be "Not Significant" for all species.

Potential behavioral disturbance to marine mammals due to airborne noise from aircraft overflights was evaluated in the previous assessment. Reactions to overflights at Milne Inlet were expected to be limited to brief startle or dive responses from the animal as the aircraft flies over, with little consequence at the individual or population level. Mitigation measures proposed to reduce disturbance effects from airborne noise included a minimum flight altitude (~450 m) when operating aircraft over marine areas, and active avoidance of marine mammals during flights. With the effective implementation of mitigation, the residual environmental effect of disturbance from aircraft noise was predicted to be "Not Significant" for all marine mammals.

2.1.3 Hearing Impairment

Potential hearing impairment in marine mammals from impulsive underwater noise sources such as pile driving noise was evaluated in the previous assessment. Based on aerial survey records, narwhal and ringed seal were the only two marine mammal species likely to occur within Milne Port during the open-water season. Mitigation measures proposed to reduce the potential for hearing impairment from pile driving noise included the use of bubble curtains for sound dampening, confirmatory underwater noise monitoring to verify model predictions, and visual monitoring of marine mammals during active piling including potential shut-downs or delayed start-ups when animals occur within the appropriate safety zone. Using the 180 and 190 dB re 1 µpa SPL (rms) injury thresholds (for impulsive sound) for cetaceans and pinnipeds, respectively; acoustic modelling results indicated that animals would need to be at very close range to the piling source (<25m for cetaceans; <5m for pinnipeds) to experience temporary hearing impairment during sheet pile driving. Given that marine mammals were unlikely to occur in the immediate proximity of piling activities after implementation of mitigation, the risk of permanent hearing impairment was considered negligible.

Potential hearing impairment in marine mammals from continuous underwater noise sources (i.e., shipping, tugs) was evaluated in the previous assessment. Temporary hearing impairment marine mammals would be possible if exposure occurred at sufficiently high levels over a set duration. For cetaceans, it was assumed that exposure to a noise source of 175 dB re 1µPa SPL over a continuous 100-s period could induce TTS (Southall et al. 2007). Based on acoustic modelling results, ambient noise data, and existing audiogram and aerial survey data, cetaceans were not expected to be exposed to continuous underwater noise sources capable of resulting in TTS. For pinnipeds, it was determined that continuous underwater noise sources would not result in hearing impairment.

Potential hearing impairment in pinnipeds from continuous in-air noise sources was evaluated in the previous assessment. In-air sound levels from aircraft overflights were not predicted to exceed established thresholds for hearing impairment in pinnipeds: 149 dB re 20µPa (peak) (flat) or 144 dB re 20µPa^2-s (M_{pa}) in air (South all et al. 2007). Similarly, sound levels from Project vessels (ore carriers, tugs) were not expected to exceed the 100 dB sensation level associated with onset of TTS.

With the effective implementation of mitigation, the residual environmental effect of hearing impairment from all Project noise sources was predicted to be “Not Significant” for all marine mammals.

2.1.4 Auditory Masking

Potential auditory masking effects from shipping and pile driving were evaluated in the previous assessment. Masking occurs when a noise source interferes with an animal’s ability to detect and interpret other acoustic signals of interest (e.g. vocalizations) in their environment. Masking typically occurs when the masking noise and the signal of interest share similar frequencies and overlap in time (Richardson et al. 1995).

For impulsive noise sources such as pile driving, masking was predicted to be limited for all marine mammals because of the intermittent nature of pile driving noise and the very short-duration of the sound pulses involved.

For continuous noise sources such as shipping, masking was predicted to be negligible for pinnipeds because most of their communication occurs at higher frequencies than ship noise. Some degree of auditory masking was predicted for both narwhal and beluga given that ship noise overlaps in frequency with the lower end of their communication range. However, given that most of their calls occur at predominantly higher frequencies than ship noise, and acknowledging the short duration of vessel noise, it was considered unlikely that masking from ship noise would significantly affect narwhal or beluga. Auditory masking effects were most relevant for bowhead whales given the large degree of frequency overlap between ship noise and bowhead communication. Masking effects on bowhead were predicted to be localized in Milne Port, and short-term along the shipping route relative to the interval between ship transits.

With the effective implementation of mitigation, the residual environmental effect of auditory masking from pile driving and shipping was predicted to be “Not Significant” for all marine mammals.

2.1.5 Mortality

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

2.2 Changes from FEIS / FEIS Addendum

Components of the Phase 2 Proposal that have potential to result in adverse effects on marine mammals but were not assessed as part of the Approved Project include the following:

- Construction of a second ore dock and associated marine infrastructure in Milne Port;
- An increase in the number of ship transits on the Northern Shipping Route during the open-water season;
- The addition of a larger size class vessel (i.e. Cape size carrier) to the present shipping fleet; and
- An extension of the shipping season into early ice conditions (mid-November).

2.3 Project Monitoring

Ore shipping along the Northern Shipping Route began during the open-water period in 2015, the first year of ERP operations. Prior to 2015, Baffinland conducted marine mammal baseline studies with the purpose of establishing baseline conditions on marine mammal abundance and distribution along the Northern Shipping Route, including Milne Inlet, Eclipse Sound, Pond Inlet and adjacent inlets. Prior to these baseline investigations, limited regional data existed for marine mammals during late-summer and early-fall. The marine mammal baseline studies addressed important data gaps and provided a framework for future marine mammal effects monitoring programs supportive of the Project. A summary of the marine mammal monitoring programs conducted to date are provided in Table 2.1 and are summarized below:

- **Aerial surveys** – Marine mammal aerial surveys were first conducted during the open-water seasons of 2007 and 2008 in support of the FEIS. Subsequent aerial surveys were conducted in 2013 and 2014 to establish marine mammal distribution and abundance along the Northern Shipping Route during the open-water season and prior to ERP operations. In 2015, aerial surveys were undertaken with a modified approach to examine potential effects of large vessel shipping on marine mammal distribution and abundance during the first year of ERP operations. In 2016, aerial marine mammal surveys were conducted by DFO along the Northern Shipping Route and adjacent inlet areas. Aerial photography from these surveys was analyzed by Baffinland to calculate abundance and density estimates for narwhal during the 2016 open-water season;

- **Shore-based monitoring** – Marine mammal monitoring was conducted annually (open-water season) at Bruce Head Peninsula between 2013 and 2017 to study narwhal responses to vessel traffic. Information was collected on vessel movements, narwhal abundance and distribution, group composition, and narwhal behavior in the presence and absence of vessels;
- **Acoustic monitoring** – Passive underwater acoustic monitoring was conducted near Bruce Head and at the mouth of Koluktoo Bay during the 2014 and 2015 open water seasons. Acoustic recorders were deployed in several locations along the Northern Shipping Route to collect information on underwater ambient noise, vessel noise, and marine mammal acoustic behavior over an extended deployment period. In 2017, passive acoustic recording tags were deployed on nine live-captured narwhal during the open-water season to assess potential changes in narwhal acoustic behavior related to exposure to ship noise and ship traffic. Additional acoustic tags will be deployed on narwhal during the 2018 open water season to support this ongoing study.
- **Ship-based monitoring** – A marine mammal surveillance monitoring program was conducted onboard Project ore carriers in 2014 and 2015. The program was discontinued in 2016 as it was determined that very few marine mammals were visible to observers on board the vessels, and there were safety concerns regarding observers boarding the vessels at sea; and
- **Narwhal tagging study** – During the 2017 open-water season, 18 narwhal were live captured in Tremblay Sound and instrumented with data-archiving ARGOS satellite tags for the purpose of monitoring fine-scale narwhal movement, dive behavior and habitat use throughout their summering grounds in the coastal fjord system of North Baffin Island. A subset of animals was also fitted with passive acoustic tags (Acousonde™ 3B) with integrated dive and accelerometer sensors to measure the tagged animal's acoustic environment and vocal activity in tandem with dive and foraging behavior. The deployment of high-resolution movement and acoustic tags on individual narwhal over an extended time series provided a means to fill existing knowledge gaps in general narwhal ecology, as well as evaluate potential changes in animal behavior related to shipping events along Baffinland's Northern Shipping Route. This study was part of an ongoing research collaboration with Fisheries and Oceans Canada (Arctic Research Division).

Table 2.1: Summary of Baffinland's Marine Mammal Monitoring Programs - Mary River Project

Survey Method	Year							
	2006	2007	2008	2013	2014	2015	2016	2017
Marine mammal aerial surveys	✓	✓	✓	✓	✓	✓	✓*	
Shore-based marine mammal monitoring				✓	✓	✓	✓	✓
Ship-based marine mammal monitoring				✓	✓	✓		
Acoustic monitoring				✓	✓			✓
Narwhal tagging study								✓

Notes: (*) Baffinland analysis of DFO-collected aerial survey photographs. Grey shaded areas indicate pre-operations (ERP) sampling

2.4 Assessment Methods

The assessment methods used for conducting the effects assessment of the Phase 2 Proposal's activities on marine mammals are consistent with those used in the Approved Project; including measurable parameters and threshold values.

Inputs to the marine mammal assessment that were completed in support of the Phase 2 Proposal included the following:

- Marine Mammals Baseline Report (Appendix A);
- Underwater Acoustic Modelling Report (Appendix B);
- 2016 Marine Mammal Aerial Photography Survey - Milne Inlet and Eclipse Sound (Appendix C; Golder 2018b);
- Hydrodynamic Modelling Report – Milne Port (Golder 2018c);
- Ship Wake and Propeller Wash Assessment (Golder 2018d);
- Marine Environment Effects Assessment (Golder 2018e);
- Marine Offsetting Plan (Golder 2018f); and
- Climate Change Assessment (Golder 2018g).

2.4.1 Issues Scoping

A comprehensive review of potential Project interactions with mammals was conducted for the Phase 2 Proposal, and included interactions scoped in the amended EIS Guidelines (NIRB 2015). A summary of these interactions is presented in Table 2.2. Effects that are not likely to be of notable environmental importance or consequence were defined as Subject of Note, or Level 1 interactions, and were not carried forward in the assessment; however, are discussed in Section 2.4.1.1. Key Issues, defined as Level 2 interactions (Volume 2, Section 3.5.3; Baffinland 2012) that were identified as being of substantial public interest and/or of potentially high environmental importance or consequence, were carried forward in the assessment.

Table 2.2: Phase 2 Proposal Interactions with Marine Mammals

Project Infrastructure or Activity	Interaction	Marine Mammal					
		Ringed Seal	Walrus	Beluga	Narwhal	Bowhead	Polar Bear
Milne Site							
Marine Construction	Sediment resuspension	0	0	0	0	0	0
	Disturbance/ hearing impairment due to underwater noise (pile driving)	2	0	1	2	1	1
Land-based Construction	Terrestrial runoff	0	0	0	0	0	0
Ancillary Facilities	Terrestrial runoff	0	0	0	0	0	0

Project Infrastructure or Activity	Interaction	Marine Mammal					
		Ringed Seal	Walrus	Beluga	Narwhal	Bowhead	Polar Bear
Marine Port Operation	Propeller wash	0	0	0	0	0	0
	Ballast water discharge	0	0	0	0	0	0
	Habitat change	2	0	1	2	1	1
	Disturbance/ hearing impairment due to underwater noise (shipping/vessel ops)	2	0	2	2	1	1
Land-Based Port Operation	Surface runoff	0	0	0	0	0	0
Emissions and Wastes	Dust emission and deposition	0	0	0	0	0	0
	Wastewater discharge	1	1	1	1	1	1
Shipping							
Open-water Operations	Vessel wake	1	1	0	0	0	0
	Antifouling agent introductions	0	0	0	0	0	0
	Disturbance/ hearing impairment due to underwater noise (shipping/vessel ops)	2	1	2	2	2	1
	Vessel strike	2	1	2	2	2	2

NOTES:
Interactions are rated as follows:
0 - No Interaction.
1 - Minor interaction post-mitigation, discussion assessment.
2 - Major interaction subject to detailed assessment.

2.4.1.1 Subject of Note Interactions

The following Subject of Note (Level 1) interactions were identified for the Phase 2 Proposal:

- Potential contaminant loading from wastewater discharges (all Marine Mammal VEC subcomponents);
- Potential vessel wake effects on haul-out habitat (seal and walrus);
- Potential change in habitat due to new ore dock footprint (beluga, bowhead, polar bear);
- Potential disturbance/ hearing impairment due to pile driving noise (beluga, bowhead, polar bear);
- Potential disturbance/ hearing impairment from ship noise (walrus and polar bear); and
- Potential vessel strikes on marine mammals (walrus and polar bear).

A brief rationale is provided below as to why the above interactions were not carried forward in the effects analysis.

Contaminant loading from wastewater discharge (all species)

Potential contaminant loading in seal and walrus was identified as an issue of concern in the NIRB EIS Guidelines (NIRB 2015). Marine mammals can take up contaminants through the ingestion of contaminated prey. A review of contaminants in marine mammals and their prey was provided in the FEIS (Baffinland 2012, Marine Mammal Baseline Report - Appendix 8A-2). Potential effects of introducing contaminants to the marine environment by means of site run-off, effluent discharge, fugitive ore dust emissions and fossil fuel combustion were assessed in Sections 3.5 of the FEIS (marine water and sediment quality) and Section 4.6 of the FEIS (marine biota). With mitigation measures in place, potential contaminants from the Project were not predicted to exceed applicable water and sediment quality guidelines, and by extension, not significantly affect prey (or prey habitat) of marine mammals. In addition, the risk of mortality to polar bears as a result of interactions with humans and ingestion of toxic materials was assessed in the FEIS Addendum. No further risks of contaminant uptake in marine mammals are anticipated as a result of the Phase 2 Proposal. This pathway was therefore not considered further in the assessment.

Vessel wake effects on shoreline habitat (haul-outs) - seal and walrus

Vessel wake effects on seal and walrus haul-out habitats were not carried forward in the assessment as there are no known haul-out sites for either species along the Northern Shipping Route. During the open-water period, seals spend the majority of their time in the water and rarely haul-out on land. Walrus haul-out on land during summer, but no walrus haul-out sites exist along the Northern Shipping Route. This pathway was therefore not considered further in the assessment.

Change in habitat due to new ore dock footprint – beluga, bowhead and polar bear

The importance of Milne Inlet, Eclipse Sound and Pond Inlet as a summering ground for beluga is uncertain, but relatively low numbers of this species occur in these areas during the open-water season. IQ collected by Remnant and Thomas (1992) indicates that only small numbers of beluga frequent waters near Pond Inlet during spring, summer, and fall. The majority of beluga present at the mouths of Pond Inlet and Navy Board Inlet during ice break-up are thought to migrate farther north and west into Admiralty Inlet and Barrow Strait (Remnant and Thomas 1992; COSEWIC 2004). No sightings of beluga were reported during five consecutive years of shore-based monitoring conducted at Bruce Head from 2013 to 2017 (Thomas et al. 2014; Smith et al. 2015; 2016; 2017; Golder 2018). Similarly, no sightings of beluga were recorded along the Northern Shipping Route during three consecutive years of aerial surveys conducted for Baffinland between 2013 and 2015 (Elliott et al. 2015; Thomas et al. 2015; 2016). Based on these results, beluga were considered unlikely to occur in the Milne Port area during the open-water season and the new ore dock footprint is not considered to overlap with important habitat for this species.

Few bowhead are expected to occur in Southern Milne Inlet during the open-water season. A total of 14 bowhead were recorded near Bruce Head during five consecutive years of shore-based monitoring conducted for Baffinland from 2013 to 2017 (Thomas et al. 2014; Smith et al. 2015; 2016; 2017; Golder 2018). Similarly, a total of 14 bowhead were recorded along the Northern Shipping Route during three consecutive years of aerial surveys conducted between 2013 and 2015 (Elliott et al. 2015; Thomas et al. 2015; 2016). Based on the most recent High Arctic Cetacean Survey completed by DFO in the Project area, the predicted number of bowhead in Eclipse Sound during 2013 was 32 (Doniol-Valcroze et al. 2015). Bowhead vocalizations were detected on underwater recorders near Bruce Head on 14 of 59 recording days in August 2014 (Kim and Conrad 2015), and were rarely detected over a two-month recording period during the summer of 2015 (Kim and Conrad 2016). Based on these results, bowhead are predicted to occur infrequently in the Milne Port area during the open-water season, and the new ore dock footprint is not considered to overlap with important habitat for this species.

Few polar bears are expected to occur in the open-water along the Northern Shipping Route during the open water season when they are forced ashore by the absence of ice (Taylor and Lee 1995). A total of four polar bear were reported during five consecutive years of shore-based monitoring conducted at Bruce Head from 2013 to 2017 (Thomas et al. 2014; Smith et al. 2015; 2016; 2017; Golder 2018). A total of nine polar bear were recorded along the Northern Shipping Route during three consecutive years of aerial surveys conducted for Baffinland between 2013 and 2015 (Elliott et al. 2015; Thomas et al. 2015; 2016). Based on these results, polar bear were considered unlikely to occur in the Milne Port area during the open-water season and the new ore dock footprint is not considered to overlap with important habitat for this species at this time of year.

Due to the lack of direct interactions between port construction activities and these three species during the open-water season, this pathway was not considered further in the assessment for beluga, bowhead and polar bear.

Potential disturbance/ hearing impairment from pile driving noise (beluga, bowhead and polar bear)

Beluga, bowhead and polar bear are not anticipated to occur in Milne Port during the open-water season (as described above). This pathway was therefore not considered further in the assessment for these species.

Disturbance and/or hearing impairment from ship noise - walrus and polar bear

Potential at-sea interactions between polar bear and Project vessels along the Northern Shipping Route are anticipated to be rare during the open-water season, as polar bear mostly occur on land during this period. Polar bear hearing sensitivity in-water is also assumed to be less acute than that in cetaceans and pinnipeds because they are not dependant on the use of underwater sound for communication, foraging or navigation purposes. Any potential response by polar bear to ships is likely triggered by visual cues rather than acoustic cues, with effects including short-term disturbance of the approaching ship by swimming away. Given the low likelihood of interactions between ship noise and polar bear during the open-water season, potential disturbance and hearing impairment effects were considered negligible and this pathway was not considered further in the assessment.

Based on extensive aerial survey records, very few walrus occur along the Northern Shipping Route during the open-water season and no walrus haul-out sites are present in this area (Thomas et al. 2016). The closest aggregations of walrus occur near Kane Basin in northern Baffin Bay, extending into Lancaster Sound, Barrow Strait, and Jones Sound in the Canadian Arctic archipelago (Vibe 1967; Davis et al. 1978; DFO 2002; COSEWIC 2006b). This is consistent with local IQ information indicating that small numbers of walrus occur at the northern entrance of Navy Board Inlet and in Lancaster Sound - west of Admiralty Inlet (Baffinland 2013). Only one walrus sighting was made during five consecutive years of shore-based monitoring conducted at Bruce Head from 2013 to 2017 (Thomas et al. 2014; Smith et al. 2015; 2016; 2017; Golder 2018). A total of five walrus sightings were recorded along the Northern Shipping Route during three consecutive years of aerial surveys conducted for Baffinland between 2013 and 2015 (Elliott et al. 2015; Thomas et al. 2015; 2016). Given the low likelihood of interactions between Project vessels and walrus, potential disturbance and hearing impairment effects from ship noise were considered negligible and this pathway was not considered further in the assessment.

Vessel strike on walrus

As previously noted, walrus are an uncommon species in the LSA and RSA during the open-water season and occur in very low numbers along the Northern Shipping Route. Given the low likelihood of interactions between Project vessels and walrus, the potential for vessel strikes on walrus were considered negligible and this pathway was not considered further in the assessment.

2.5 Effects Assessment – Ringed Seal

Key issues / Level 2 interactions carried forward in the assessment for ringed seal relevant to the Phase 2 Proposal are summarized in Table 2.3.

Table 2.3: Summary of Project Interactions and Potential Environmental Effects – Ringed Seal

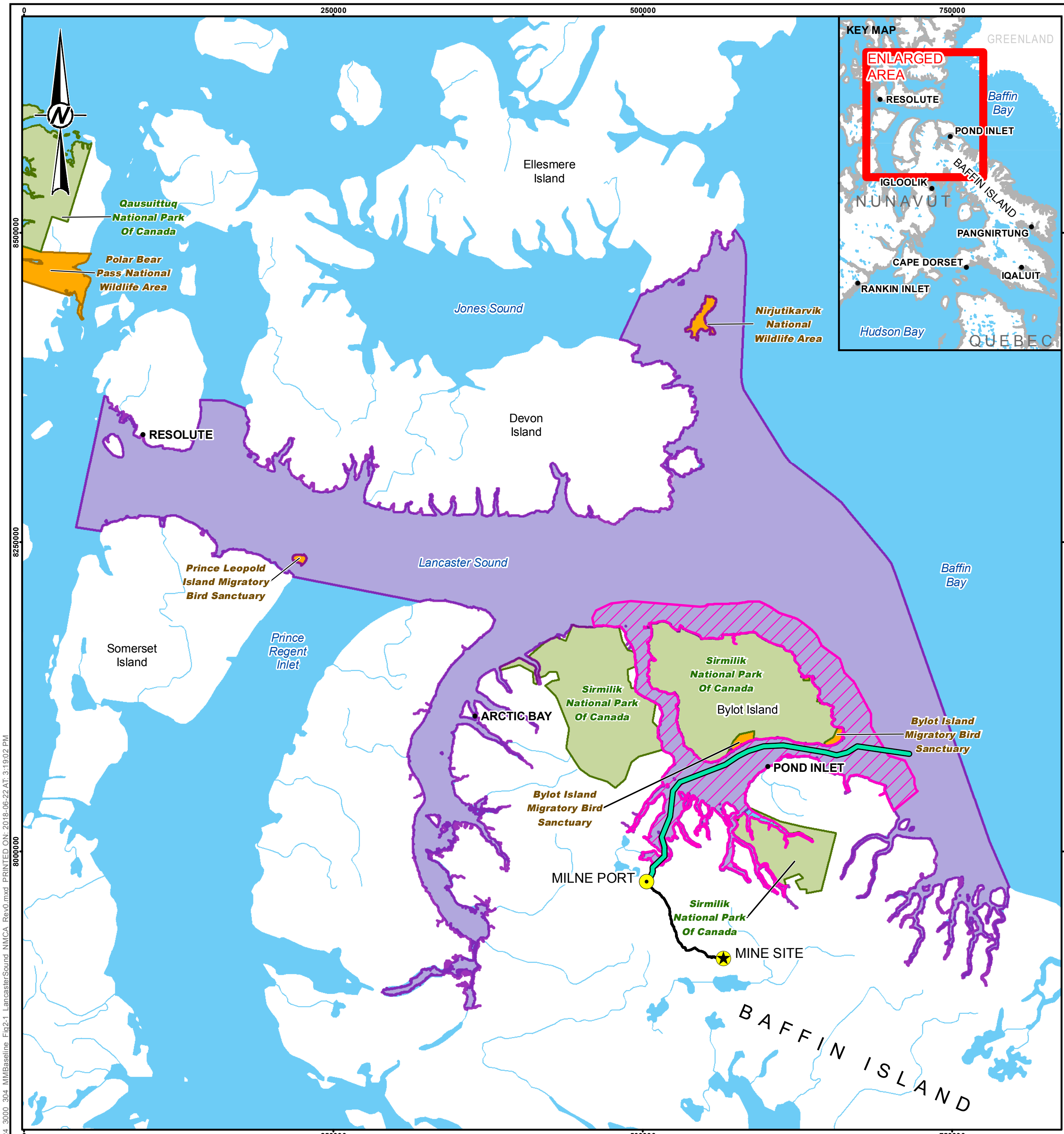
Project Interaction	Environmental Effects
Change in habitat caused by construction of new ore dock and freight dock	Change (decrease) in suitable pupping habitat in Milne Inlet
Disturbance caused by underwater noise from pile driving and shipping	Disturbance effects - avoidance response leading to seasonal abandonment of suitable habitat areas
Hearing impairment caused by underwater noise from pile driving and shipping	Potential hearing impairment (temporary or permanent)
Auditory masking caused by underwater noise from shipping	Potential masking of communication
Vessel strikes on seal during shipping	Potential injury and/or mortality

2.5.1 Change in Habitat

The proposed expansion of Milne Port will include construction of a second ore dock capable of berthing Cape size vessels. The new ore dock will be constructed east of the existing ore dock and connected to shore via a main access causeway (Figure 1.2). The dock face will be oriented parallel to the existing seabed contours, and kept within a range that provides sufficient depth and under keel clearance for fully laden vessels and stays within the physical limitations of steel sheet pile dock construction. The new ore dock will connect to the existing ore dock (to the west) and the freight dock (to the east) by means of secondary causeways (rock fill), which will effectively close off the wetted areas behind the causeways and result in two isolated water bodies separated by the main access causeway. Localized suction dredging of surficial sediment at the berth face of the new ore dock will be required to accommodate the installation of scour protection, and other Project components.

It is anticipated that construction of the ore dock expansion will occur primarily during the ice-covered season (December through June), with construction works extending over a three-year period (2019-2022). The proposed ore dock will be constructed in succession to limit disturbance to the natural environment, with a focus on in-water activities and producing an effective structure for long term, low maintenance operation.

The new marine infrastructure may permanently alter available ringed seal habitat in the nearshore environment for the duration of the Project. Potential effects on ringed seal include the loss of suitable winter pupping habitat within the marine footprint of the new dock footprint. Most suitable ringed seal pupping habitat in the LSA is located in northern Milne Inlet and Eclipse Sound (Baffinland 2013), although ringed seal are known to occur throughout the region including Milne Port. The footprint of the new dock layout was calculated to determine the amount of potential suitable habitat that may be directly lost due to the Phase 2 Proposal. The total footprint of the new ore dock expansion with connecting causeways, including the isolated waterbodies, is 17.1 ha (Figure 2.1). The total area of the new dock footprint corresponding with water depths adequate for ringed seal pupping / denning (>3m; Moulton et al. 2002) was calculated to be 1.5 ha (Figure 2.2). Similar pupping habitat was shown to be available in adjacent areas of Milne Inlet.



LEGEND

- • COMMUNITY
- MILNE PORT
- MINE SITE
- MILNE INLET TOTE ROAD
- SHIPPING ROUTE (APPROXIMATE)
- NORTHERN SHIPPING ROUTE REGIONAL STUDY AREA
- PROPOSED LANCASTER SOUND NATIONAL MARINE CONSERVATION AREA BOUNDARY
- NATIONAL PARK
- NATIONAL WILDLIFE AREA
- WATERBODY

0 100 200

1:4,500,000 KILOMETRES

REFERENCE(S)

HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. PROTECTED AREAS DATA OBTAINED FROM CANADIAN COUNCIL ON ECOLOGICAL AREAS (CCEA), APRIL 21, 2017.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
PROPOSED BOUNDARIES OF THE NATIONAL MARINE CONSERVATION AREA FOR LANCASTER SOUND (TALLURUTIUP IMANGA)

CONSULTANT

GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	2.1

Mitigation Measures

- The proposed ore dock will be constructed in succession to limit disturbance to the natural marine environment, with a focus on in-water activities and producing an effective structure for long term, low maintenance operation;
- The dock face will be oriented parallel to the existing seabed contours to minimize dredging activities; and
- The proposed ore dock will be constructed during the ice-covered season, when ringed seal would be the only marine mammal species present in Southern Milne Inlet.

Residual Effect

The total area of suitable pupping habitat that will be lost (<1.5 ha) as a direct result of the new dock structures is small. Given the relatively small footprint and in consideration of proposed mitigation, the effects of habitat change on ringed seal are anticipated to be negligible. The residual environmental effect of habitat change on ringed seal is predicted to be “Not Significant” (Table 2.5).

2.5.2 Acoustic Disturbance

Potential acoustic disturbance to marine mammals is generally measured through observations of behavioral responses to sounds used as a surrogate measure for sensitivity or susceptibility (McCauley 1994; Richardson et al. 1995). Potential effects range from subtle changes in behaviour at low received levels to strong disturbance effects at high received levels.

Underwater noise generated during pile driving (construction) and shipping (construction and operations) has the potential to result in disturbance effects in ringed seal including avoidance and displacement behavior, and potential abandonment of suitable habitat areas. In the extreme cases, disturbance effects may lead to reduced foraging efficiency, increased energy expenditure, and reduced fecundity and population health effects (Richardson 2002).

2.5.2.1 Pile Driving

Construction of the new ore dock will require installation of cylindrical piles using both impact and vibratory driving methods, and installation of sheet piles using vibratory methods. Impact and vibratory driving of both sheet piles and cylindrical piles were modelled based on the following modelling inputs / scenarios:

- Vibratory driving of AS 500-12.7 sheet piles (35 m × 0.5 m with 12.7 mm thickness) installed during summer using an ICE 28D vibratory hammer. During sheet pile installation of the existing dock at Milne Port, vibratory pile driving of each sheet pile took between 4 and 97 s (MacDonnell and Martin 2014; ERM 2015). For calculation of cumulative metrics, it was assumed that the vibratory installation of each sheet pile will take 96 s, and a maximum of 10 sheet piles will be installed over a 24-h period;
- Vibratory driving of AZ26-700 sheet piles (35 m × 1.4 m with 50 mm thickness) installed during winter using an ICE 28D vibratory hammer. For calculation of cumulative metrics, it was assumed that the vibratory installation of each sheet pile will take 108 s, and a maximum of four sheet piles can be installed over a 24-h period;

- Vibratory driving of steel cylindrical piles (70 m length ×1.829 m diameter with 2.54 cm pile wall thickness) installed during winter using an APE400B vibratory hammer to drive the pile until refusal; and
- Impact driving of steel cylindrical piles (70 m length ×1.829 m diameter with 2.54 cm pile wall thickness) installed during winter using an APE D180-42 impact hammer to seat the pile.

For vibratory pile driving, the maximum range (R_{max})[2] for disturbance of ringed seal (based on the 120 dB re 1 µPa SPL threshold) was 10.7 km for sheet piles in summer, 11.2 km for sheet piles in winter and 21.7 km for cylindrical piles in winter. It is important to note that the 21.7 km line-of-sight from the pile location towards Koluktoo Bay (evident in Figure E-26 in Appendix B) corresponds to a very narrow angular span of sound propagation. In this case, the corresponding $R_{95\%}$[3] radii of 16.1 km provides a more representative seal disturbance zone resulting from vibratory driving of cylindrical piles during winter. For impact driving of cylindrical piles during winter, the maximum range for disturbance of ringed seal (based on the 160 dB re1 µPa SPL threshold) was 11.4 km (R_{max}). Detailed modelling results are presented in Appendix B.

Mitigation Measures

The following mitigation measures will be implemented during construction activities for the Phase 2 Proposal:

- A ramp-up procedure consists of initial activation of the equipment using the lowest energy source / pulse and gradually increasing the intensity of the sound until it reaches the required intensity, thus allowing time and incentive for marine mammals to leave the immediate zone of potential injury before the pile driver is operating at full power;
- Installation of a bubble curtain around the wetted pile to dampen sound transmission through water during active pile driving;
- During all pile driving activities, marine mammal monitoring will be undertaken by a qualified and experienced Marine Mammal Observer (MMO), with all sightings communicated to the piling contractor;
- Implementation of a 1-km Marine Mammal Exclusion Zone – defined as the zone within which MM may be potentially exposed to sound levels above the injury threshold criteria (180 dB re 1 µPa SPL_{rms} for cetaceans and 190 dB re 1 µPa SPL_{rms} for pinnipeds). The occurrence of a marine mammal within the exclusion zone will trigger specific mitigation actions (e.g., shut-downs) such to avoid potential for physical injury to animals from pile driving noise;
- Shut-down procedures –pile driving will be temporarily suspended when a marine mammal enters within the exclusion zone until which time it moves outside the safety zone;
- Implementation of a 30 minute pre-operational (pre-ops) search for marine mammals prior to start-up of pile driving. This would consist of a visual scan of the water by the MMO to determine that no marine mammals are present within the exclusion zone. If an animal is spotted within the exclusion zone during the pre-ops search, the ramp-up procedure will be delayed 20 minutes from the time the marine mammal has left the exclusion zone, or was last sighted in this zone; and

[2] the maximum distance at which the threshold is exceeded,

[3] the maximum range, after excluding 5% of the farthest points, at which marine mammals might encounter a sound level, which would create an estimate less affected by sound field outliers

- The MMO will periodically verify underwater sound levels in the field using a hydrophone and a real-time sound monitor to confirm that sound levels at the modeled exclusion zone radius are below the established injury thresholds for marine mammals. If sound levels are shown to exceed the injury thresholds at the exclusion zone radius, the exclusion zone boundary will be adjusted accordingly.

The above mitigation measures were applied during ore dock construction in 2014 and were shown to be highly effective for avoiding potential adverse effects on ringed seal during pile driving works.

Residual Effect

The zone of disturbance onset for pile driving is predicted to occur out to a distance of 16.1 km from the source (with no bubble curtain mitigation). There are no density estimates for seals in the LSA during the open-water and ice-covered seasons, but few seals are expected to occur near Milne Port during this time. Animals occurring near Milne Port during active vibratory or impact pile driving are expected to exhibit temporary and localized avoidance behavior. The number of seals likely to be affected is expected to be low. With the effective implementation of mitigation including the use of bubble curtains around the wetted pile to reduce sound propagation, disturbance effects from pile driving on ringed seal are anticipated to be negligible. The residual environmental effect of disturbance on ringed seal is predicted to be “Not Significant”.

2.5.2.2 Shipping

As part of the Phase 2 Proposal, the volume of ore shipped along the Northern Shipping Route will increase from 4.2 Mtpa to 12 Mtpa. In order to account for the increased tonnage of ore being transported, an increase in total vessel traffic serving Milne Port will be required. An estimated 176 ore carrier round trips (upper limit) will be required per season to support Phase 2 operations (Table 2.1). Ore carriers ranging in size from Supramax to Cape size will be retained by Baffinland depending on availability - a proposed shipping schedule is provided in Table 2.1. Shipping will occur seasonally between July 01 and November 15, with each chartered vessel making one to three round trips per season.

Table 2.4: Maximum Number of Ore Carrier Calls (Round-trips) at Milne Port during Phase 2 Operations

Vessel Type	Vessel Size	July	August	September	October	Total
Supramax	50,000 DWT	10	5	5	10	30
Panamax	65,000 DWT	9	45	45	34	133
Cape size	150,000 DWT	0	6	5	2	13
Total		**19**	**56**	**55**	**46**	**176**

DWT = Dead Weight Tonnage. Note – Above schedule assumes all shipping will occur between July and October, although this may extend into mid-November.

In general, evidence on reactions of seals to vessel sound is scarce; the limited data suggest that seals are fairly tolerant of vessel sound / vessel activity, and are known to return to areas of previous disturbance (full review in Richardson et al. 1995). Harbour seals hauled out on land have been shown to move into the water in response to vessel sounds, particularly during the pupping period (Reijnders 1981; Brasseur 1993 in Richardson et al. 1995). This species has also been observed returning to haul out sites within an hour of being displaced into the water as a result of vessel disturbance (Bowles and Stewart 1980; Osborn 1985). Several other studies report habituation of harbour seals and gray seals to repeated vessel approaches in high traffic areas (Bonner 1982; Johnson et al. 1989).

JASCO performed underwater acoustic modelling of Project vessels (ore carriers, tugs) under several different operational scenarios (e.g., berthing, transiting, and mooring) for the Phase 2 Proposal (Appendix B). The following vessel source levels were used as model inputs:

- 168 dB SEL re 1 µPa^{2}s for a moored bulk carrier;
- 172 and 187 dB SEL re 1 µPa^{2}s for a Post-Panamax carrier transiting at 5 and 9 knots, respectively;
- 175 and 190 dB SEL re 1 µPa^{2}s for a Cape size carrier transiting at 5 and 9 knots, respectively;
- 175 and 190 dB SEL re 1 µPa^{2}s for a Cape size carrier transiting at 5 and 9 knots, respectively; and
- 167 dB and 198 dB SEL re 1 µPa^{2}s for a tug for tug transiting at 5 knots and berthing, respectively.

Based on the 120 dB re 1 µPa SPL disturbance threshold for pinnipeds, the maximum range for ringed seal disturbance for Phase 2 shipping operations was predicted to be:

- 10.7 km for tug-assisted berthing in Milne Port (limited by land);
- 3.7 km for tug-assisted carrier movements in Milne Port;
- 2.6 km for carriers moored at Ragged Island;
- Between 9.8 km and 19.2 km for Post-Panamax carriers travelling at 9 knots along the shipping route;
- Between 12.3 km and 29.5 km for Cape size carriers travelling at 9 knots along the shipping route;
- 1.7 km (Post-Panamax) and 3.7 km (Cape size) for carriers travelling at 5 knots in Milne Port; and
- 2.6 km for carriers moored at anchorages in Milne Port and Ragged Island.

Detailed modelling results including maps showing distances to the 120 dB re 1 µPa SPL disturbance threshold are presented in Appendix B. The modeled disturbance zone distances presented above do not consider the overall duration of the noise or the frequency of the sound relative to seal hearing sensitivity in water. Shipping noise generally dominates ambient noise at low frequencies, with most energy occurring between 20 to 300 Hz and some components extending into the 1 to 5 kHz range (Richardson et al. 1995a). Ringed seal vocalizations occur in the 400 Hz to 16 kHz frequency range, with dominant frequencies concentrated above 5 kHz (Stirling 1973; Cummings et al. 1984). Ship noise is therefore unlikely to result in major disturbance effects in ringed seal given it is primarily emitted in the frequency band in which seals have low hearing sensitivity. The maximum disturbance ranges presented herewith should therefore be considered as conservative estimates.

Mitigation Measures

The following mitigation measures will be implemented to reduce or avoid adverse effects on marine mammals as a result of shipping activities for the Phase 2 Proposal:

- Vessels will reduce speeds to a maximum of 9 knots when transiting along the established shipping corridor, and 5 knots when operating in Milne Port, thus reducing the overall noise output generated by ship propulsion and the potential for ship strikes;
- Vessels will maintain a constant course and speed when in transit;
- Vessels will minimize idling when docked at Milne Port;
- During shoulder seasons, vessels will transit along the same route during round-trip transits;
- Idling at the ore dock and moorage will be kept to a minimum in an effort to decrease underwater noise;
- 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 move away from the immediate area;
- Project vessels shall not approach within 300 m of a walrus or polar bear observed on sea ice; and
- All Project vessels will not be operated in such a way as to separate an individual member(s) of a group of marine mammals from other members of the group.

Residual Effect

Disturbance effects are predicted to be negligible for ringed seal because most of their communication occurs at higher frequencies than ship noise. It was anticipated that ringed seal will actively avoid ore carriers traveling along the Northern Shipping Route and any effect would be localized and short-term. With the effective implementation of mitigation, the residual environmental effect of disturbance from ship noise was predicted to be "Not Significant" for ringed seal.

2.5.3 Hearing Impairment

2.5.3.1 Pile Driving

Auditory trauma in marine mammals can occur at close distances of very strong sound sources. The severity of the effect is dependent on the species of marine mammal. Seals are most sensitive to moderate frequencies; whereas, baleen whales are most sensitive to low frequencies and toothed whales are most sensitive to high frequencies (Richardson 2002).

The potential for auditory injury due to Project activities was assessed using functional hearing group designations and impact criteria from NMFS (NOAA 2016) and Southall et al. (2007), as described in Section 1.3.1.1. Both criteria categorize species with similar hearing sensitivities into hearing groups, but apply slightly different hearing ranges for each group and different noise weighting across the hearing frequency ranges among different groups.

Construction of the new ore dock will require installation of cylindrical piles using both impact and vibratory driving methods, and installation of sheet piles using vibratory methods. Impact and vibratory driving of both sheet piles and cylindrical piles were modelled by JASCO based on modelling inputs / scenarios described in Section 2.5.2.1. The potential for auditory injury due to pile driving was assessed using functional hearing group designations and impact criteria from NMFS (NOAA 2016), Wood et al. (2012) and Southall et al. (2007), as described in Section 1.3.1.1. These injury criteria categorize species with similar hearing sensitivities into hearing groups, but apply slightly different hearing ranges for each group and different noise weighting across the hearing frequency ranges among different groups.

For vibratory driving (sheet piles and cylindrical piles combined), modelling results indicated that the largest $R_{95\%}$ and R_{max} distance to the injury threshold for ringed seal (based on the 24-h auditory weighted SEL injury thresholds) was 50 m. For impact driving of cylindrical piles, modelling results indicated that the largest $R_{95\%}$ and R_{max} distances to the injury threshold for ringed seal (based on 24-h auditory weighted SEL injury thresholds) were 1.8 km and 2.2 km, respectively. Detailed modelling results are presented in Appendix B.

Mitigation Measures

Proposed mitigation measures to avoid potential auditory injury from pile driving activities are identified in Section 2.5.2.1. It should be noted that ringed seal were occasionally observed in Milne Port during the previous ore dock construction in 2014, although they rarely occurred within the 200 m exclusion zone (ERM 2015). No shut-down notifications were required during the 2014 piling program.

Residual Effect

The zone for potential auditory injury for ringed seal from pile driving is predicted to extend up to 2 km from the source (unmitigated). No density estimates are available for ringed seal in the LSA during the open-water season, but few seals are expected to occur in Milne Port during this time. Animals occurring near Milne Port during active pile driving are expected to exhibit temporary and localized avoidance behavior. With the effective implementation of mitigation including the use of bubble curtains to reduce sound propagation from the pile, the potential for auditory injury from vibratory pile driving on ringed seal is anticipated to be negligible. The residual environmental effect of hearing impairment on ringed seal is predicted to be “Not Significant”.

2.5.3.2 Shipping

There is no direct evidence of hearing impairment (either PTS or TTS) occurring in seals as a consequence of exposure to vessel-generated sound (Southall et al. 2007). Acoustic modelling was conducted to quantity the underwater sound fields and associated sound level contours generated by Project vessels during transiting, berthing, and mooring events at defined anchorages in Milne Port and at Ragged Island. Modelling allowed for prediction of potential injury zones for ringed seal, represented by the maximum range (relative to the source) to the SEL_{24h} injury thresholds for ‘pinnipeds in water (PPW)’, based on the dual criteria (Southall et al. 2007; NOAA 2016).

Modelling results indicated that noise generated by transiting vessels would not exceed the SEL_{24h} injury thresholds for PPW under any of the scenarios considered in the acoustic model (Appendix B). The risk of permanent hearing impairment in ringed seal from open-water shipping was therefore considered negligible.

For mooring activities at all anchorage locations considered in the model, the maximum distance to the SEL_{24h} injury thresholds for PPW was predicted to be <20 m (relative to the source) under both criteria (Southall et al.

2007; NOAA 2016). Sound fields were not predicted to overlap for simultaneous mooring events in adjacent anchorage areas. Map of SEL_{24h} distances to injury thresholds are presented in Appendix B.

For tug-assisted berthing activities at the ore docks, the maximum distance to the SEL_{24h} injury thresholds for PPW was predicted to be <50 m (relative to the source) under the NMFS criteria (NOAA 2016) and <100m (relative to the source) under the Southall et al. (2007) criteria. The predicted injury zone was marginally smaller for berthing of Post-Panamax vessels than Cape size carriers. Sound fields were not predicted to overlap for concurrent tug-assisted berthing events occurring at both ore docks. Map of SEL_{24h} distances to injury thresholds are presented in Appendix B.

Mitigation Measures

Proposed mitigation measures to avoid potential auditory injury from shipping are identified in Section 2.5.2.2.

Residual Effect

Modelling results indicate that ship noise will not exceed applicable injury thresholds for ringed seal. With the effective implementation of mitigation, the residual environmental effect of hearing impairment in ringed seal from ship noise was predicted to be “Not Significant”.

2.5.4 Auditory Masking

The potential effects of auditory masking in ringed seal are dependent on the received sound level and the frequency content of the received sound signal relative to hearing ability in this species and the level of natural background noise. Ringed seal are not a particularly vocal species, with highest calling rates observed during the spring breeding season (Stirling et al. 1983). The majority of their calls occur in the 400 Hz to 16 kHz frequency range, (Stirling 1973; Cummings et al. 1984), which is above the frequency range of the most intense shipping and pile driving noise. Ringed seal have a flat audiogram between 1 kHz and 30 to 50 kHz (Mohl 1968; Terhune and Ronald 1972, 1975; Terhune 1981), with best in-water hearing sensitivity reported at 49 dB re 1 µPa (12.8 kHz) (Sills et al. 2015).

There is no evidence of auditory masking in ringed seal in the available literature. For continuous noise sources such as shipping and vibratory pile driving, masking effects on ringed seal are likely limited because of the relatively short duration of these events, and the limited overlap in frequency between these noise sources and ringed seal communication.

Mitigation Measures

Proposed mitigation measures to avoid potential auditory masking from pile driving and shipping activities are identified in Section 2.5.2.1 and 2.5.2.2, respectively.

Residual Effect

With the effective implementation of mitigation, the residual environmental effects of auditory masking from pile driving and shipping was predicted to be “Not Significant” for ringed seal.

2.5.5 Mortality

Vessel strikes on ringed seal may result in serious injury or death by means of blunt force trauma from direct impact with the hull of a vessel, or from lacerations due to contact with rotating propellers (Knowlton and Kraus 2001; Silber et al. 2010; Neilson et al. 2012). Depending on the severity of the strike and the injuries inflicted, the animal may or may not recover. In general, most lethal and severe injuries are linked to large vessels with bulbous bows travelling at speeds greater than 13 knots (Laist et al. 2001; Jensen and Silber 2003; Dolman et al. 2006). This vessel speed is considered to be the critical threshold above which vessel strikes resulting in severe injury and/or mortality are more likely to occur (Dolman et al. 2006; Jensen and Silber 2003). The probability of a lethal vessel strike is thus positively correlated with vessel speed and gross tonnage of the vessel (Dolman et al. 2006; Kite-Powell et al. 2007; Vanderlaan and Taggart 2007).

Species-specific behavioral and physical differences are also factors that determine a given species' vulnerability to a vessel strike (Laist et al. 2001; Nichol et al. 2017). There are relatively few documented cases of vessel strikes in pinnipeds (seals and walrus) (Wells and Scott 1997; Richardson et al. 1995; Van Waerebeek et al. 2007). These animals are considered to be at relatively low risk of vessel strike owing to their fast swimming speed, manoeuvrability and agility (Richardson et al. 1995; Laist et al. 2001; Jensen and Silber 2003).

Ringed seal were considered to have a low likelihood of being struck by a vessel due to their maneuverability and agility in the water. Due to Project vessel speed restrictions (9 knots in shipping corridor, 5 knots in Milne Port), in addition to ships maintaining minimum distances from any observed marine mammals, the likelihood of a vessel strike is considered low.

In addition to normal open-water shipping, ice-strengthened ore carriers may transit the shipping corridor during the period of initial ice break-up in late spring and during initial ice formation in the fall. During these shoulder seasons, animals hauled out on ice pans and floating ice are likely to show a greater response to ships. Although there is no evidence of ringed seal injury or mortality due to icebreaker movements in the available literature, seals have been reported to demonstrate fleeing behaviour when a ship approached within 0.4 to 0.8 km (Richardson et al. 1995a).

Mitigation Measures

Proposed mitigation measures to avoid potential ringed seal mortality from ship strikes are identified in Section 2.6.2.2.

Residual Effect

Ringed seal mortality is not expected to occur as a result of the Phase 2 Proposal activities. With the effective implementation of mitigation, the potential residual effects of ringed seal mortality due to vessel strikes is predicted to be negligible. The residual environmental effect on ringed seal is expected to be "Not Significant".

2.5.6 Significance of Residual Effects

Residual effects of Phase 2 Proposal activities on ringed seal are identified in Table 2.5, and are summarized below.

2.5.6.1 Change in Habitat

With the effective implementation of mitigation, the residual effects of habitat loss on ringed seal due to the new ore dock footprint are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent in occurrence (Level I), medium-term (Level II) in duration, and fully reversible (Level I) (Table 2.5). The residual environmental effect is predicted to be ‘Not Significant’ (Table 2.5).

2.5.6.2 Acoustic Disturbance

With the effective implementation of mitigation, the residual disturbance effects on ringed seal from pile driving and shipping are predicted to be moderate in magnitude (Level II), confined to the LSA (Level I), intermittent (Level II) in frequency, short-term (Level I) for pile driving and medium-term (Level II) for shipping, and fully reversible (Level I) (Table 2.5). The residual environmental effect is predicted to be ‘Not Significant’ (Table 2.5).

2.5.6.3 Hearing Impairment

With the effective implementation of mitigation, the residual effects of hearing impairment on ringed seal due to pile driving and shipping are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent (Level I) in occurrence, short-term (Level I) in duration, and fully reversible (Level I) (Table 2.5). The residual environmental effect is predicted to be ‘Not Significant’ (Table 2.5).

2.5.6.4 Auditory Masking

With the effective implementation of mitigation, the residual effects of auditory masking in ringed seal due to pile driving and shipping noise are predicted to be low in magnitude (Level I), confined to the LSA (Level I), intermittent (Level II) in occurrence, short-term (Level I) for pile driving and medium-term (Level II) for shipping, and fully reversible (Level 1) (Table 2.5). The residual environmental effect is predicted to be ‘Not Significant’ (Table 2.5).

2.5.6.5 Mortality

With the effective implementation of mitigation, the residual effects of mortality on ringed seal due to vessel strikes are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent (Level I) in occurrence, medium-term (Level I) in duration, and fully reversible (Level I) (Table 2.5). The residual environmental effect is predicted to be ‘Not Significant’ (Table 2.5).

Table 2.5: Effects Assessment Summary and Significance of Residual Effects on Ringed Seal

Residual Effect	Residual Effect Evaluation Criteria					Significance of Predicted Residual Effect	Qualifiers	
	Magnitude	Extent	Frequency	Duration	Reversibility		Probability (Likelihood of Effect Occurring)	Certainty (Confidence in Effects Prediction)
Change in Habitat	Level I	Level I	Level I	Level II	Level I	N	--	--
Disturbance	Level II	Level I	Level II	Level I (pile driving) Level II (shipping)	Level I	N	--	--
Hearing Impairment	Level I	Level I	Level I	Level I	Level I	N	--	--
Auditory Masking	Level I	Level I	Level II	Level I (pile driving) Level II (shipping)	Level I	N	--	--
Mortality	Level I	Level I	Level I	Level I	Level I	N	--	--

Notes:
Magnitude: 1 (Level I) = a change that is less than threshold values; 2 (Level II) = a change that is greater than threshold values; 3 (Level III) = a change that is an order of magnitude greater than threshold values; includes consideration of environmental sensitivity
Extent: 1 (Level I) = confined to the LSA; 2 (Level II) = beyond the LSA and within the RSA; 3 (Level III) = beyond the RSA
Frequency: 1 (Level I) = infrequent (rarely occurring); 2 (Level II) = frequent (intermittently occurring); 3 (Level III) = continuous
Duration: 1 (Level I) = short-term; 2 (Level II) = medium-term; 3 (Level III) = long-term (beyond the life of the project) or permanent
Reversibility: 1 (Level I) = fully reversible after activity is complete; 2 (Level II) = partially reversible after activity is complete; 3 (Level III) = non-reversible after the activity is complete
Significance Rating: S=Significant, N=Not Significant, P=Positive
Qualifiers- only applicable to significant effects
Probability: 1 (Level I) = unlikely; 2 (Level II) = moderate; 3 (Level III) = likely
Certainty: 1 (Level I) = low; 2 (Level II) = medium; 3 (Level III) = high

2.6 Effects Assessment – Narwhal

Key issues / Level 2 interactions carried forward in the present assessment for narwhal are summarized in Table 2.6.

Table 2.6: Summary of Project Interactions and Potential Environmental Effects - Narwhal

Project Interaction	Environmental Effects
Change in habitat caused by construction of new ore dock and freight dock	Change (decrease) in suitable foraging habitat in Milne Inlet
Disturbance caused by underwater noise from pile driving and shipping	Disturbance effects - avoidance response leading to seasonal abandonment of suitable habitat areas
Hearing impairment caused by underwater noise from pile driving and shipping	Potential hearing impairment (temporary or permanent)
Vessel strikes on narwhal during shipping	Potential injury and/or mortality

2.6.1 Change in Habitat

Narwhal occur in high numbers in the RSA during the open-water season, including in the Milne Port area (ERM 2015). They were regularly observed during port construction in August 2014, and passed within the 200-m exclusion zone on several occasions. The footprint of the new dock structures was calculated to determine the amount of potential narwhal foraging habitat that may be directly lost for the life of the Project. The total area of the new dock structures corresponding with water depths adequate for narwhal access was calculated to be 1.8 ha. This minor change (i.e. loss) in habitat caused by the new dock structures was lower than the threshold value of 10% and was considered to result in a negligible, low magnitude effect. The residual environment effect is predicted to be “Not Significant”.

Mitigation Measures

The ore dock and freight dock were designed to minimize the footprint in the marine environment.

Residual Effect

The total area of narwhal foraging habitat that will be lost (<1.8 ha) as a direct result of the new dock structures is small. Given the relatively small footprint and in consideration of proposed mitigation, the effects of habitat change on narwhal are anticipated to be negligible. The residual environmental effect of habitat change on narwhal is predicted to be “Not Significant” (Table 2.6).

2.6.2 Acoustic Disturbance

Underwater noise generated during pile driving (construction) and shipping (construction and operations) has the potential to result in disturbance effects in narwhal including avoidance and displacement behavior, and potential abandonment of suitable habitat areas. In the extreme cases, disturbance effects may lead to reduced foraging efficiency, increased energy expenditure, and reduced fecundity and population health effects (Richardson 2002).

2.6.2.1 Pile Driving

Construction of the new ore dock will require installation of cylindrical piles using both impact and vibratory driving methods, and installation of sheet piles using vibratory methods. Impact and vibratory driving of both sheet piles and cylindrical piles were modelled by JASCO based on modelling inputs / scenarios described in Section 2.5.2.1

For vibratory pile driving, the maximum range (R_{max})[4] for disturbance of narwhal (based on the 120 dB re 1 µPa SPL threshold) was 10.7 km for sheet piles in summer, 11.2 km for sheet piles in winter and 21.7 km for cylindrical piles in winter. It is important to note that the 21.7 km line-of-sight from the pile location towards Koluktoo Bay (evident in Figure E-26 in Appendix B) corresponds to a very narrow angular span of sound propagation. In this case, the corresponding $R_{95\%}$[5] radii of 16.1 km provides a more representative disturbance zone resulting from vibratory driving of cylindrical piles during winter. For impact driving of cylindrical piles during winter, the maximum range for disturbance of narwhal (based on the 160 dB re1 µPa SPL threshold) was 11.4 km (R_{max}). Detailed modelling results are presented in Appendix B.

[4] the maximum distance at which the threshold is exceeded,
[5] the maximum range, after excluding 5% of the farthest points, at which marine mammals might encounter a sound level, which would create an estimate less affected by sound field outliers

Mitigation Measures

Proposed mitigation measures to avoid potential auditory injury from pile driving activities are identified in Section 2.5.2.1. The same mitigation measures were applied during ore dock construction in 2014 and were shown to be highly effective for avoiding potential adverse effects on narwhal during pile driving works.

Residual Effect

The zone of disturbance onset for vibratory pile driving is predicted to occur at a distance of 16.1 km from the source (with no bubble curtain mitigation). Narwhal occurring near Milne Port during active pile driving are expected to exhibit temporary and localized avoidance behavior. With the effective implementation of mitigation including the use of bubble curtains to reduce sound propagation, disturbance effects from vibratory pile driving on narwhal are anticipated to be negligible. The residual environmental effect of disturbance on narwhal is predicted to be “Not Significant”.

2.6.2.2 Shipping

Shipping has potential to effect narwhal distribution as their summer range overlaps with the Northern Shipping Route, and it is thought this this summering area is used for calving and mating. Underwater noise generated during shipping may elicit behavioral changes such as avoidance, evasive maneuvers (diving) or changes in swimming direction and/or speed. Mom-calf pairs traveling along the shipping corridor may be more sensitive to ship noise given their slower travel speeds and reduced manoeuvrability around vessel traffic. Although ore carriers are also slow moving; there are several narrow areas along the shipping route where narwhal are known to transit in large groups and ships have limited ability to change course.

Ship noise has been shown to result in temporary displacement of toothed whales, but no clear evidence is available that narwhal and other toothed whales have abandoned significant parts of their range because of vessel traffic (full review in Richardson et al. 1995a and Gordon et al. 2004). Many toothed whales show considerable tolerance of vessel traffic (Richardson et al. 1995a). Little is known on how whales respond to repeated disturbance from ship traffic over time. Photographic surveys in Milne Inlet in 2015 indicate that large groups of transiting narwhal show temporary avoidance of ore carriers transiting along the shipping route (Thomas et al. 2016).

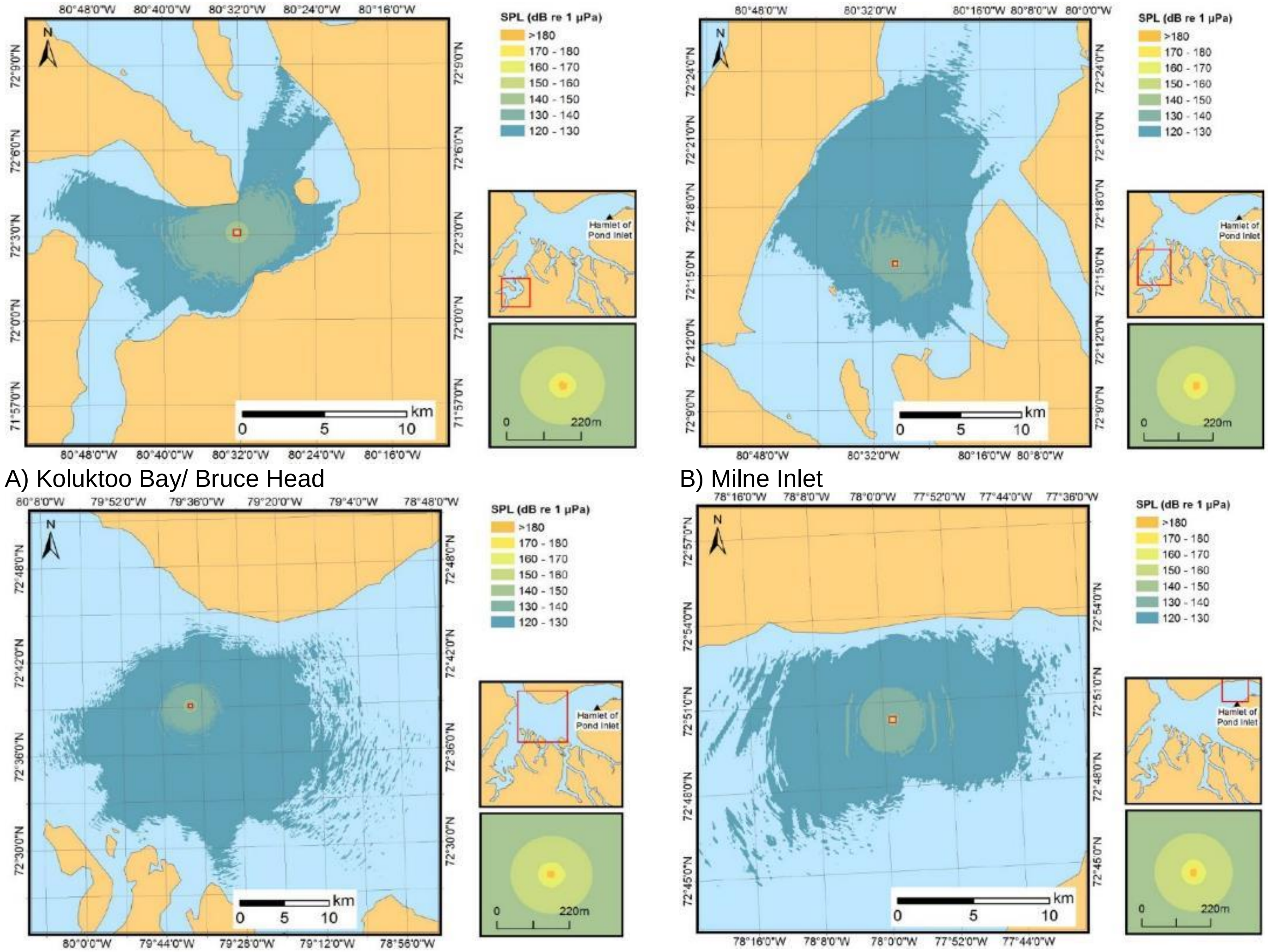
Since 2013, Baffinland has conducted shore based monitoring at Bruce Head to study narwhal response to shipping traffic along the shipping route in Milne Inlet during the open-water season, with data collected on abundance, distribution, group composition, and behavior (Moulton et al. 2016). Most narwhal occurring along the shipping route near Bruce Head were shown to be in transit, with some evidence of nursing, mating and foraging behavior also observed. Approximately 40% of the group sightings included calves or yearlings, supporting the hypothesis that southern Milne Inlet is an important area for calf rearing. Results collectively indicated that narwhal do not respond to large vessels by fleeing; but rather remain in the area with some individuals showing temporary avoidance behavior during active ship transits. Animals demonstrated a more pronounced avoidance behavior to ships approaching from the south (Milne Port) than from the north. No changes in yearly relative abundance or distribution were observed, nor any evidence of long-term displacement or avoidance behavior (Moulton et al. 2016).

JASCO performed underwater acoustic modelling of Project vessels (ore carriers, tugs) under several different operational scenarios (e.g., berthing, transiting, and mooring) for the Phase 2 Proposal (Appendix B). Based on the 120 dB re 1 µPa SPL disturbance threshold for toothed whales, the maximum range for narwhal disturbance for Phase 2 shipping operations was predicted to be:

- 10.7 km for tug-assisted berthing in Milne Port (limited by land);
- 3.7 km for tug-assisted carrier movements in Milne Port;
- 2.6 km for carriers moored at Ragged Island;
- Between 9.8 km and 19.2 km for Post-Panamax carriers travelling at 9 knots along the shipping route;
- Between 12.3 km and 29.5 km for Cape size carriers travelling at 9 knots along the shipping route;
- 1.7 km (Post-Panamax) and 3.7 km (Cape size) for carriers travelling at 5 knots in Milne Port; and
- 2.6 km for carriers moored at anchorages in Milne Port and Ragged Island.

Detailed modelling results including maps showing distances to the 120 dB re 1 µPa SPL disturbance threshold are presented in Appendix B. Noise fields generated by Cape size carriers were predicted to be fractionally larger than those generated by ships presently involved in ERP shipping operations (e.g. Post Panamax) (Appendix B). Figure 2.2 illustrates sound propagation from a Cape size carrier traveling at 9 knots along the Northern Shipping Route at four locations: a) Koluktoo Bay, b) Milne Inlet, c) Eclipse Sound, and d) Pond Inlet. The disturbance threshold of 120 dB re 1 µPa was shown to reach out to several tens of km from the ship, and in some cases, extended from shoreline to shoreline (e.g. Bruce Head, Milne Inlet). Animals exposed to ship noise in these areas may have limited options for avoidance. Distances to the 120 dB SPL disturbance threshold are considered conservative estimates as this threshold does not account for the overall duration of noise exposure to the animal, nor does it account for the frequency of the noise source relative to narwhal hearing sensitivity.

Narwhal are considered MF cetaceans (Southall et al. 2007) with their most sensitive hearing range occurring in the mid-frequency range ranging from 20 to 100 kHz (Richardson et al. 1995a). Using sound for foraging, navigation, and social purposes, they are a highly vocal species with call types consisting of echolocation clicks, pulsed tones, and whistles. No behavioural or electrophysiological audiograms are available for narwhal; however, their hearing abilities at high frequencies are exceptionally well developed. This likely is related to their use of high frequency sounds for echolocation. Narwhal vocalization studies indicate that this species primarily vocalizes in the 300 Hz to 24 kHz range (Ford and Fisher 1978; Marcoux et al. 2011; Marcoux et al. 2012). Ship noise generally dominates ambient noise at low frequencies, with most energy occurring between 20 to 300 Hz and some components extending into the 1 to 5 kHz range (Richardson et al. 1995a). Ship noise is therefore emitted at frequencies at which narwhal have lower hearing sensitivity.



A) Koluktoo Bay/ Bruce Head
B) Milne Inlet
C) Eclipse Sound
D) Pond Inlet

Figure 2.2: Noise Propagation from a Cape sized Carrier Traveling at Four Locations along the Northern Shipping Route

Mitigation Measures

Proposed mitigation measures to avoid potential disturbance from shipping activities are identified in Section 2.5.2.2.

Residual Effect

Narwhal are expected to exhibit temporary and localized avoidance behavior when encountering Project vessels along the shipping route and in Milne Port. No abandonment or long-term displacement behavior is anticipated. As most ship noise energy occurs below the sensitive hearing range for narwhal, the severity of this effect will likely be reduced. With the effective implementation of mitigation, the residual environmental effect of disturbance from ship noise on narwhal was predicted to be “Not Significant”.

2.6.3 Hearing Impairment

2.6.3.1 Pile Driving

Construction of the new ore dock will require installation of cylindrical piles using both impact and vibratory driving methods, and installation of sheet piles using vibratory methods. Impact and vibratory driving of both sheet piles and cylindrical piles were modelled by JASCO based on modelling inputs / scenarios described in Section 2.5.2.1. The potential for auditory injury due to pile driving was assessed using functional hearing group designations and impact criteria from NMFS (NOAA 2016), Wood et al. (2012) and Southall et al. (2007), as described in Section 1.3.1.1. These injury criteria categorize species with similar hearing sensitivities into hearing groups, but apply slightly different hearing ranges for each group and different noise weighting across the hearing frequency ranges among different groups.

For vibratory driving (sheet piles and cylindrical piles combined), modelling results indicated that the largest $R_{95\%}$ and R_{max} distance to the injury threshold for narwhal (based on the 24-h auditory weighted SEL injury thresholds) was 10 m. For impact driving of cylindrical piles, modelling results indicated that the largest $R_{95\%}$ and R_{max} distances to the injury threshold for narwhal (based on 24-h auditory weighted SEL injury thresholds) were 70 m and 90 m, respectively. Detailed modelling results are presented in Appendix B.

Mitigation Measures

Proposed mitigation measures to avoid potential auditory injury from pile driving activities are identified in Section 2.5.2.1. The same mitigation measures were applied during ore dock construction in 2014 and were shown to be highly effective for avoiding potential adverse effects on narwhal during pile driving works.

Residual Effect

Modelling results indicate that pile driving noise will only exceed applicable injury thresholds for narwhal at close ranges (within 100 m). With the timing of the pile driving works (during the ice-covered season when narwhal are not present in RSA) and with the effective implementation of mitigation, the residual environmental effect of hearing impairment in narwhal from ship noise was predicted to be “Not Significant”.

2.6.3.2 Shipping

There is no direct evidence of hearing impairment (either PTS or TTS) occurring in toothed whales as a consequence of exposure to vessel-generated sound (Southall et al. 2007). Acoustic modelling was conducted to quantity the underwater sound fields and associated sound level contours generated by Project vessels during transiting, berthing, and mooring events at defined anchorages in Milne Port and at Ragged Island. Modelling allowed for prediction of potential injury zones for narwhal, represented by the maximum range (relative to the source) to the SEL_{24h} injury thresholds for ‘mid-frequency cetaceans (MFC)’, based on the dual criteria (Southall et al. 2007; NOAA 2016).

Modelling results indicated that noise from transiting and moored vessels would not exceed the SEL_{24h} injury thresholds for MFC under any of the scenarios considered in the acoustic model (Appendix B). The risk of permanent hearing impairment in narwhal from open-water shipping was therefore considered negligible.

For tug-assisted berthing activities at the ore docks, the maximum distance to the SEL_{24h} injury thresholds for MFC was predicted to be <100 m (relative to the source) under the NMFS criteria (NOAA 2016). Sound levels did not exceed the MFC injury threshold under the Southall et al. (2007) criteria. The predicted injury zone was marginally smaller for Post-Panamax vessels than Cape size carriers. Sound fields were not predicted to overlap for concurrent tug-assisted berthing events occurring at both ore docks. Map of SEL_{24h} distances to injury thresholds are presented in Appendix B.

Mitigation Measures

Proposed mitigation measures to avoid potential auditory injury from shipping are identified in Section 2.5.2.2.

Residual Effect

With the effective implementation of mitigation, the residual environmental effect of hearing impairment on narwhal from ship noise was predicted to be “Not Significant”.

2.6.4 Auditory Masking

The potential effects of auditory masking in narwhal are dependent on the received sound level and the frequency content of the received sound signal relative to hearing ability in this species and the level of natural background noise. As previously noted, narwhal are considered MF cetaceans (Southall et al. 2007) with their most sensitive hearing range occurring in the mid-frequency range ranging from 20 to 100 kHz (Richardson et al. 1995a). Narwhal vocalization studies indicate that this species primarily vocalizes in the 300 Hz to 24 kHz range (Ford and Fisher 1978; Marcoux et al. 2011; Marcoux et al. 2012). Ship noise generally dominates ambient noise at low frequencies, with most energy occurring between 20 to 300 Hz and some components extending into the 1 to 5 kHz range (Richardson et al. 1995a).

For continuous noise sources such as shipping and vibratory pile driving, masking effects on narwhal are likely limited because of the relatively short duration of these events, and the limited overlap in frequency between these noise sources and narwhal hearing / communication range.

Mitigation Measures

Proposed mitigation measures to avoid potential auditory masking from pile driving and shipping activities on narwhal are identified in Section 2.5.2.1 and 2.5.2.2, respectively.

Residual Effect

With the effective implementation of mitigation, the residual environmental effects of auditory masking from pile driving and shipping on narwhal was predicted to be “Not Significant”.

2.6.5 Mortality

Collisions between cetaceans and vessels, known as vessel strikes, are considered a key threat to cetaceans in Canadian waters (Laist et al. 2001; Vanderlaan and Taggart 2007; Vanderlaan et al 2008; COSEWIC 2009; DFO 2013a; DFO 2013b; DFO 2016). Vessel strikes on narwhal may result in serious injury or even death by means of blunt force trauma from direct impact with the hull of a vessel, or from lacerations due to contact with rotating propellers (Knowlton and Kraus 2001; Silber et al. 2010; Neilson et al. 2012). Depending on the severity of the strike and the injuries inflicted, the animal may or may not recover. The Baffin Bay population of narwhal occur in large densities throughout the RSA during summer months and are known to rely on habitat that overlaps directly with the Northern Shipping Route as preferred calving grounds (Marcoux et al. 2009).

In general, most lethal and severe injuries are linked to large vessels with bulbous bows travelling at speeds greater than 13 knots (Laist et al. 2001; Jensen and Silber 2003; Dolman et al. 2006). This vessel speed is considered to be the critical threshold above which vessel strikes resulting in severe injury and/or mortality are more likely to occur (Dolman et al. 2006; Jensen and Silber 2003). The probability of a lethal vessel strike is thus positively correlated with vessel speed and gross tonnage of the vessel (Dolman et al. 2006; Kite-Powell et al. 2007; Vanderlaan and Taggart 2007).

Species-specific behavioral and physical differences are also factors that determine a given species' vulnerability to a vessel strike (Laist et al. 2001; Nichol et al. 2017). There are relatively few documented cases of vessel strikes in toothed whales (Wells and Scott 1997; Richardson et al. 1995; Van Waerebeek et al. 2007) and none for narwhal specifically. These animals are considered to be at relatively low risk of vessel strike owing to their fast swimming speed, manoeuvrability and agility (Richardson et al. 1995; Laist et al. 2001; Jensen and Silber 2003, Silber et al. 2010; Lawson and Lesage 2012). Narwhal also possess sensitive hearing and the ability to actively perceive their environment using biosonar (i.e., echolocation), enabling them to effectively detect and avoid approaching vessels However, the gregarious nature of this species means that if one animal is impacted by vessel strike, many are likely to be (Marcoux et al. 2009; Lawson and Lesage 2012; Smith et al. 2016; Smith et al. 2015; Smith et al. 2014). Furthermore, the large number of slow-moving mom-calf pairs present within the LSA puts these individuals at greater risk of vessel strike.

Mitigation Measures

Proposed mitigation measures to avoid potential narwhal mortality from shipping are identified in Section 2.5.2.2.

Residual Effect

Narwhal mortality is not expected to occur as a result of the Phase 2 Proposal activities. With the effective implementation of mitigation, the potential residual effect of narwhal mortality due to vessel strikes is predicted to be negligible. The residual environmental effect on narwhal is expected to be "Not Significant".

2.6.6 Significance of Residual Effects

Residual effects of Phase 2 Proposal activities on narwhal are identified in Table 2.7, and are summarized below.

2.6.6.1 Change in Habitat

With the effective implementation of mitigation, the residual effects of habitat loss on narwhal due to the new ore dock footprint are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent in occurrence (Level I), medium-term (Level II) in duration, and fully reversible (Level I) (Table 2.7). The residual environmental effect is predicted to be 'Not Significant' (Table 2.7).

2.6.6.2 Acoustic Disturbance

With the effective implementation of mitigation, the residual disturbance effects on narwhal from pile driving and shipping are predicted to be moderate in magnitude (Level II), confined to the LSA (Level I), intermittent (Level II) in frequency, short-term (Level I) for pile driving and medium-term (Level II) for shipping, and fully reversible (Level I) (Table 2.7). The residual environmental effect is predicted to be 'Not Significant' (Table 2.7).

2.6.6.3 Hearing Impairment

With the effective implementation of mitigation, the residual effects of hearing impairment on narwhal due to pile driving and shipping are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent (Level I) in occurrence, short-term (Level I) in duration, and fully reversible (Level I) (Table 2.7). The residual environmental effect is predicted to be 'Not Significant' (Table 2.7).

2.6.6.4 Auditory Masking

With the effective implementation of mitigation, the residual effects of auditory masking in narwhal due to pile driving and shipping noise are predicted to be low in magnitude (Level I), confined to the LSA (Level I), intermittent (Level II) in occurrence, short-term (Level I) for pile driving and medium-term (Level II) for shipping, and fully reversible (Level 1) (Table 2.7). The residual environmental effect is predicted to be 'Not Significant' (Table 2.7).

2.6.6.5 Mortality

With the effective implementation of mitigation, the residual effects of mortality on narwhal due to vessel strikes are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent (Level I) in occurrence, medium-term (Level I) in duration, and fully reversible (Level I) (Table 2.7). The residual environmental effect is predicted to be 'Not Significant' (Table 2.7).

Table 2.7: Effects Assessment Summary and Significance of Residual Effects on Narwhal

Residual Effect	Residual Effect Evaluation Criteria					Significance of Residual Effect	Qualifiers	
	Magnitude	Extent	Frequency	Duration	Reversibility		Probability (Likelihood of the Effect Occurring)	Certainty (Confidence in the effects prediction)
Change in Habitat	Level I	Level I	Level I	Level II	Level I	NS	--	--
Disturbance	Level II	Level I	Level II	Level I (pile driving) Level II (shipping)	Level I	NS		
Hearing Impairment	Level I	Level I	Level I	Level I	Level I	NS	--	--
Auditory Masking	Level I	Level I	Level II	Level I (pile driving) Level II (shipping)	Level I	NS		
Mortality	Level I	Level I	Level I	Level I	Level I	NS	--	--

Notes:
Magnitude: 1 (Level I) = a change that is less than threshold values; 2 (Level II) = a change that is greater than threshold values; 3 (Level III) = a change that is an order of magnitude greater than threshold values; includes consideration of environmental sensitivity
Extent: 1 (Level I) = confined to the LSA; 2 (Level II) = beyond the LSA and within the RSA; 3 (Level III) = beyond the RSA
Frequency: 1 (Level I) = infrequent (rarely occurring); 2 (Level II) = frequent (intermittently occurring); 3 (Level III) = continuous
Duration: 1 (Level I) = short-term; 2 (Level II) = medium-term; 3 (Level III) = long-term (beyond the life of the project) or permanent
Reversibility: 1 (Level I) = fully reversible after activity is complete; 2 (Level II) = partially reversible after activity is complete; 3 (Level III) = non-reversible after the activity is complete
Significance Rating: S=Significant, N=Not Significant, P=Positive
Qualifiers- only applicable to significant effects
Probability: 1 (Level I) = unlikely; 2 (Level II) = moderate; 3 (Level III) = likely
Certainty: 1 (Level I) = low; 2 (Level II) = medium; 3 (Level III) = high

2.7 Effects Assessment – Beluga Whale

Key issues / Level 2 interactions carried forward in the present assessment for beluga are summarized in Table 2.8.

Table 2.8: Summary of Project Interactions and Potential Environmental Effects - Beluga Whale

Project Interaction	Environmental Effects
Disturbance caused by underwater noise from shipping	Disturbance effects - avoidance response leading to seasonal abandonment of suitable habitat areas
Hearing impairment caused by underwater noise from shipping	Potential hearing impairment (temporary or permanent)
Vessel strikes on beluga during shipping	Potential injury and/or mortality

2.7.1 Acoustic Disturbance

Historically, important beluga feeding areas during the open-water season included Koluktoo Bay, south Milne Inlet, Navy Board Inlet, and Lancaster Sound adjacent to Bylot Island (Remnant and Thomas 1992). However, recent multi-year survey data indicates low numbers of beluga in waters of Eclipse Sound and Pond Inlet during the open-water season, with movements more common in Admiralty Inlet and Barrow Strait. During the previous ore dock installation in 2014, no beluga were observed in Milne Port during construction activities (SEM 2014).

Beluga have demonstrated habituation to ship noise as indexed by their lack of responsiveness to vessel traffic in the St. Lawrence, Cook Inlet and Beaufort Sea (Richardson et al. 1995a). When feeding, beluga in Bristol Bay, Alaska were not easily disturbed by vessels even when purposefully approached at close range, indicating a tolerance to vessels in some cases. However, beluga have also been documented to flee following quick and erratic approaches by small vessels and in response to high frequency outboard motor vessels, possibly due to their increased hearing sensitivity at these frequencies (Richardson et al. 1995a). During close vessel encounters, beluga have been shown to modify their call rates, call frequencies and call types - possibly to increase call detectability or decrease masking (Lesage et al. 1999; Richardson et al. 1995a).

Based on the 120 dB re 1 µPa SPL disturbance threshold for toothed whales, the maximum range for beluga disturbance for Phase 2 shipping operations was predicted to be:

- 10.7 km for tug-assisted berthing in Milne Port (limited by land);
- 3.7 km for tug-assisted carrier movements in Milne Port;
- 2.6 km for carriers moored at Ragged Island;
- Between 9.8 km and 19.2 km for Post-Panamax carriers travelling at 9 knots along the shipping route;
- Between 12.3 km and 29.5 km for Cape size carriers travelling at 9 knots along the shipping route;
- 1.7 km (Post-Panamax) and 3.7 km (Cape size) for carriers travelling at 5 knots in Milne Port; and
- 2.6 km for carriers moored at anchorages in Milne Port and Ragged Island.

Detailed modelling results including maps showing distances to the 120 dB re 1 µPa SPL disturbance threshold are presented in Appendix B. Distances to the 120 dB SPL disturbance threshold are considered conservative estimates as this threshold does not account for the overall duration of noise exposure to the animal, nor does it account for the frequency of the noise source relative to beluga hearing sensitivity.

Beluga are considered mid-frequency (MF) cetaceans, meaning their most sensitive hearing range occurs in the mid-frequency range. Using sound for foraging, navigation, and social purposes, they are a highly vocal species with call types consisting of echolocation clicks, pulsed tones, whistles, and noisy vocals. Echolocation clicks are produced in the 40 to 60 kHz and 100 to 120 kHz range, with source levels reported at 206 to 225 dB re 1 µPa at 1 m (Au 1993). Non-echolocation calls (e.g., whistles) are centered on frequencies below 6 kHz, but may sometimes attain frequencies up to 14 kHz (Schevill and Lawrence 1949; Sjare and Smith 1986), with dominant frequencies ranging between 400 Hz and 8.3 kHz. Belugas can detect frequencies as low as 40 to 75 Hz; however, their sensitivity at this range is poor (Awbrey et al. 1988). Beluga whales have been documented to communicate with one another at distances of over 300 to 500 m (Bel'kovich and Shchekotov 1992).

Shipping noise generally dominates ambient noise at frequencies from 20 to 300 Hz; above 300 Hz, shipping sounds may or may not be significant depending on the level of wind-dependent ambient noise (Richardson et al. 1995a). Ship noise is therefore emitted at frequencies at which beluga have lower hearing sensitivity.

Mitigation Measures

Proposed mitigation measures to avoid potential disturbance from shipping are identified in Section 2.5.2.2.

Residual Effect

Beluga are expected to exhibit temporary and localized avoidance behavior when encountering Project vessels along the shipping route and in Milne Port. No abandonment or long-term displacement behavior is anticipated. As most ship noise energy occurs below the sensitive hearing range for beluga, the severity of this effect will likely be reduced. With the effective implementation of mitigation, the residual environmental effect of disturbance from ship noise on beluga was predicted to be "Not Significant".

2.7.2 Hearing Impairment

There is no direct evidence of hearing impairment (either PTS or TTS) occurring in toothed whales as a consequence of exposure to vessel-generated sound (Southall et al. 2007). Acoustic modelling was conducted to quantity the underwater sound fields and associated sound level contours generated by Project vessels during transiting, berthing, and mooring events at defined anchorages in Milne Port and at Ragged Island. Modelling allowed for prediction of potential injury zones for beluga, represented by the maximum range (relative to the source) to the SEL_{24h} injury thresholds for 'mid-frequency cetaceans (MFC)', based on the dual criteria (Southall et al. 2007; NOAA 2016).

Modelling results indicated that noise from transiting and moored vessels would not exceed the SEL_{24h} injury thresholds for MFC under any of the scenarios considered in the acoustic model (Appendix B). The risk of permanent hearing impairment in beluga from open-water shipping and mooring activities was therefore considered negligible.

For tug-assisted berthing activities at the ore docks, the maximum distance to the SEL_{24h} injury thresholds for MFC was predicted to be <100 m (relative to the source) under the NMFS criteria (NOAA 2016). Sound levels did not exceed the MFC injury threshold under the Southall et al. (2007) criteria. The predicted injury zone was marginally smaller for berthing of Post-Panamax vessels than Cape size carriers. Sound fields were not predicted to overlap for concurrent tug-assisted berthing events occurring at both ore docks. Map of SEL_{24h} distances to injury thresholds are presented in Appendix B.

Mitigation Measures

Proposed mitigation measures to avoid potential auditory injury from shipping are identified in Section 2.5.2.2.

Residual Effect

With the effective implementation of mitigation, the residual environmental effect of hearing impairment on beluga from ship noise was predicted to be "Not Significant".

2.7.3 Auditory Masking

The potential effects of auditory masking in beluga are dependent on the received sound level and the frequency content of the received sound signal relative to hearing ability in this species and the level of natural background noise. As previously noted, beluga are considered mid-frequency (MF) cetaceans, producing echolocation clicks in the 40 to 60 kHz and 100 to 120 kHz range, and non-echolocation calls (e.g., whistles) in the 400 Hz to 8 kHz range (Schevill and Lawrence 1949; Sjare and Smith 1986). They can detect frequencies as low as 40 Hz; however, their sensitivity at this range is poor (Awbrey et al. 1988). Ship noise generally dominates ambient noise at low frequencies, with most energy occurring between 20 to 300 Hz and some components extending into the 1 to 5 kHz range (Richardson et al. 1995a).

For continuous noise sources such as shipping and vibratory pile driving, masking effects on beluga are likely limited because of the relatively short duration of these events, and the limited overlap in frequency between these noise sources and optimal beluga hearing range.

Mitigation Measures

Proposed mitigation measures to avoid potential auditory masking from ship noise on beluga are identified in Section 2.5.2.1 and 2.5.2.2, respectively.

Residual Effect

With the effective implementation of mitigation, the residual environmental effect of auditory masking in beluga from ship noise was predicted to be "Not Significant".

2.7.4 Mortality

Beluga may experience serious injury or death as a result of collision with Project-related vessels transiting the Northern Shipping Route. However, like narwhal, the species-specific physical and biological attributes of beluga, make them relatively less vulnerable to vessel strikes when compared with the larger baleen whales. Beluga use echolocation to perceive their environment and are better able to manoeuvre out of the way of oncoming vessels. Furthermore, the Eastern High Arctic-Baffin Bay population of beluga is present along the Northern Shipping Route in relatively low densities and does not exhibit the degree of site fidelity to the Project RSA as other Arctic cetaceans such as narwhal.

Mitigation Measures

Proposed mitigation measures to avoid potential beluga mortality from ship strikes are identified in Section 2.6.2.2.

Residual Effect

Beluga mortality is not expected to occur as a result of the Phase 2 Proposal activities. With the effective implementation of mitigation, the potential residual effects of beluga mortality due to vessel strikes is predicted to be negligible. The residual environmental effect on beluga is expected to be “Not Significant”.

2.7.5 Significance of Residual Effects

Residual effects of Phase 2 Proposal activities on beluga are identified in Table 2.9, and are summarized below.

2.7.5.1 Acoustic Disturbance

With the effective implementation of mitigation, the residual disturbance effects on beluga from ship noise are predicted to be moderate in magnitude (Level II), confined to the LSA (Level I), intermittent (Level II) in frequency, medium-term (Level II) in duration, and fully reversible (Level I) (Table 2.9). The residual environmental effect is predicted to be ‘Not Significant’ (Table 2.9).

2.7.5.2 Hearing Impairment

With the effective implementation of mitigation, the residual effects of hearing impairment on beluga due to ship noise are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent (Level I) in occurrence, medium-term (Level II) in duration, and fully reversible (Level I) (Table 2.9). The residual environmental effect is predicted to be ‘Not Significant’ (Table 2.9).

2.7.5.3 Auditory Masking

With the effective implementation of mitigation, the residual effects of auditory masking in beluga due to pile driving and shipping noise are predicted to be low in magnitude (Level I), confined to the LSA (Level I), intermittent (Level II) in occurrence, medium-term (Level II) in duration, and fully reversible (Level 1) (Table 2.9). The residual environmental effect is predicted to be ‘Not Significant’ (Table 2.9).

2.7.5.4 Mortality

With the effective implementation of mitigation, the residual effects of mortality on beluga due to vessel strikes are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent (Level I) in occurrence, medium-term (Level I) in duration, and fully reversible (Level I) (Table 2.9). The residual environmental effect is predicted to be ‘Not Significant’ (Table 2.9).

Table 2.9: Effects Assessment Summary and Significance of Residual Effects on Beluga

Residual Effect	Residual Effect Evaluation Criteria					Significance of Residual Effect	Qualifiers	
	Magnitude	Extent	Frequency	Duration	Reversibility		Probability (Likelihood of the Effect Occurring)	Certainty (Confidence in the effects prediction)
Disturbance	Level II	Level I	Level II	Level II	Level I	NS	--	--
Hearing Impairment	Level I	Level I	Level I	Level I	Level I	NS	--	--
Auditory Masking	Level I	Level I	Level II	Level II	Level I	NS	--	--
Mortality	Level I	Level I	Level I	Level I	Level I	NS	--	--

Notes:
Magnitude: 1 (Level I) = a change that is less than threshold values; 2 (Level II) = a change that is greater than threshold values; 3 (Level III) = a change that is an order of magnitude greater than threshold values; includes consideration of environmental sensitivity
Extent: 1 (Level I) = confined to the LSA; 2 (Level II) = beyond the LSA and within the RSA; 3 (Level III) = beyond the RSA
Frequency: 1 (Level I) = infrequent (rarely occurring); 2 (Level II) = frequent (intermittently occurring); 3 (Level III) = continuous
Duration: 1 (Level I) = short-term; 2 (Level II) = medium-term; 3 (Level III) = long-term (beyond the life of the project) or permanent
Reversibility: 1 (Level I) = fully reversible after activity is complete; 2 (Level II) = partially reversible after activity is complete; 3 (Level III) = non-reversible after the activity is complete
Significance Rating: S=Significant, N=Not Significant, P=Positive
Qualifiers- only applicable to significant effects
Probability: 1 (Level I) = unlikely; 2 (Level II) = moderate; 3 (Level III) = likely
Certainty: 1 (Level I) = low; 2 (Level II) = medium; 3 (Level III) = high

2.8 Effects Assessment – Bowhead Whale

Key issues / Level 2 interactions carried forward in the present assessment for bowhead whale are summarized in Table 2.10.

Table 2.10: Summary of Project Interactions and Potential Environmental Effects - Bowhead Whale

Project Interaction	Environmental Effects
Disturbance caused by underwater noise from shipping	Disturbance effects - avoidance response leading to seasonal abandonment of suitable habitat areas
Hearing impairment caused by underwater noise from shipping	Potential hearing impairment (temporary or permanent)
Vessel strikes on bowhead during shipping	Potential injury and/or mortality

2.8.1 Acoustic Disturbance

Project shipping along the Northern Shipping Route overlaps within the summer range of bowhead in the RSA. Underwater shipping noise has the potential to result in disturbance of bowhead including avoidance behavior and potential displacement from feeding areas or migratory routes. In the extreme cases, disturbance effects may lead to abandonment of key habitat areas, reduced foraging efficiency, increased energy expenditure, and reduced fecundity and population health effects (Richardson 2002).

Bowhead have been reported to avoid vessels at distances up to several kilometres (Koski and Johnson 1987; Richardson et al. 1995a), corresponding with received sound levels as low as 84 dB re 1 µPa (Richardson et al. 1995a). At close range, responses can include changes in travel direction, increases in swim speed, and longer dive times (shorter surface intervals) (Richardson and Malme 1993; Richardson et al. 1995a). Displaced bowhead have been shown to return to feeding areas relatively quickly following exposure (Koski and Johnson 1987). Animals approached by slow-moving vessels have been shown to exhibit tolerance of vessels, often showing little to no response until the vessel is within several hundred meters (Richardson and Finley 1989; Wartzok et al. 1989). This is particularly true if vessels maintained a constant course and speed when in transit, and avoided the direct path of whales (Wartzok et al. 1989; Richardson et al. 1995). Bowhead have been reported to approach to within 100 metres of small ships when the vessel was not moving towards the whales (Wartzok et al. 1989).

Based on the 120 dB re 1 µPa SPL disturbance threshold for baleen whales, the maximum range for bowhead disturbance for Phase 2 shipping operations was predicted to be:

- 10.7 km for tug-assisted berthing in Milne Port (limited by land);
- 3.7 km for tug-assisted carrier movements in Milne Port;
- 2.6 km for carriers moored at Ragged Island;
- Between 9.8 km and 19.2 km for Post-Panamax carriers travelling at 9 knots along the shipping route;
- Between 12.3 km and 29.5 km for Cape size carriers travelling at 9 knots along the shipping route;
- 1.7 km (Post-Panamax) and 3.7 km (Cape size) for carriers travelling at 5 knots in Milne Port; and
- 2.6 km for carriers moored at anchorages in Milne Port and Ragged Island.

Detailed modelling results including maps showing distances to the 120 dB re 1 µPa SPL disturbance threshold are presented in Appendix B. Distances to the 120 dB SPL disturbance threshold are considered conservative estimates as this threshold does not account for the overall duration of noise exposure to the animal, nor does it account for the frequency of the noise source relative to bowhead hearing sensitivity.

Bowhead are considered low-frequency cetaceans (LFC), with their most sensitive hearing range occurring in the lower frequency band (Richardson et al. 1995b). Most calls produced by bowhead occur in the 25-900 Hz range, with dominant frequencies at 100-400 Hz (Clark et al. 1986; Cummings and Holliday 1987; Wursig and Clark 1993). Ship noise generally dominates ambient noise at similar low frequencies, with most energy occurring between 20 to 300 Hz and some components extending into the 1 to 5 kHz range (Richardson et al. 1995a). Given the large degree of frequency overlap between ship noise and bowhead hearing, animals occurring within the modelled disturbance zones are predicted to demonstrate avoidance of ships on a local and short-term scale. However, interactions between bowhead and Project vessels are predicted to be rare during the open-water period, given bowhead only occur in very low densities along the Northern Shipping Route during this time (Smith et al. 2014, 2015; 2016).

Mitigation Measures

Proposed mitigation measures to avoid potential disturbance from shipping are identified in Section 2.5.2.2.

Residual Effect

Bowhead are expected to exhibit temporary and localized avoidance behavior when encountering Project vessels along the shipping route. No abandonment or long-term displacement behavior is anticipated. As most ship noise energy occurs within the sensitive hearing range for bowhead, the potential for disturbance is high. However, the likelihood of occurrence is predicted to be low given the low number of bowhead occurring in the LSA during the open-water season. With the effective implementation of mitigation, the residual environmental effect of bowhead disturbance from ship noise was predicted to be “Not Significant”.

2.8.2 Hearing Impairment

There is no direct evidence of hearing impairment (either PTS or TTS) occurring in baleen whales as a consequence of exposure to vessel-generated sound (Southall et al. 2007). Acoustic modelling was conducted to quantity the underwater sound fields and associated sound level contours generated by Project vessels during transiting, berthing, and mooring events at defined anchorages in Milne Port and at Ragged Island. Modelling allowed for prediction of potential injury zones for bowhead whale, represented by the maximum range (relative to the source) to the SEL_{24h} injury thresholds for LFC’, based on the dual criteria (Southall et al. 2007; NOAA 2016).

Modelling results indicated that noise generated by transiting vessels would not exceed the SEL_{24h} injury thresholds for LFC under any of the scenarios considered in the acoustic model (Appendix B). The risk of permanent hearing impairment in bowhead from open-water shipping was therefore considered negligible.

For mooring activities at all anchorage locations considered in the model, the maximum distance to the SEL_{24h} injury thresholds for LFC was predicted to be <20 m (relative to the source) under both criteria (Southall et al. 2007; NOAA 2016). Sound fields associated with acoustic injury were not predicted to overlap for simultaneous mooring events in adjacent anchorage areas. Maps of SEL_{24h} distances to injury thresholds are presented in Appendix B.

For tug-assisted berthing activities at the ore docks, the maximum distance to the SEL_{24h} injury thresholds for LFC was predicted to be <150 m (relative to the source) under the NMFS criteria (NOAA 2016). Sound levels did not exceed the LFC injury threshold under the Southall et al. (2007) criteria. The predicted injury zone was marginally smaller for berthing of Post-Panamax vessels than Cape size carriers. Sound fields associated with acoustic injury were not predicted to overlap for concurrent tug-assisted berthing events occurring at both ore docks. Maps of SEL_{24h} distances to injury thresholds are presented in Appendix B.

Mitigation Measures

Proposed mitigation measures to avoid potential auditory injury from shipping are identified in Section 2.5.2.2.

Residual Effect

With the effective implementation of mitigation, the residual environmental effect of hearing impairment on bowhead from ship noise was predicted to be “Not Significant”.

2.8.3 Auditory Masking

The potential effects of auditory masking in bowhead are dependent on the received sound level and the frequency content of the received sound signal relative to hearing ability in this species and the level of natural background noise. Bowhead whales are considered low-frequency (LF) cetaceans, with their most sensitive hearing range occurring in the lower frequency band (Richardson et al. 1995b). Most calls produced by bowhead occur in the 25-900 Hz range, with dominant frequencies at 100-400 Hz (Clark et al. 1986; Cummings and Holliday 1987; Wursig and Clark 1993). Ship noise generally dominates ambient noise at similar low frequencies, with most energy occurring between 20 to 300 Hz and some components extending into the 1 to 5 kHz range (Richardson et al. 1995a). For continuous noise sources such as shipping, masking effects on bowhead are relevant because of the large degree of frequency overlap between ship noise and bowhead communication range.

Mitigation Measures

Proposed mitigation measures to avoid potential auditory masking on bowhead from shipping activities are identified in Section 2.5.2.2.

Residual Effect

For continuous noise sources such as shipping, masking effects on bowhead are relevant because of the large degree of frequency overlap between ship noise and bowhead communication range. However, this effect is predicted to be rare given the low occurrence of bowheads in the RSA during the open water season, along with the relatively short duration of exposure bowheads would experience given the vessel would be in transit. With the effective implementation of mitigation, the residual environmental effects of auditory masking on bowhead from shipping was predicted to be “Not Significant”.

2.8.4 Mortality

Project shipping along the Northern Shipping Route overlaps within the summer range of bowhead in the RSA. Potential collisions between bowhead and Project-related vessels could result in serious injury or death. Collisions between cetaceans and vessels, known as vessel strikes, are considered a key threat to cetaceans in Canadian waters (Laist et al. 2001; Vanderlaan and Taggart 2007; Vanderlaan et al 2008; COSEWIC 2009; DFO 2013a; DFO 2013b; DFO 2016). Vessel strikes may result in serious injury or even death by means of blunt force trauma from direct impact with the hull of a vessel, or from lacerations due to contact with rotating propellers (Knowlton and Kraus 2001; Silber et al. 2010; Neilson et al. 2012). Depending on the severity of the strike and the injuries inflicted, the marine mammal may or may not recover.

Baleen whales such as bowheads are particularly susceptible to vessel strikes as a result of their large body size, slow swimming speed and inability to manoeuvre (Vanderlaan and Taggart 2007; Reeves et al. 2012; Allen 2014). This vulnerability is further compounded by their inability to echolocate (Nichol et al. 2017). Further to this, baleen whales often spend extended periods of time at the surface either foraging or recovering from a dive than do toothed whales (Constantine et al. 2015; Goldbogen et al. 2006; Nichol et al. 2017), thus making them particularly vulnerable to vessel strikes. Although there is relatively little data available to fully evaluate the susceptibility of bowhead whales to vessel strike specifically, it is reasonable to draw from what is known about its close relative, the North Atlantic right whale (*Eubalaena glacialis*), who is highly vulnerable to lethal and sub-lethal vessel strike (Allen 2014). North Atlantic right whales have been found to exhibit no avoidance response when presented with sounds of approaching vessels (either real or play-back recordings) (Nowacek et al. 2004) and have been the subject of numerous vessel strike casualties in the past year alone. Given that the two species share many similar morphological characteristics and life history strategies, it is reasonable to assume that bowhead whales are similarly vulnerable to serious injury or death as a result of being struck by transiting vessels.

In general, most lethal and severe injuries in baleen whales are linked to large vessels with bulbous bows travelling at speeds greater than 13 knots (Laist et al. 2001; Jensen and Silber 2003; Dolman et al. 2006). This vessel speed is considered to be the critical threshold above which vessel strikes resulting in severe injury and/or mortality are more likely to occur (Dolman et al. 2006; Jensen and Silber 2003). The probability of a lethal vessel strike is thus positively correlated with vessel speed and gross tonnage of the vessel (Dolman et al. 2006; Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). For this reason, Baffinland has implemented a speed limit of 9 knots for Project vessels transiting along the Northern Shipping Route and 5 knots for vessels transiting in Milne Port. In the rare event that a marine mammal strike were to occur, the consequence is more likely to be a non-lethal injury (laceration from propeller and/or blunt force injury) than direct mortality (Vanderlaan and Taggart 2007). The lower vessel speeds during operations are predicted to reduce the likelihood of ship strikes on bowhead by providing ample time for these animals to avoid oncoming vessels, as well as time for crew on Project vessels to detect and avoid marine mammals during active vessel operations.

All available information indicates that bowhead are likely to avoid vessels under way in the LSA, given that ore carriers will travel at reduced speeds along the shipping route (9 knots) and in Milne Port to (5 knots), which is well below the critical vessel speed threshold (13 knots) above which vessel strikes resulting in severe injury and/or mortality are more likely to occur. Furthermore, the likelihood of occurrence of a ship strike on bowhead is predicted to be low, given the low number of bowhead occurring along the Northern Shipping Route during the open-water season, based on results from extensive aerial surveys and shore-based marine mammal monitoring programs conducted to date in the LSA (Smith et al. 2015; 2016; 2017).

Mitigation Measures

Proposed mitigation measures to avoid potential bowhead mortality from shipping are identified in Section 2.5.2.2.

Residual Effect

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

2.8.5 Significance of Residual Effects

Residual effects of Phase 2 Proposal activities on bowhead whale are identified in Table 2.11, and are summarized below.

2.8.5.1 Acoustic Disturbance

With the effective implementation of mitigation, the residual disturbance effects on bowhead from shipping noise are predicted to be moderate in magnitude (Level II), confined to the LSA (Level I), intermittent (Level II) in frequency, medium-term (Level II) in duration, and fully reversible (Level I) (Table 2.11). The residual environmental effect is predicted to be ‘Not Significant’ (Table 2.11).

2.8.5.2 Hearing Impairment

With the effective implementation of mitigation, the residual effects of hearing impairment on bowhead due shipping noise are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent (Level I) in occurrence, short-term (Level I) in duration, and fully reversible (Level I) (Table 2.11). The residual environmental effect is predicted to be 'Not Significant' (Table 2.11).

2.8.5.3 Auditory Masking

With the effective implementation of mitigation, the residual effects of auditory masking in bowhead due to shipping noise are predicted to be low in magnitude (Level I), confined to the LSA (Level I), intermittent (Level II) in occurrence, medium-term (Level II) in duration, and fully reversible (Level 1) (Table 2.11). The residual environmental effect is predicted to be 'Not Significant' (Table 2.11).

2.8.5.4 Mortality

With the effective implementation of mitigation, the residual effects of mortality on bowhead due to vessel strikes are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent (Level I) in occurrence, medium-term (Level I) in duration, and fully reversible (Level I) (Table 2.11). The residual environmental effect is predicted to be 'Not Significant' (Table 2.11).

Table 2.11: Effects Assessment Summary and Significance of Residual Effects on Bowhead Whale

Residual Effect	Residual Effect Evaluation Criteria					Significance of Residual Effect	Qualifiers	
	Magnitude	Extent	Frequency	Duration	Reversibility		Probability (Likelihood of the Effect Occurring)	Certainty (Confidence in the effects prediction)
Disturbance	Level II	Level I	Level II	Level II	Level I	NS	--	--
Hearing Impairment	Level I	Level I	Level I	Level I	Level I	NS	--	--
Auditory Masking	Level I	Level I	Level II	Level II	Level I	NS	--	--
Mortality	Level I	Level I	Level I	Level I	Level I	NS	--	--

Notes:
Magnitude: 1 (Level I) = a change that is less than threshold values; 2 (Level II) = a change that is greater than threshold values; 3 (Level III) = a change that is an order of magnitude greater than threshold values; includes consideration of environmental sensitivity
Extent: 1 (Level I) = confined to the LSA; 2 (Level II) = beyond the LSA and within the RSA; 3 (Level III) = beyond the RSA
Frequency: 1 (Level I) = infrequent (rarely occurring); 2 (Level II) = frequent (intermittently occurring); 3 (Level III) = continuous
Duration: 1 (Level I) = short-term; 2 (Level II) = medium-term; 3 (Level III) = long-term (beyond the life of the project) or permanent
Reversibility: 1 (Level I) = fully reversible after activity is complete; 2 (Level II) = partially reversible after activity is complete; 3 (Level III) = non-reversible after the activity is complete
Significance Rating: S=Significant, N=Not Significant, P=Positive
Qualifiers- only applicable to significant effects
Probability: 1 (Level I) = unlikely; 2 (Level II) = moderate; 3 (Level III) = likely
Certainty: 1 (Level I) = low; 2 (Level II) = medium; 3 (Level III) = high

2.9 Effects Assessment - Polar Bear

Key issues / Level 2 interactions carried forward in the present assessment for polar bear are summarized in Table 3.12.

Table 3.12: Effects Assessment Summary and Significance of Residual Effects on Polar Bear

Project Interaction	Environmental Effects
Vessel strikes on polar bear during shipping	Potential injury and/or mortality

2.9.1 Mortality

Although polar bear are common in the RSA and throughout most of the Canadian Arctic archipelago, their seasonal occurrence is largely determined by the distribution and extent of sea ice. During the open-water season, polar bears are forced ashore by the absence of ice (Taylor and Lee 1995) with bears in the RSA spending the majority of this period on Bylot and Baffin Islands (Lunn et al. 2002). Interactions between polar bear and vessel traffic along the Northern Shipping Route during the open-water period were predicted to be rare as polar bears are primarily located on land during this period. Polar bear swimming in water would be at potential risk of a ship strike, but the likelihood of this effect occurring was considered low, given their rare occurrence along the Northern Shipping Route (Golder 2017g) and because of the relatively slow travel speeds of ships in this area (9 knots on shipping route, 5 knots in Milne Port). Further, there exists no record of polar bear being struck by vessels in the published literature.

Mitigation Measures

Proposed mitigation measures to avoid potential polar bear mortality from shipping are identified in Section 2.5.2.2.

Residual Effect

Polar bear mortality is not expected to occur as a result of the Phase 2 Proposal activities. The increase in open-water shipping along the Northern Shipping Route is not anticipated to result in increased risk of ship strikes on polar bear given the rare occurrence of polar bear along the Northern Shipping Route (Golder 2017g) and because of the relatively slow travel speeds of ships in this area. The effect of vessel strike on polar bear is “Not Significant”.

2.9.2 Significance of Residual Effects

Residual effects of Phase 2 Proposal activities on polar bear are identified in Table 3.13, and are summarized below.

2.9.2.1 Mortality

With the effective implementation of mitigation, the residual effects of polar bear due to vessel strikes are predicted to be low in magnitude (Level I), confined to the LSA (Level I), infrequent (Level I) in occurrence, medium-term (Level I) in duration, and fully reversible (Level I) (Table 3.13). The residual environmental effect is predicted to be ‘Not Significant’ (Table 3.13).

Table 3.13: Significance of Residual Effects to Polar Bear

Residual Effect	Residual Effect Evaluation Criteria					Significance of Residual Effect	Qualifiers	
	Magnitude	Extent	Frequency	Duration	Reversibility		Probability (Likelihood of the Effect Occurring)	Certainty (Confidence in the effects prediction)
Mortality	Level I	Level I	Level I	Level I	Level I	NS	--	--

Notes:
Magnitude: 1 (Level I) = a change that is less than threshold values; 2 (Level II) = a change that is greater than threshold values; 3 (Level III) = a change that is an order of magnitude greater than threshold values; includes consideration of environmental sensitivity
Extent: 1 (Level I) = confined to the LSA; 2 (Level II) = beyond the LSA and within the RSA; 3 (Level III) = beyond the RSA
Frequency: 1 (Level I) = infrequent (rarely occurring); 2 (Level II) = frequent (intermittently occurring); 3 (Level III) = continuous
Duration: 1 (Level I) = short-term; 2 (Level II) = medium-term; 3 (Level III) = long-term (beyond the life of the project) or permanent
Reversibility: 1 (Level I) = fully reversible after activity is complete; 2 (Level II) = partially reversible after activity is complete; 3 (Level III) = non-reversible after the activity is complete
Significance Rating: S=Significant, N=Not Significant, P=Positive
Qualifiers- only applicable to significant effects
Probability: 1 (Level I) = unlikely; 2 (Level II) = moderate; 3 (Level III) = likely
Certainty: 1 (Level I) = low; 2 (Level II) = medium; 3 (Level III) = high

2.10 Summary of Residual Effects on Marine Mammals

This section provides a summary of the potential effects of the Phase 2 Proposal on the Marine Mammals VEC, including the following VEC sub-components: narwhal, beluga, bowhead whale, ringed seal, walrus and polar bear). The present assessment focused on issues of primary concern for marine mammals and their habitats relevant to the Phase 2 Proposal, as identified through consultation with local Inuit communities, Project stakeholders, and Project regulators. Project effects carried forward in the assessment included loss of habitat due to port expansion, disturbance and hearing impairment from underwater noise generated by shipping and port construction (i.e., pile driving), and potential injury or mortality from ship strikes along the shipping corridor.

The construction of a new ore dock in Milne Port capable of berthing Cape size vessels has the potential to result in the loss and/or alteration of suitable foraging habitat for narwhal and ringed seal, as well as pupping habitat for ringed seal. A number of mitigation-by-design features have been incorporated into dock design to reduce potential adverse effects on nearshore marine mammal habitat. This includes constructing the dock during the ice-covered season when ringed seal would be the only marine mammal species present in the RSA (in low densities), constructing the dock and causeways in succession to limit disturbance to the marine environment, reducing the overall subtidal footprint of the dock, placement of the dock face in parallel to the required seabed contour which eliminates the need for blasting and minimizes the amount of dredging required. Given the dock's relatively small subtidal footprint, the residual environmental effect of habitat change due to dock installation was predicted to be not significant.

Pile driving and ship berthing were determined to be the loudest underwater noise sources for all Project phases under the Phase 2 Proposal. Based on aerial survey records, narwhal and ringed seal were the only two species considered likely to occur within the proposed port area during the open-water season. Acoustic modelling was undertaken to determine potential for auditory impairment (injury) and disturbance of marine mammals as a result of these activities. Modelling results indicated that ringed seal could experience hearing injury from pile driving at distances up to 2 km from the source, and that narwhal would have to be at very close range to the piling source (<100 m) to experience hearing impairment during active pile driving. Ship berthing noise levels did not exceed the applicable acoustic thresholds for marine mammal injury. The marine mammal disturbance threshold of 120 dB re 1 µPa SPL was shown to extend up to 16 km from the source (to the entrance of Milne Port). Mitigation measures proposed to reduce the potential for hearing impairment and disturbance from pile driving noise included use of bubble curtains for sound dampening, confirmatory underwater noise monitoring to verify model predictions, and visual monitoring of marine mammals during active pile driving, including potential shut-downs or delayed start-ups when animals occur within the appropriate marine mammal safety (exclusion) zone. Given that marine mammals are unlikely to occur in immediate proximity of pile driving activities, the risk of permanent hearing impairment is considered negligible. Animals potentially occurring near Milne Port during active pile driving and ship berthing are predicted to exhibit a temporary and localized avoidance response. The residual effects of hearing impairment or disturbance of marine mammals from pile driving noise were predicted to be not significant.

With the addition of the new Cape size ore dock, there will be an increased number of ships transiting the Northern Shipping Route. There is no direct evidence of hearing impairment occurring in marine mammals as a consequence of exposure to vessel-generated sound. However, ship noise may result in disturbance effects and potential auditory masking for animals present along the shipping corridor. Modelling results indicate that the disturbance threshold may extend up to distances ranging from 12 to 30 km from the source, depending on vessel size and location along the shipping corridor. Auditory masking from ship noise was predicted to be negligible for pinnipeds because most of their communication occurs at higher frequencies than ship noise. Some degree of auditory masking was predicted for both narwhal and beluga given that ship noise overlaps in frequency with the lower end of their communication range. However, given that most of their calls occur at predominantly higher frequencies than ship noise, and acknowledging the intermittent nature of vessel noise, it was considered unlikely that masking from ship noise would significantly affect narwhal or beluga. Auditory masking effects were most relevant for bowhead whales given the large degree of frequency overlap between ship noise and bowhead communication. Masking effects on bowhead were predicted to be localized and short-term along the shipping route relative to the interval between ship transits. Mitigation measures proposed to reduce disturbance effects from ship noise included reductions in ship speed (to 9 knots upon entering Pond Inlet from Baffin Bay), which reduces the overall noise output generated by ship propulsion. Other mitigation includes the requirement for vessels to maintain a constant course and speed when in transit, and minimize idling when docked at Milne Port. With effective implementation of mitigation, animals are predicted to actively avoid ore carriers traveling along the shipping route and resulting effects are predicted be localized and short-term in nature. The residual effects of acoustic disturbance and auditory masking in marine mammals from ship noise were predicted to be not significant.

With the increase in ship traffic along the Northern Shipping Route and in Milne Port, there is an increased risk for potential marine mammal-vessel strikes resulting in potential injury or death. The physical and biological attributes of pinnipeds (i.e., seals and walrus) and toothed whales (i.e., beluga, narwhal) make them relatively less vulnerable to vessel strikes compared to baleen whales (i.e., bowhead whale). Pinnipeds are at low risk for being struck by a vessel due to their maneuverability and agility in the water. Toothed whales use echolocation to perceive their environment and are better able to manoeuvre out of the way of oncoming vessels. Bowhead whales are at an increased risk to ships strikes due to their larger size, slower speeds and preferred foraging behaviour in surface waters. Proposed mitigation measures to reduce potential for ship strikes include reductions in ship speed along the shipping corridor (maximum of 9 knots) and the requirement for vessels to maintain a constant course and speed when in transit. With mitigation measures in place, there is a low likelihood for potential ship strikes on marine mammals. The residual effect of ship strikes on marine mammals was predicted to be not significant.

3.0 UNCERTAINTY

This section identifies key sources of uncertainty in the present effects assessment and the level of confidence that adverse effects will not be worse than predicted. Confidence in the assessment of environmental significance is related to the following elements:

- Understanding of narwhal population dynamics, foraging ecology, dive behaviour, functional hearing ability and vocal behaviour, predator/prey dynamics, seasonal migratory movements, reproductive and social behaviour, and ecological role in the Eastern High Arctic ecosystem;
- Adequacy of baseline data for understanding current conditions and future changes unrelated to the Project (e.g., extent of future developments, climate change, catastrophic events);
- Understanding of Project-related adverse effects on complex ecosystems that contain interactions across different scales of time and space; and
- Knowledge of the effectiveness of the environmental design features and mitigation for reducing or removing adverse effects (e.g., vessel speed restrictions).

Ecosystems are complex, characterized by interactions across multiple scales, nonlinearity, self-organization, and emergent properties (Boyce 1992; Holling 1992; Levin 1998; Wu and Marceau 2002). These characteristics can confound understanding of ecosystem processes and limit capacity to make predictions on, for example, population sizes. One of the challenges is to aggregate and simplify available ecological knowledge, retain what is essential and disregard that which is not essential at the particular scale of interest.

Like all scientific results and inferences, residual impact predictions must be tempered with uncertainty associated with the data and the current knowledge of the system. It is anticipated that the baseline data are moderately sufficient for understanding current conditions, and that there is a moderate level of understanding of Project-related adverse effects on the ecosystem.

It is understood that development activities will directly and indirectly affect marine habitat, and behaviour / movement of marine wildlife species; however, long-term monitoring studies documenting the resilience of marine animals to development and the time required to reverse adverse effects are lacking. Direct disturbance from previous, existing, and future development footprints was estimated to affect a small fraction of the natural range of most marine mammal indicator species considered in the present assessment. However, uncertainty remains surrounding the degree to which some effects may occur (e.g., magnitude and duration).

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

Prediction confidence for adverse effects on marine mammal habitats as a result of installation of the new ore dock is considered moderate to high as the extent of the habitat loss/alteration is well known.

Prediction confidence is considered moderate for adverse effects related to potential vessel strikes and Project-generated underwater noise on marine mammals, as impact predictions are based on best-available science and quantitative modelling in the case of underwater noise effects. Further, recommended mitigation measures are based on best management practices established by industry and applicable regulatory bodies to reduce and/or avoid adverse effects associated with these activities.

Prediction confidence for adverse effects related to acoustic disturbance is considered moderate due to the level of information available regarding short and long-term behavioral effects of underwater noise on marine mammals as a result of increased exposure to industrial noise. Confidence in the underwater noise model was considered to be moderate based on the following factors:

- The activities associated with construction of the dock facilities and shipping operations were modeled using measured values (or conservative estimates when direct measurements were not available) from similar materials, equipment, and operations; and
- Quality assurance was accomplished by implementing quality control checks on all model runs to confirm that model input parameters were correct, model output was plotted correctly, and any calculations were checked.

There is some uncertainty in terms of how narwhal will respond to more frequent ore carrier traffic in the narrow waterways of Milne Inlet. There exists similar uncertainty concerning masking effects on narwhal communication from increased ship traffic in these areas. Although no significant residual effects are predicted for narwhal, Baffinland will continue to conduct tailored environmental effects monitoring programs to evaluate narwhal responses to ore carrier traffic along the shipping corridor. This will include acoustic monitoring studies to assess for potential auditory masking effects of shipping on narwhal, as well as potential adverse effects of shipping on narwhal communication. Detailed information on the marine mammal environmental effects monitoring programs is provided in the Shipping and Marine Wildlife Management Plan.

4.0 MITIGATION AND MONITORING PLAN UPDATES

Baffinland's management plans relevant to marine mammals includes:

- Shipping and Marine Wildlife Management Plan (SMWMP) – current revision March 2016 - describes response to emergencies and mitigation measures for marine mammals during construction and operation phases;
- Polar Bear Safety Plan – current revision March 2016 – describes the procedures to be undertaken to reduce and/or avoid the potential for worker encounters with polar bear, and procedure to manage polar bear encounters when they occur;
- Biophysical Environmental Effects Monitoring Framework – Appendix 4: Candidate Environmental Effects Monitoring Studies Marine Mammal;
- Emergency Response Plan (ERP) – current revision March 2017 – primary plan that assesses the risk of various emergencies and outlines the generic steps to be taken in an emergency;
- Spill Contingency Plan (SCP) – current revision March 2017 – addresses spills on land or water, excluding spills during fuel transfer at Milne Port and spills at sea;
- Oil Pollution Emergency Plan (OPEP) – current revision July 2016 – Addresses ship to shore fuel transfer protocols at the Milne Port Oil Handling Facility (OHF), and response to spills if they occur during the fuel transfer process;
- Spill at Sea Response Plan (SSRP) – current revision August 2015 – Provides guidance on the actions and reporting requirements during a fuel spill from Project shipping operations; and
- Environmental Protection Plan – current version August 2016 – describes the Project environmental issues and concerns and provides guidance and control measures to avoid potential adverse effects to the environment.

5.0 POTENTIAL CHANGES TO THE PROJECT CERTIFICATE AND OTHER APPROVALS

Project Certificate No. 005 Conditions 76 through 128, 172 to 177, 178, 179 and 180 to 182 relate to the marine environment. The wording of the majority of these conditions is sufficiently broad as to encompass any changes contemplated by the Phase 2 Proposal for the assessment of marine mammals.

Baffinland expects that an authorization under the *Fisheries Act* will be required for the new ore dock expansion at Milne Port; this is discussed further in TSD No. 17 (Marine Environment Effects Assessment; Golder 2018e). A conceptual-level Marine Offsetting Plan is provided in TSD No. 23 (Golder 2018f).

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APPENDIX A

Marine Mammal Baseline Report

REPORT

Baffinland Iron Mines Corporation
Mary River Project - Phase 2 Proposal

MARINE MAMMAL BASELINE REPORT

Submitted by:

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1663724-037-R-Rev1

13 July 2018

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Abbreviation and Acronym List

Baffinland	Baffinland Iron Mines Corporation
BB	Baffin Bay
cm	centimetre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSAS	Canadian Science Advisory Secretariat
DD	Data Deficient
DFO	Fisheries and Oceans Canada
EBSA	Ecologically and Biologically Significant Area
EC-WG	Eastern Canada-West Greenland
EHA-BB	Eastern High Arctic-Baffin Bay
EIS	Environmental Impact Statement
EN	Endangered
ERP	Early Revenue Phase
FEIS	Final Environmental Impact Statement
Golder	Golder Associates Ltd.
ICES	International Council for the Exploration of the Sea
IQ	Inuit Qaujimajatuqangit
IWC	International Whaling Commission
km	kilometre
kts	knots
LSA	Local Study Area
m	metre
Mtpa	Million tonnes per annum
n	number
NAMMCO	North Atlantic Marine Mammal Commission
NAR	Not At Risk
NMCA	National Marine Conservation Area
NS	No status
QIA	Qikiqtani Inuit Association
RSA	Regional Study Area
SARA	Species at Risk Act
SC	Special Concern
Sc1	Schedule 1
Sc2	Schedule 2
T	Threatened
the Project	Mary River Project
UC	Under Consideration

1.0 INTRODUCTION

The Mary River Project (the Project) is an operating iron ore mine located in the Qikiqtani Region of Nunavut (Figure 1.1). Baffinland Iron Mines Corporation (Baffinland; the Proponent) is the owner and operator of the Project. As part of the regulatory approval process, Baffinland submitted a Final Environmental Impact Statement (FEIS) to the Nunavut Impact Review Board (NIRB), which presented in-depth analyses and evaluation of potential environmental and socioeconomic effects associated with the Project.

In 2012, NIRB issued Project Certificate No 005 which provided approval for Baffinland to mine 18 million tonnes per annum (Mtpa) of iron ore, construct a railway to transport the ore south to a port at Steensby Inlet which operates year-round, and to ship the ore to market. The Project Certificate was subsequently amended to include the mining of an additional 4.2 Mtpa of ore, trucking this amount of ore by an existing road (the Tote Road) north to an existing port at Milne Inlet, and shipping the ore to market during the open water season. The total approved iron ore production was increased to 22.2 Mtpa (4.2 Mtpa transported by road to Milne Port, and 18 Mtpa transported by rail to Steensby Port). This is now considered the Approved Project. The 18 Mtpa Steensby rail project has not yet been constructed, however 4.2 Mtpa of iron ore is being transported north by road to Milne Port currently. Baffinland recently submitted a request for a second amendment to Project Certificate No.005 to allow for a short-term increase in production and transport of ore via road through Milne Port from the current 4.2 Mtpa to 6.0 Mtpa.

1.1 Phase 2 Proposal Overview

The Phase 2 Proposal (the third project certificate amendment request) involves increasing the quantity of ore shipped through Milne Port to 12 Mtpa, via the construction of a new railway running parallel to the existing Tote Road (called the North Railway). The total mine production will increase to 30 Mtpa with 12 Mtpa being transported via the North Railway to Milne Port and 18 Mtpa transported via the South Railway to Steensby Port. Construction on the North Railway is planned to begin in late 2019. Completion of construction of the North Railway is expected by 2020 with transportation of ore to Milne Port by trucks and railway ramping up as mine production increases to 12 Mtpa by 2020. Shipping from Milne Port will also increase to 12 Mtpa by 2020. Construction of the South Railway and Steensby Port will commence in 2021 with commissioning and a gradual increase in mine production to 30 Mtpa by 2024. Shipping of 18 Mtpa from Steensby Port will begin in 2025.

Phase 2 also involves the development of additional infrastructure at Milne Port, including a second ore dock (Figure 1.2). Shipping at Milne Port will continue to occur during the open water season, and may extend into the shoulder periods when the landfast ice is not being used to support travel and harvesting by Inuit. Various upgrades and additional infrastructure will also be required at the Mine Site and along both the north and south transportation corridors to support the increase in production and construction of the two rail lines.

In order to account for the increased tonnage of ore being transported under the Phase 2 Proposal, an increase in total vessel traffic serving Milne Port is proposed. Vessels ranging in size from Supramax to Cape Size will be retained by Baffinland depending on availability. An estimated 176 ore carrier round trips (upper range) will occur per season, with an average voyage time per vessel of 26 days. Shipping will occur seasonally over a period of approximately 90 days between July 01 and November 15, with each chartered vessel making one to three round trips per season.

LEGEND

- PROJECT SITE
- COMMUNITY
- FUTURE SOUTH RAILWAY
- MILNE INLET TOTE ROAD
- NUNAVUT SETTLEMENT AREA
- SHIPPING ROUTE
- SIRMILIK NATIONAL PARK
- WATER

0 125 250

1:5,000,000 KILOMETRES

REFERENCE(S)

BASE MAP: © ESRI DATA AND MAPS (ONLINE) (2016). REDLANDS, CA: ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE. ALL RIGHTS RESERVED.

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
PROJECT LOCATION

CONSULTANT

GOLDER

YYYY-MM-DD	2018-06-21
DESIGNED	DC
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
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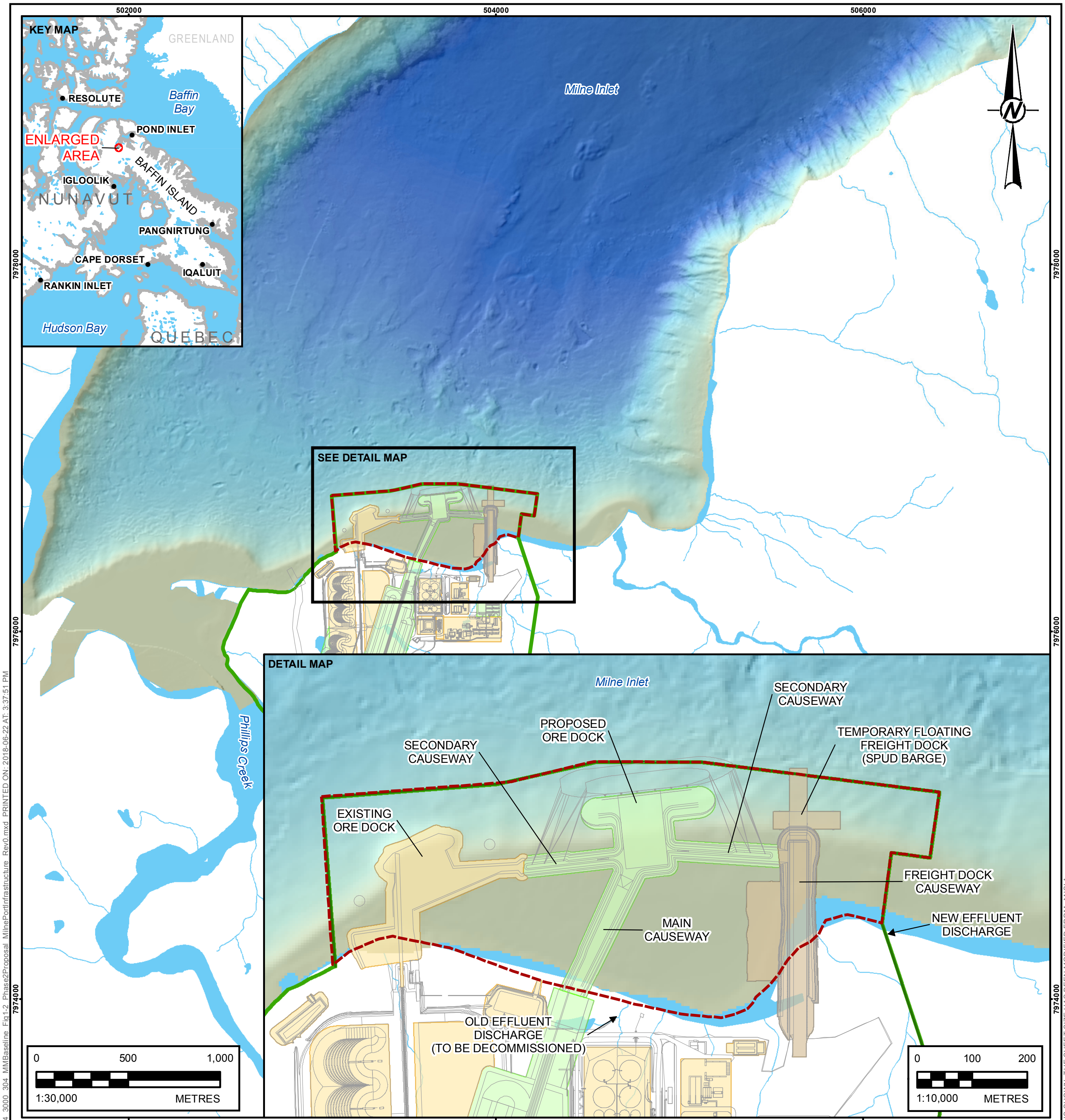

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LEGEND

- PDA / QIA COMMERCIAL LEASE
- SITE LAYOUT
- WATERCOURSE
- INAC FORESHORE LEASE
- EXISTING ORE DOCK
- NEW ORE DOCK AND CAUSEWAYS
- EXISTING FREIGHT DOCK AND CAUSEWAY
- WATERBODY

ELEVATION (masl)

High : 25

Low : -225

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA OBTAINED FROM CLIENT, MAY 28, 2108, AND BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. BATHYMETRY CREATED BY GOLDER FROM MULTIPLE DATA SOURCES.. HYDROGRAPHY DATA BY EAGLE MAPPING (2005), RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE, MAY 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
MILNE PORT MARINE INFRASTRUCTURE

CONSULTANT

GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	PR
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
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1.2 Context

Project activities under the Phase 2 Proposal will occur in waters inhabited by a variety of marine mammals, predominantly narwhal, beluga, bowhead whale, ringed seal, bearded seal, harp seal, walrus and polar bear. These areas provide marine mammals with valuable habitat for foraging, mating and rearing young. Marine mammals contribute to the overall ecosystem health in the North Baffin region and provide social, cultural and economic benefits to communities in the region.

In Canada, marine mammals and their habitats are protected under federal legislation, including the federal *Fisheries Act*, RSC 1985, C. F-14 (amended November 25, 2013) and the *Species at Risk Act* (SARA), SC 2002, c. 29 (SARA).

The *Fisheries Act* (Government of Canada 1985) is a federal *Act* that offers protection of all fish[1] that are part of a commercial, recreational or Aboriginal fishery (CRA), or to fish that support such a fishery, including marine mammals. Under section 35 of the *Fisheries Act*, no one may undertake activities that result in harm, permanent alteration or destruction of fish or fish habitat that are part of a CRA fishery, or to fish that support such a fishery, unless authorised by the Minister of Fisheries and Oceans Canada (DFO). Under the *Fisheries Act*, the Marine Mammal Regulations were enacted in 1993 (amended in 2015) which prohibits the disturbance of marine mammals by any person except when fishing for marine mammals under the authority of the Regulations (Government of Canada 1993).

The federal *SARA* protects Canadian indigenous species, subspecies, and distinct populations from becoming extirpated or extinct, provides for the recovery of endangered or threatened species, and encourages the management of other species to prevent them from becoming at-risk. This is achieved by promoting and securing necessary actions for recovery through legal protection (Government of Canada 2012). To kill, harm, harass, capture or take an individual of a species listed as extirpated, endangered or threatened is prohibited under Section 32 of *SARA*. To damage or destroy the residence of individuals of a species listed as Extirpated, Endangered or Threatened is prohibited under Section 33 of *SARA*. Under SARA, critical habitat is defined as *"the habitat that is necessary for the survival or recovery of a listed wildlife species that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species"* and is legally protected from destruction within 180 days of being identified in a recovery strategy or action plan.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is a scientific advisory panel that assesses the national status of wild species, subspecies, varieties, or other designable units that are considered to be at risk in Canada. COSEWIC uses a scientific process whereby species are assessed and ranked according to conservation concern (i.e., Extinct, Extirpated, Endangered, Threatened, Special Concern, Not at Risk, or Data Deficient) (Government of Canada 2014). COSEWIC has no legislative or management role, but rather provides an independent recommendation on the status of "at risk" species to the Federal Minister of Environment and Climate Change, who in turn makes recommendations to the Cabinet regarding potential legal protection of a species through provisions under *SARA*. The COSEWIC assessment is taken into consideration during a SARA listing process; however, only species and their critical habitats listed under SARA Schedule 1 are legally protected.

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[1] *Under the Fisheries Act, 'fish' is defined as shellfish, crustaceans, marine animals and any part of the life history of the animal, including eggs, sperm, spat, larvae and juvenile stages (Government of Canada 1985).*

1.3 Objectives

This report provides a summary review of baseline conditions for marine mammals in the Project Area and highlights new information collected or published since submission of materials for the Final Environment Impact Statement (FEIS) and Early Revenue Phase (ERP) assessments. Information presented in this report is based on a summary of existing published scientific literature, grey literature, Inuit traditional knowledge (Inuit Qaujimajatuqangit), and results from Project-specific baseline studies and monitoring programs conducted in the Project area to date.

The specific objectives of this report are:

- To characterize the existing baseline environment for marine mammals along the Northern Shipping Route;
- To provide a summary of findings from Project-specific marine mammal studies conducted to present day;
- To provide background information supportive of the marine mammal effects assessment; and
- To update baseline conditions to support future environmental effects monitoring studies.

1.4 Study Area

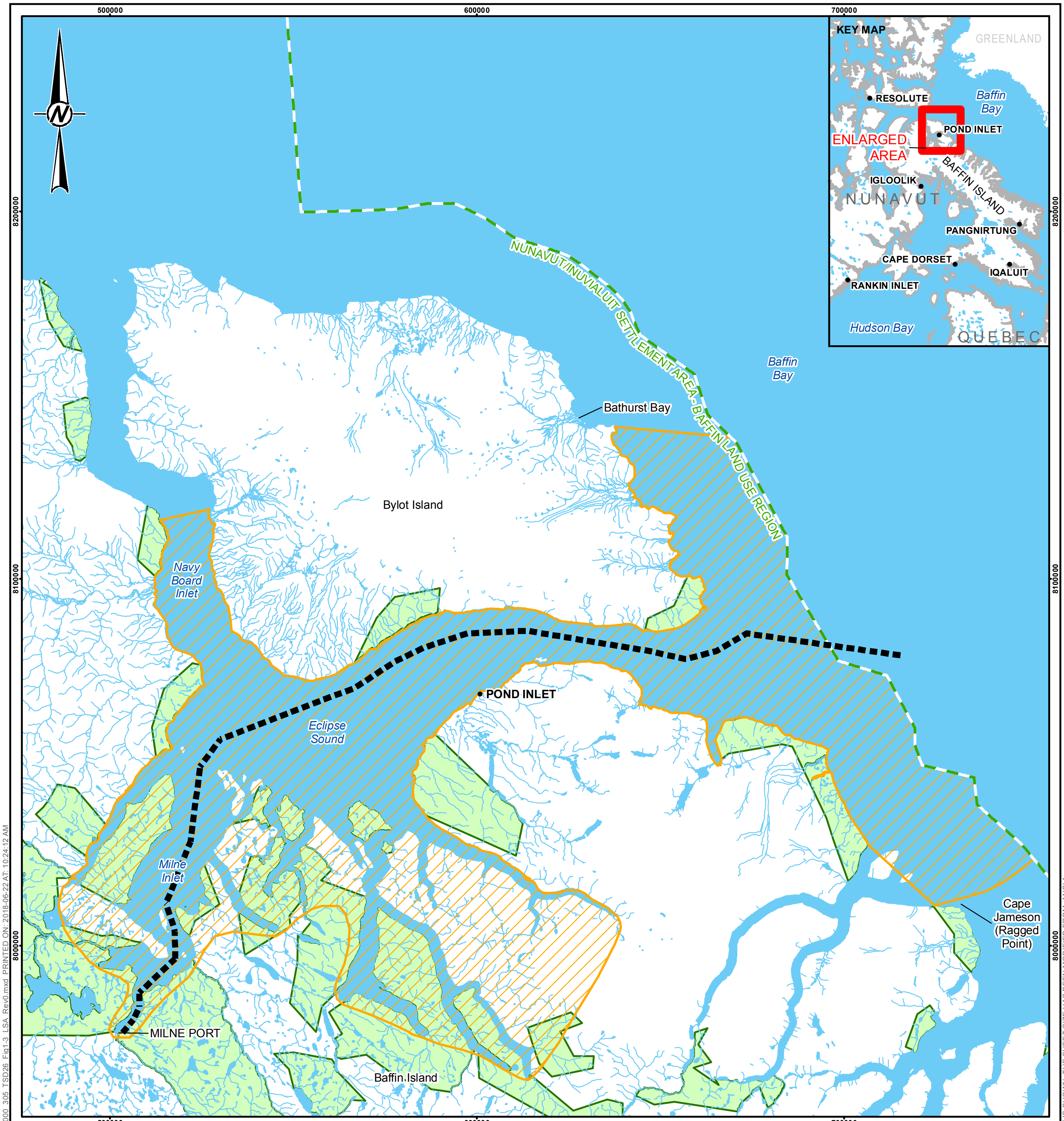
The study area for Marine Mammals includes Milne Port and the Northern Shipping Route, which encompasses Milne Inlet, Eclipse Sound, Pond Inlet, and adjacent water bodies. Milne Port is located at the head of Milne Inlet at the north end of Baffin Island. Milne Inlet is a narrow fjord characterized by high surrounding headlands and deep water that is covered by landfast ice for much of the year. Eclipse Sound separates Baffin Island from Bylot Island, and extends from Milne Inlet to the South-west, Navy Board Inlet to the North-west, and Baffin Bay to the east via Pond Inlet.

Two spatial boundaries were used for the assessment of effects on Marine Mammals in the Project area: a Local Study Area (LSA) (Figure 1.3) and a Regional Study Area (Figure 1.4). The LSA allows an assessment of Project-related effects at a local, operational scale. The RSA represents marine mammals and their habitats at a regional, ecologically relevant scale on northern Baffin Island.

The Marine Mammal LSA represents the area where there exists a reasonable potential for direct measurable effects from routine Project activities on marine mammals, including shipping. This includes marine waters of Milne Port and the Northern Shipping Route, and includes a buffer extending up to 50 km on either side of the shipping route (where applicable).

The Marine Mammal RSA encompasses the area where there is potential for direct and indirect incremental effects from Project shipping on marine mammals, in addition to potential cumulative effects from the Project in conjunction with existing, historical, and reasonably foreseeable developments in the Project area. The RSA encompasses all waters of Milne Inlet, Navy Board Inlet, Tremblay Sound, Eclipse Sound and Pond Inlet extending to the entrance of Baffin Bay, consistent with the Nunavut Settlement Area Boundary. This regional area is considered sufficient to encompass the full range of direct and indirect effects (incremental and cumulative) resulting from routine Project shipping activities, including those related to shipping noise.

The temporal boundaries for the assessment of effects on marine mammals includes the construction, operations, and closure phases of the Phase 2 Proposal, which will occur over a total period of 28 years (2018-2045).



LEGEND

- COMMUNITY
- SHIPPING ROUTE (APPROXIMATE)
- WATERCOURSE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- MARINE MAMMAL LOCAL STUDY AREA
- NUNAVUT LAND CLAIMS AGREEMENT – POND INLET INUIT OWNED LAND
- WATERBODY

0 25 50
1:1,500,000 KILOMETRES

REFERENCE(S)
ABORIGINAL LANDS, HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
MARINE MAMMAL LOCAL STUDY AREA

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-305	0	1.3

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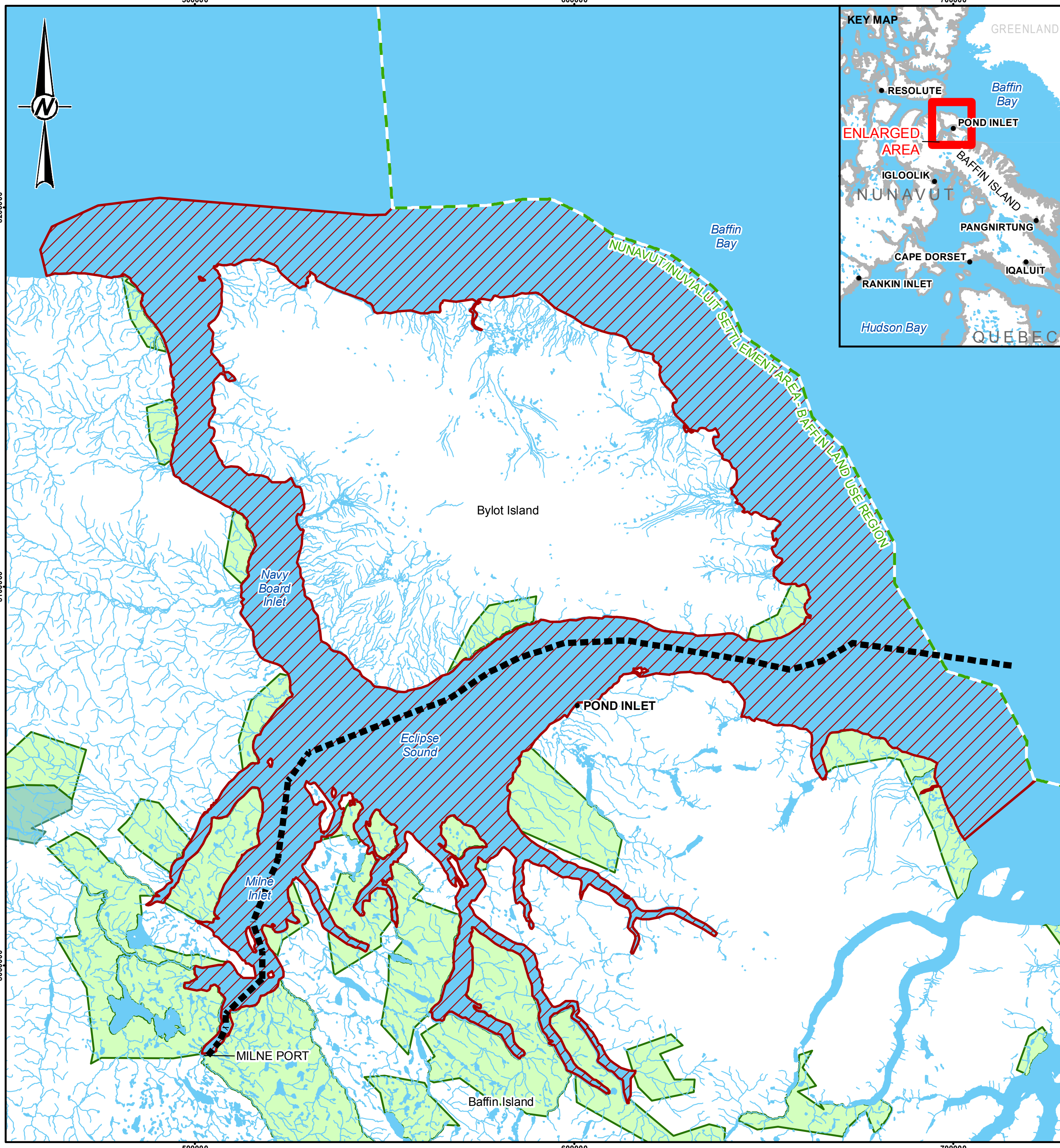

LEGEND

- COMMUNITY
- SHIPPING ROUTE (APPROXIMATE)
- WATERCOURSE
- NUNAVUT SETTLEMENT AREA BOUNDARY
- MARINE MAMMAL REGIONAL STUDY AREA
- NUNAVUT LAND CLAIMS AGREEMENT – ARCTIC BAY INUIT OWNED LAND
- NUNAVUT LAND CLAIMS AGREEMENT – POND INLET INUIT OWNED LAND
- WATERBODY

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1:1,500,000 KILOMETRES

REFERENCE(S)
ABORIGINAL LANDS, HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
MARINE MAMMAL REGIONAL STUDY AREA

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	PR
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-305	0	1.4

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2.0 EXISTING CONDITIONS

Characterization of existing environmental conditions in the LSA and RSA is integral to developing a baseline case to which potential project-related change can be compared. Existing conditions for marine mammals in the Project area were determined based on a comprehensive literature review, marine mammal baseline surveys conducted in the RSA over a five-year period (2006-2008; 2013; 2014), and marine mammal monitoring programs conducted over a consecutive three-year period (2015-2017). This section presents an overview of marine mammals in the LSA and RSA including details on species occurrence and distribution, seasonal residency, habitat use and behaviour (e.g., foraging and mating).

2.1 Information Sources

2.1.1 Desktop Review

A comprehensive literature review was completed to describe the existing environment for marine mammals in the LSA and RSA. Sources of information included the following:

- Relevant peer-reviewed scientific publications and grey literature;
- Governmental and non-governmental reports and environmental metadata records, including:
  - DFO Canadian Science Advisory Secretariat (CSAS) reports;
  - Species at Risk Public Registry (ECCC 2018) including relevant species recovery plans, action plans or species update reports; and
  - Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessment and status reports.
- Previous marine-based investigations and research programs, environmental resource surveys, and environmental reports completed in the Project site (as available in the public domain);
- Reports from the International Whaling Commission (IWC), and North Atlantic Marine Mammal Commission (NAMMCO); and
- Feedback from the applicable regulatory agencies including the Marine Environmental Working Group.

Results of the marine mammal literature review are presented by species in Section 3.0.

2.1.2 Inuit Qaujimajatuqnagit (IQ)

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 marine mammals that were discussed in the workshops included:

- Seasonal activities related to marine mammals;

- Narwhal distribution;
- Shipping; and
- Community input on marine mammal monitoring, mitigation and adaptive management.

Marine mammal IQ shared as part of these workshops has been integrated within this baseline report.

2.1.3 Field Studies

Marine mammal baseline studies and environmental effects monitoring (EEM) programs were undertaken by Baffinland between 2006 and 2017 in support of the Project. These included systematic aerial surveys, shore-based monitoring surveys, ship-based monitoring, acoustic monitoring, and a narwhal tagging study, as summarized in Table 2.1. Results from these primary data collection studies and post-operation monitoring programs are presented in Section 4.0.

Table 2.1 Summary of Field Studies Undertaken in Support of the Mary River Project (2006-2017)

Survey Method	Year							
	2006	2007	2008	2013	2014	2015	2016	2017
Aerial marine mammal surveys	✓	✓	✓	✓	✓	✓	✓*	
Shore-based marine mammal monitoring				✓	✓	✓	✓	✓
Ship-based marine wildlife monitoring				✓	✓	✓		
Acoustic monitoring				✓	✓			✓
Narwhal tagging study								✓

Notes: (*) Baffinland analysis of DFO-collected aerial survey photographs. Grey shaded areas indicate pre-operations (ERP) sampling

2.2 Summary of Existing Information

At least 10 species of marine mammals have the potential to occur along the Northern Shipping Route, including one species of baleen whale (mysticete), three species of toothed whale (odontocete), four species of seal, walrus, and polar bear (Table 2.2). Each of these species varies in their seasonal occurrence and habitat use in the RSA. Narwhal and ringed seal are the most common species present in the RSA. Narwhal are common along the Northern Shipping Route during the open-water season, with many mother/calf pairs observed at this time, confirming the importance of this area as a summer calving ground. Ringed seals overwinter under, and construct dens in, the ice and use the area for pupping, nursing and moulting from mid-March to mid-June. Polar bears use the northern coast of Bylot Island for maternity denning (Schweinsburg et al. 1982). Polar bear are the only species listed under Schedule 1 of SARA (designed as Special Concern).

Table 2.2 Marine Mammal Species with Potential to Occur in the RSA (with Conservation Status)

Species Common Name	Population or Subspecies (if subdivided)	SARA[1]	COSEWIC[2]
Bowhead Whale	Eastern Canada-West Greenland (EC-WG) population	NS	SC
Beluga Whale	Eastern High Arctic-Baffin Bay (EHA-BB) population	NS	SC
Narwhal	Baffin Bay (BB) population	NS	SC
Killer Whale	Northwest Atlantic / Eastern Arctic population	NS	SC
Atlantic Walrus	Baffin Bay (High Arctic) population	NS	SC
Bearded Seal	N/A – subspecies not delineated	NS	DD
Ringed Seal	N/A – subspecies not delineated	NS	NAR
Harp Seal	Northwest Atlantic population	NS	NS
Hooded Seal	Western North Atlantic stock	NS	NAR
Polar Bear	N/A – subspecies not delineated	Sc1:SC	SC

Notes:
[1] SARA (GoC 2009): EN=Endangered; T=Threatened; SC=Special concern; UC=Under consideration; NS=No status; Sc1=Schedule 1; Sc2=Schedule 2
[2] COSEWIC (COSEWIC 2010): EN=Endangered; T=Threatened; SC=Special concern; DD=Data deficient; NAR=Not at risk; NS=No status.

IQ collected by Jason Prno Consulting (2017) indicates that harbour porpoise (*Phocoena phocoena*), fin whale (*Balaenoptera physalus*), and sperm whale (*Physeter microcephalus*) have also been historically observed in the RSA, though these anecdotal observations are scarce. There are also historical accounts of harbour seal (*Phoca vitulina*) occurring occasionally around Pond Inlet (Tuck 1957; Bissett 1967) and as far north as Ellesmere Island (Mansfield 1967; Smith and Taylor 1977); however, their distribution in the high Arctic is generally localized to Cumberland Sound, Frobisher Bay, and the Foxe Peninsula (Southwest Baffin Island) (Mansfield 1967; Mansfield and McLaren 1958).

An overview of the biology of each marine mammal species known to occur in the RSA is provided in Section 3.0.

2.3 Protected Areas and Key Habitat Sites

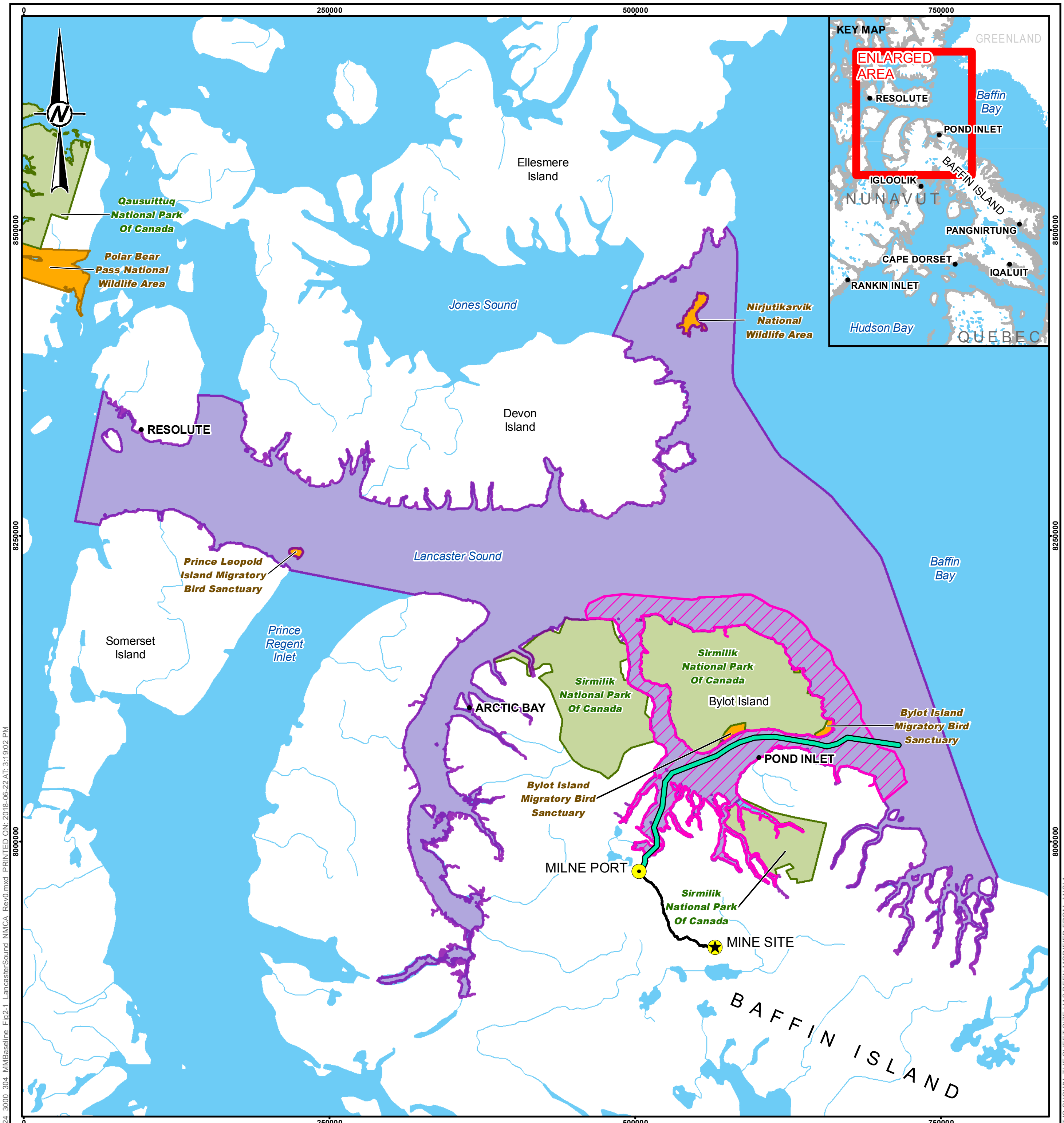
Eclipse Sound and Navy Board Inlet have been designed by DFO as Ecologically and Biologically Significant Areas (EBSA) on the basis of their importance to narwhal, beluga, killer whale, ringed seal, harp seal and seabirds (DFO 2015a). EBSAs call attention to areas that have particularly high ecological or biological significance because of the functions they serve in the ecosystem and/or because of structural properties. On the basis of the EBSA designation of this area by DFO, the Arctic Marine Shipping Assessment (AMAP/CAFF/SDWG, 2013) also identifies Eclipse Sound/Navy Board Inlet as an area of heightened ecological significance. The rationale for the designation is that these relatively deep waters (maximum depth ~ 200 m) surrounding Bylot Island and its connection to Lancaster Sound are very important migration routes and summer feeding areas for beluga and narwhal. Lancaster Sound, including Pond Inlet and eastern Eclipse Sound is also identified as a major migration corridor for bowhead, narwhal, beluga, killer whale and seals. The area is identified as supporting the highest polar bear density in the world. Important habitat features include a recurrent polynya and associated sea-ice habitats. Productivity is high, due to a high export of sea-ice algae, along with high benthic diversity, production and remineralization. Polar cod are abundant in all stages of the life cycle.

Table 2.3 Criteria used to Define Areas of Heightened Ecological Significance (AMAP/CAFF/SDWG 2013)

Area	Ecological function relevant to marine mammals	Uniqueness or rarity	Critical habitat	Dependency	Representativeness	Diversity	Productivity	Spawning or breeding	Naturalness	Integrity	Fragility	Biogeographic importance
Eclipse Sound / Navy Board Inlet	Migration routes and summer feeding areas for marine mammals		X	X			X	X	X		X	
Lancaster Sound	Major migration route for marine mammals; High density polar bear denning / feeding	X	X	X		X	X	X	X		X	X

The Government of Canada, the Government of Nunavut, and the Qikiqtani Inuit Association (QIA) signed a memorandum of understanding in December 2009 for consideration of the establishment of a National Marine Conservation Area (NMCA) in Lancaster Sound (Tallurutiup Imanga). The area has been identified as one of the most productive areas in the Arctic and has seasonally high abundance of marine mammals (Stephenson and Hartwig 2010). Of note, it is considered critical habitat for species such as the bowhead whale, beluga whale, narwhal, and polar bear. The proposed boundary for the NMCA has been announced and encompasses the full Marine Mammal RSA, including Milne Inlet, Eclipse Sound, and Pond Inlet (Figure 2.1). A feasibility assessment on the NMCA was conducted between 2010 and 2016, and included studies of ecological values, traditional knowledge and tourism. During consultations conducted with Inuit communities, industry and government, support was expressed. Before the NMCA can be officially established under the Canada National Marine Conservation Areas Act, an Inuit Impact and Benefit Agreement (IIBA) must be negotiated and an interim management plan (including a preliminary zoning plan) prepared.

Heide-Jorgensen and Laidre (2004) identified the western portion of Lancaster Sound, including the northwestern shore of Bylot Island within the RSA, as an important winter open-water refugium for marine mammals and birds. Pond Inlet, Eclipse Sound, Milne Inlet, Tremblay Sound and most of Navy Board Sound were not considered to be part of this refugium.



LEGEND

- COMMUNITY
- MILNE PORT
- MINE SITE
- MILNE INLET TOTE ROAD
- SHIPPING ROUTE (APPROXIMATE)
- NORTHERN SHIPPING ROUTE REGIONAL STUDY AREA
- PROPOSED LANCASTER SOUND NATIONAL MARINE CONSERVATION AREA BOUNDARY
- NATIONAL PARK
- NATIONAL WILDLIFE AREA
- WATERBODY

0 100 200

1:4,500,000 KILOMETRES

REFERENCE(S)

HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. PROTECTED AREAS DATA OBTAINED FROM CANADIAN COUNCIL ON ECOLOGICAL AREAS (CCEA), APRIL 21, 2017.
PROJECTION: UTM ZONE 17 DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
PROPOSED BOUNDARIES OF THE NATIONAL MARINE CONSERVATION AREA FOR LANCASTER SOUND (TALLURUTIUP IMANGA)

CONSULTANT

GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	2.1

3.0 SPECIES ACCOUNTS – LITERATURE REVIEW

This section provides a summary of the literature review for each marine mammal species with potential to occur along the Northern Shipping Route. Information is provided on population size and status, general biology, and geographical and seasonal distributions. Species with *SARA* designation and those that are of importance for Inuit in the RSA are emphasized. Additional marine mammal information obtained from field studies and monitoring programs conducted by Baffinland to address specific management questions is presented in Section 4.0.

3.1 Bowhead Whale (Balaena mysticetus)

3.1.1.1 Population Status and Abundance

Bowhead whales (*Balaena mysticetus*) present in the RSA are considered part of the Eastern Canada-West Greenland population which is one of four defined bowhead populations in the world (COSEWIC 2009). The initial COSEWIC assessment of Canadian bowhead whales was of the “Eastern and Western Arctic populations” which were given a single designation of Endangered by COSEWIC in April 1980. They were later split into two populations (Eastern Arctic and Western Arctic) to allow separate designations in April 1986. The Eastern Arctic population was not re-evaluated at that time but retained the Endangered status. The Eastern Arctic population was further split into Hudson Bay-Foxe Basin population and David Strait-Baffin Bay population in May 2005 and each was designated Threatened. Then, in April 2009, the Hudson Bay-Foxe Basin population and Davis Strait-Baffin Bay population were re-combined as a single unit known as the Eastern Canada-West Greenland (EC-WG) population and designated a species of Special Concern (COSEWIC 2009).

Heavy exploitation by commercial whalers between the late 1600s and 1915, with some hunting continuing until about 1951, depleted bowhead whale stocks in the eastern Canadian Arctic (Nunavut Wildlife Management Board 2000, DFO 2008a). Woodby and Botkin (1993) suggested that the pre-exploitation population of bowhead whales in Davis Strait and Baffin Bay was at least 11,800 whales but may have been reduced by the end of commercial whaling to approximately 1,000 whales. Fortunately, bowhead whales have shown significant recovery since the cessation of commercial whaling (Heide-Jørgensen et al. 2007, DFO 2012). Based on aerial surveys of portions of Eclipse Sound, Prince Regent Inlet and the Gulf of Boothia in 2002 through 2004, Dueck et al. (2008) derived a partial population estimate of the Eastern Canada-West Greenland bowhead population of 14,400 (95% confidence limits 4,811-43,105).

The 2013 High Arctic Cetacean Survey was the first aerial survey, however, to cover the full extent of bowhead summer distribution in the eastern Canadian Arctic in a single year (DFO 2015b). Two methods were used to derive stock estimates. First, an aerial survey covering all major aggregation areas of the population with the exception of Foxe Basin, Repulse Bay and Lancaster Sound, adjusted to account for whales that were diving and not visible to observers, resulted in an abundance estimate of 6,446 bowhead whales (coefficient of variation=26%). Second, a genetic capture-mark-recapture approach conducted using 1,177 biopsy samples yielded an estimate of 7,660 individuals (range of uncertainty: 4,500-11,100 individuals). Uncertainties in the statistical properties of the genetics-based approach were identified and the estimate derived from the aerial survey was the one recommended for harvest management (DFO 2015b).

IQ collected by the Nunavut Wildlife Management Board (2000) indicated that since the 1960’s, most communities within the Baffin region (including Igloolik, Hall Beach, Pond Inlet, and Arctic Bay) have reported an increase of bowhead whale sightings. Participants from Pond Inlet all stated that bowhead sightings had been once been rare and that sightings were increasing. The apparent time at which the increase became detectable near Pond Inlet varied among participant responses from 1942 to 1992, with the majority suggesting dates in the late 1960s to 1970s. Increasing bowhead observations are thought by most to be the result of increasing populations; however, it has been suggested that changes in their distribution may be the cause. Inuit Elders throughout the Arctic have reported that bowhead whales are difficult to see unless travelling in large groups. As a result, they may occur more frequently than previously reported by local communities (Nunavut Wildlife Management Board 2000).

Management of bowheads in Canada is the joint responsibility of Fisheries and Oceans Canada (DFO) and Inuit in Nunavut (via the Nunavut Wildlife Management Board) and Nunavik. Under the Nunavut Land Claims Agreement, Nunavut Inuit are legally entitled to a subsistence hunt for bowhead whales, subject to conservation concerns (DFO 2008b). Subsistence hunting for bowhead whales was once restricted in 1979 but a limited hunt resumed in 1996 in Nunavut (DFO 2008b). Greenlandic hunts resumed in 2008 under conditions established by the International Whaling Commission (DFO 2015b).

3.1.1.2 General Biology

Bowhead whales are one of only three whale species that live in the Arctic year-round, usually in close association with ice (Kovacs et al. 2011). They possess the thickest blubber layer of any mammal, up to 50 cm (Ferguson et al. 2010), and are well-adapted to living in areas of heavy unconsolidated ice cover. Although bowhead whales are reportedly capable of breaking up to 30-60 cm of ice to breathe, and can navigate extensive distances under nearly solid ice cover, they are more likely to be found in areas with low ice coverage (35-65%), thin and medium first-year ice (<70 cm), and small floe areas close to the maximum ice extent during the winter months. Bowhead whales tend to avoid open water, multiyear ice, and ice >70 cm thick (Ferguson et al. 2010). This presumably reduces the risk of ice entrapments for calves born in the late winter. In summer, bowhead whales occur in areas of high ice coverage (40-70%) particularly those with thick first-year ice (70-120 cm), and large floe sizes. This habitat choice is thought to reduce risk of killer whale predation while providing enriched feeding opportunities (Ferguson et al. 2010).

Bowheads are baleen whales and eat by filtering the water column for pelagic crustacean zooplankton (primarily copepods and euphausiids) and near-bottom waters for epibenthic invertebrates (primarily mysids) (Lowry 1993, Pomerleau et al. 2011a). Other recorded diet items include isopods, decapods, gammarid and hyperiid amphipods, bivalves, and gastropods (Pomerleau et al. 2011a). Feeding takes place primarily in late summer and fall, but intensive feeding in late spring and early summer has been reported (Ferguson et al. 2010). In spring and summer, bowhead whales are distributed relatively predictably in areas where mysid and copepod blooms appear (Nunavut Wildlife Management Board 2000, Ferguson et al. 2012). The marginal ice zone inhabited by bowhead whales, between open water and permanent ice cover, is the most productive area in the Arctic (Ferguson et al. 2010).

In a satellite tracking study of whales from northern Foxe Basin and Cumberland Strait, 90% of dives by bowhead whales were in waters of ≤50 m in depth (Pomerleau et al. 2011b). They spent most of their time at shallow depths (8-16 m) in summer, likely feeding on near-surface aggregations of zooplankton. In six of the seven tracked individuals, 74-100% of dives were of duration less than 6 minutes. One immature female made dives to depths of >350 m and approximately half of her dives were of duration less than 6 minutes while 6% exceeded 15 minutes in duration (Pomerleau et al. 2011b).

The main habitat features that determine critical habitat for bowhead whales include: complex coastal areas and the presence of suitable ice cover to minimize predation, proximity to shallow bathymetry for nursery functions, and oceanographic features that concentrate prey (e.g., troughs, upwellings, eddies, funnelling ocean currents, water mass boundaries) and enhance opportunities for intensive foraging (DFO 2008b). Bowhead whale populations may be segregated during much of the year as specific habitat requirements differ between sex, age and reproductive classes (Ferguson et al. 2010). For example, fiords and bays are suitable for juveniles with limited diving capability and offer better cover from killer whales (DFO 2008b). Bowhead whales are often observed feeding along the floe edge (Nunavut Wildlife Management Board 2000).

Bowhead whales are long-lived (up to 200 years), sexually mature at about 25 years, with a long birth interval (3-4 years) and long generation times (George et al. 1999, DFO 2008b). The Inuit recognize eight different age categories of bowhead whales; 1) arvaaraq or newborn calf; 2) arvaaq or an older calf still being nursed; 3) ingutuq or a one- to two-year-old travelling with or without their mother; 4) aktuarjuk (mikinisaarjuk) or juvenile/immature that is not full-grown but mid-sized; 5) arvaaralik (arvaalik) or adult female with a calf; 6) tiggalluk or a medium-sized male; 7) akturjuaq (aktualuk) or large adult male; and 8) arviq (aktut) or adult, full-grown bowhead with white patches and spots (Nunavut Wildlife Management Board 2000). Mating can occur throughout the year, but most conceptions occur during late winter or early spring (Koski et al. 1993). Gestation is 12 to 16 months, and single calves are born during the spring migration (Nerini et al. 1984; Koski et al. 1993). IQ collected by the Nunavut Wildlife Management Board (2000) indicated that feeding, mating, and calving take place in nearshore, sheltered, shallow waters in summer.

The only known predators of bowhead whales are man and killer whales. Dead bowheads found by Inuit frequently have teeth marks corresponding to killer whale attacks (Nunavut Wildlife Management Board 2000). Of 598 bowheads from the EC-WG population which have been photographed, 10.2% had rake marks from killer whale teeth on the flukes (Reinhart et al. 2013). A higher incidence of rake marks was observed on older whales, which may imply that younger, smaller bowhead whales are less likely to survive killer whale encounters. It has been speculated that bowhead population recovery may be threatened or delayed by killer whale predation (Ferguson et al. 2012).

3.1.1.3 Geographic and Seasonal Distribution

Bowhead whales have a near circumpolar distribution in the northern hemisphere. Members of the Eastern Canada-West Greenland (EC-WG) population spend winters in waters south of the RSA. They have been observed in the mouths of Cumberland Sound and Frobisher Bay, Hudson Strait, and northeastern Hudson Bay, among open leads and loose pack ice along the west coast of Greenland, in and near Disko Bay, and in the loose pack ice and polynyas of Davis Strait and southern Baffin Bay (Finley 1990, 2001; Heide-Jørgensen and Finley 1991; Reeves and Heide-Jørgensen 1996; Koski et al. 2006; Heide-Jørgensen et al. 2007; COSEWIC 2009; Ferguson et al. 2010). There have been no reported sightings of bowheads in Eclipse Sound / Pond Inlet during the winter months.

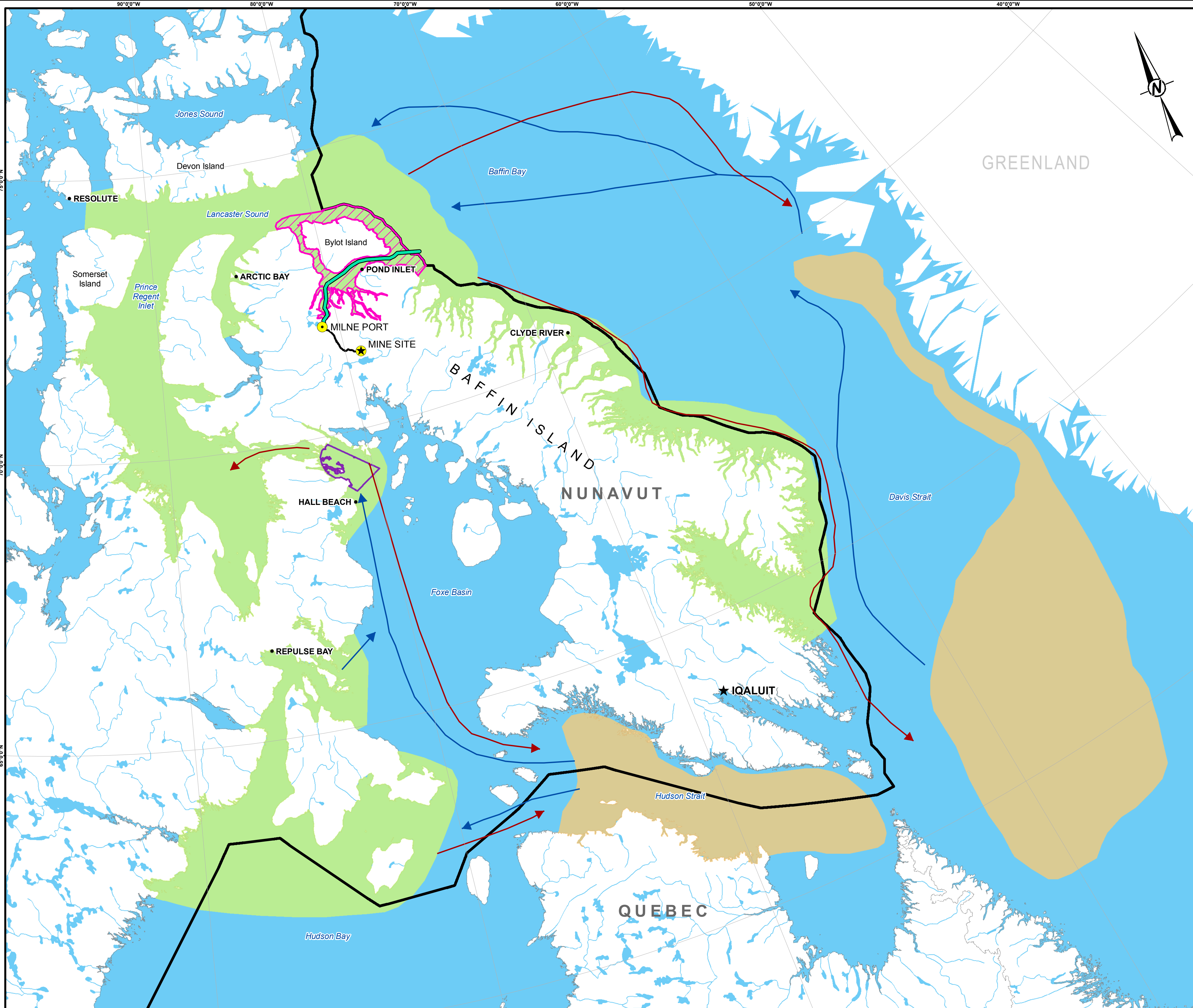
In spring and summer, bowhead whales migrate north (Davis and Koski 1980; Finley 1990, 2001; Heide-Jørgensen et al. 2003c), with many leaving Disko Bay in mid-May to travel along the west coast of Greenland and across Baffin Bay to Bylot Island in about 10 days (Heide-Jørgensen et al. 2003a). Those wintering in the pack ice in southern Davis Strait are thought to move north along the eastern coast of Baffin Island (Davis and Koski 1980; Kilabuk 1998). The Bowhead Knowledge Study (Nunavut Wildlife Management Board 2000) collected IQ from the Pond Inlet area and indicated that in early spring (Upirngassaq), a northbound migration can be observed off the floe edge of Pond Inlet. Specifically, bowhead migrate along the Pond Inlet floe edge near Sanirut / Button Point, and the floe edges of Navy Board Inlet and Lancaster Sound in May through July. Mother-calf pairs observed at Sanirut / Button Point indicate that the region is likely a calving area. IQ collected by Jason Prno Consulting (2017) states that bowhead whales may be found in the RSA during Upirngaaq (late May to July), at which point locals are often travelling and hunting on the ice throughout Eclipse Sound and on the Pond Inlet floe edge and bowheads are not regularly hunted because they are under a harvesting quota system.

In late July, as the ice breaks up, bowheads enter inlet, bays and fiords, where they feed. IQ collected by the Nunavut Wildlife Management Board (2000) indicates that bowheads are believed to return to the same summering areas year after year. This is supported by studies conducted by Heide-Jørgensen et al. (2008) who indicated that bowheads show high annual site fidelity to specific locations at the population level but not at the level of the individual. IQ collected by the Nunavut Wildlife Management Board (2000) indicates that bowheads without calves are usually the first to arrive in the summering areas in spring. Mothers and calves tend to arrive later in the season and are often observed in inlets and sounds of the Canadian Arctic archipelago during June and July (Kilabuk 1998). Adult females represent approximately 50% of the individuals in the eastern Canadian Arctic (Heide-Jørgensen et al. 2008). Reported summering areas include Pond Inlet, Navy Board Inlet, Eclipse Sound, Milne Inlet, Lancaster Sound, Cumberland Sound, and Admiralty Inlet (Nunavut Wildlife Management Board 2000). In addition, they are known to aggregate in Prince Regent Inlet, the Gulf of Boothia, Foxe Basin, Isabella Bay, and Repulse Bay in summer (DFO 2015b).

Approximately half of the Eastern Canada-West Greenland bowhead population summers in the bays and passages of the north-central and northeastern Canadian Arctic archipelago during August and September, and the remainder summer in Baffin Bay (Davis and Koski 1980; Koski and Davis 1980). Of note, bowhead whales occur at Qaurnak in western Eclipse Sound, Milne Inlet and Pond Inlet during the open-water season (Nunavut Wildlife Management Board 2000). Isabella Bay (Niginganiq, near Clyde River) is another important late-summer concentration area for bowheads, most of which are adults (Finley 1990). Summer aerial surveys in 1978 and 1979 recorded bowheads in the Baffin Bay pack ice off Bylot Island (Koski and Davis 1979, 1980). Bowheads have also been observed in the mouth of Lancaster Sound in June and July, but not in August or September (APP 1982). Cosens et al. (2005) observed several bowheads along the west shore of Eclipse Sound during aerial surveys in August 2002, but observed no bowheads on a replicate survey on the same day or when the surveys were repeated in 2004. Of 33 bowhead sightings recorded at Bruce Head, Milne Inlet in 2007 and 2008 by Marcoux et al (2009), 70% were observed within narwhal herds.

Most bowheads then leave the fiords in mid-September before the freeze and smaller out-migrations continue into October as sea ice begins to form, according to IQ collected by the Nunavut Wildlife Management Board (2000). This observation is consistent with IQ collected by Jason Prno Consulting (2017), who indicated that bowhead whales have been observed to migrate through the RSA with their calves in Aujaq (end of July to September). Fall migration is almost entirely coastal, and occurs quite rapidly (APP 1982). Shore-based observers at Cape Adair on northeast Baffin Island observed 43 bowheads passing between 13 September and 7 October 1978, with most passing between 1 and 7 October; and in 1979, 92 bowheads passed this same point between 28 September and 16 October (Koski and Davis 1979, 1980). Peak numbers passed the point in early October for both 1978 and 1979. A bowhead whale was also tracked by satellite, leaving Lancaster Sound on 7 October and moving rapidly southward along the east coast of Baffin Island, reaching the southeast corner of Baffin Island by 31 October (Heide-Jørgensen et al. 2006). Bowhead whales using Isabella Bay on the east coast of Baffin Island leave by late October (Finley 1990).

Satellite tracking of 27 whales of the EC-WG population indicated there were two distinct periods of the year with respect to bowhead rates of movement: a “winter” period of 28 December through 15 March, when daily movement of bowheads averaged 16.6±2.65 km/d; and a “summer” period of 27 June through 27 December, when movement averaged 31.9±1.05 km/d (Ferguson et al. 2010).



LEGEND

- ★ TERRITORY CAPITAL
- • COMMUNITY
- MILNE PORT
- MINE SITE
- FALL MIGRATION
- SPRING MIGRATION
- SHIPPING ROUTE (APPROXIMATE)
- MILNE INLET TOTE ROAD
- NORTHERN SHIPPING ROUTE REGIONAL STUDY AREA
- NUNAVUT SETTLEMENT BOUNDARY
- BOWHEAD NURSERY
- SUMMERING AREA
- WINTERING AREA

0 200 400

1:7,500,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. COUNTRY BASE DATA © ESRI AND ITS LICENSORS. USED UNDER LICENSE, ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012
PROJECTION: CANADA ALBERS EQUAL AREA CONIC DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
SEASONAL OCCURRENCE AND MIGRATION CORRIDORS FOR THE EASTERN CANADA-WEST GREENLAND BOWHEAD WHALE STOCK

CONSULTANT

GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	3.1

3.1.2 Beluga Whale (*Delphinapterus leucas*)

3.1.2.1 Population Status and Abundance

The beluga whale (*Delphinapterus leucas*) has a northern circumpolar distribution and is found between 47°N and 78°N across all longitudes in Canadian waters (Richard et al. 1988 cited in Luque and Ferguson 2010). Six beluga stocks (management units) occur in Nunavut (DFO 2010) and those present in the RSA belong to the Eastern High Arctic–Baffin Bay (EHA-BB) population. The Eastern High Arctic – Baffin Bay population of beluga was designated as a species of Special Concern by COSEWIC in April 1992. The species was re-examined and this designation was confirmed in May 2004. SARA has not listed the species.

There is some uncertainty as to whether the Eastern High Arctic – Baffin Bay population of beluga might actually comprise two populations, subdivided into North Water and West Greenland components. Specifically, movement patterns and genetic evidence suggest that this population occupies two distinct winter habitats in the Canadian High Arctic, the North Water and the West Greenland coast (Thomsen 1993; de March et al. 2002; Heide-Jørgensen et al. 2003b; COSEWIC 2004a), though it is unclear if they also occupy separate summer habitats in the Canadian High Arctic (COSEWIC 2004a). The most recent abundance estimate for the Eastern High Arctic - Baffin Bay population of beluga, corrected for submerged animals, is 21,213 (95% CI = 10,985-32,619; Innes et al. 2002). This estimate is based on aerial and photographic surveys of Prince Regent Inlet, Barrow Strait, and Peel Sound during summer 1996. Based on aerial winter surveys in 2006 and 2008, the population estimate for beluga in West Greenland is 10,595 (95% CI = 4,904-24,650; Heide-Jørgensen et al. 2010).

3.1.2.2 General Biology

Belugas feed primarily on Arctic cod, but are opportunistic feeders utilizing a variety of prey species including Arctic char, Greenland halibut, sculpins, eelpout, capelin, Greenland cod, and shrimp (Remnant and Thomas 1992; Kilabuk 1998; Stewart 2001). Koluktoo Bay, the southern half of Milne and Navy Board inlets, and Lancaster Sound adjacent to the coast of Bylot Island, have been identified as important areas for beluga for the purpose of feeding specifically (Remnant and Thomas 1992). Important habitat types for belugas include the edge of landfast ice (spring), fiords (summer), along the shelf in depths of 200-500 m (fall), and polynyas and open pack ice (winter) (DFO 2009). In spring, belugas have been observed in Cumberland Sound along the floe edge feeding on Arctic cod or Greenland halibut. In summer, they may select fiords or other areas of complex coastline for protection from killer whales (DFO 2009). Eclipse Sound and Lancaster Sound were not, however, mentioned in a list of important summer aggregations of Nunavut belugas compiled by DFO (2009).

Maximum ages of 77 years (males) and 74 years (females) have been recorded for belugas (Luque and Ferguson 2010). In one study, all sampled populations had two peaks in age distributions: for males, 20-23 years (except for Baffin Bay, which had the first peak around 10 years) and 37-40 years; for females, 11-18 years and 35-54 years (Luque and Ferguson 2010). Belugas typically have one calf at a time and are thought to reproduce annually (Stewart 2001). Some Inuit suggest that gestation is less than one year (Remnant and Thomas 1992). Grey belugas are juveniles and scientists believe that only the white adults breed, although hunters in Grise Fiord have reported that grey belugas occasionally give birth (Remnant and Thomas 1992; Stewart 2001). Near Pond Inlet, breeding is believed to take place in August, although belugas have been observed mating as early as May and July at the Admiralty Inlet floe edge (Stewart 2001). Other mating and calving areas that have been identified include the floe edge at Pond Inlet and Navy Board Inlet, offshore areas in Lancaster Sound and Baffin Bay, and Eclipse Sound and Milne Inlet. Calving is believed to occur in bays, inlets, and the mouths of rivers, and newborn calves have been observed along the floe edge in June, July, August, and September (Stewart 2001). Grise Fiord hunters have also reported calving along the floe edge in October and February (Stewart 2001). It is predicted that calving likely also occurs in offshore areas during the late spring migration (COSEWIC 2004a).

Belugas may concentrate some anthropogenic contaminants in their tissues. Of note, there was significantly more mercury present in the teeth of belugas in the Mackenzie Delta of the Beaufort Sea sampled in 1993 compared to archeological samples from1450-1650 AD (Outridge et al. 2002). Isotope analysis indicated that this was not related to dietary differences over time, and suggested that the more likely explanation is anthropogenic inputs of mercury. In this same study, it was found that ten year old belugas contained four times the pre-industrial concentration of mercury, and 30 year old belugas had seventeen times the pre-industrial levels (Outridge et al. 2002).

IQ collected by Kilabuk (1998) indicated that some behavioural changes had been observed in southeastern Baffin Island belugas in response to the noise of motor boats and snowmobiles introduced in the 1960s. Of note, belugas were said to avoid areas where boats and snowmobiles were heard, and were not found in areas where they were formerly densely concentrated. Belugas are also thought to avoid vibrations from power plants, as has been observed in Kimmirut, Nunavut (Kilabuk 1998). These observations of distribution shifts, however, may be confounded by changes in abundance, as beluga numbers are much lower now in southeastern Baffin Island than they were 50 years ago (Kilabuk 1998).

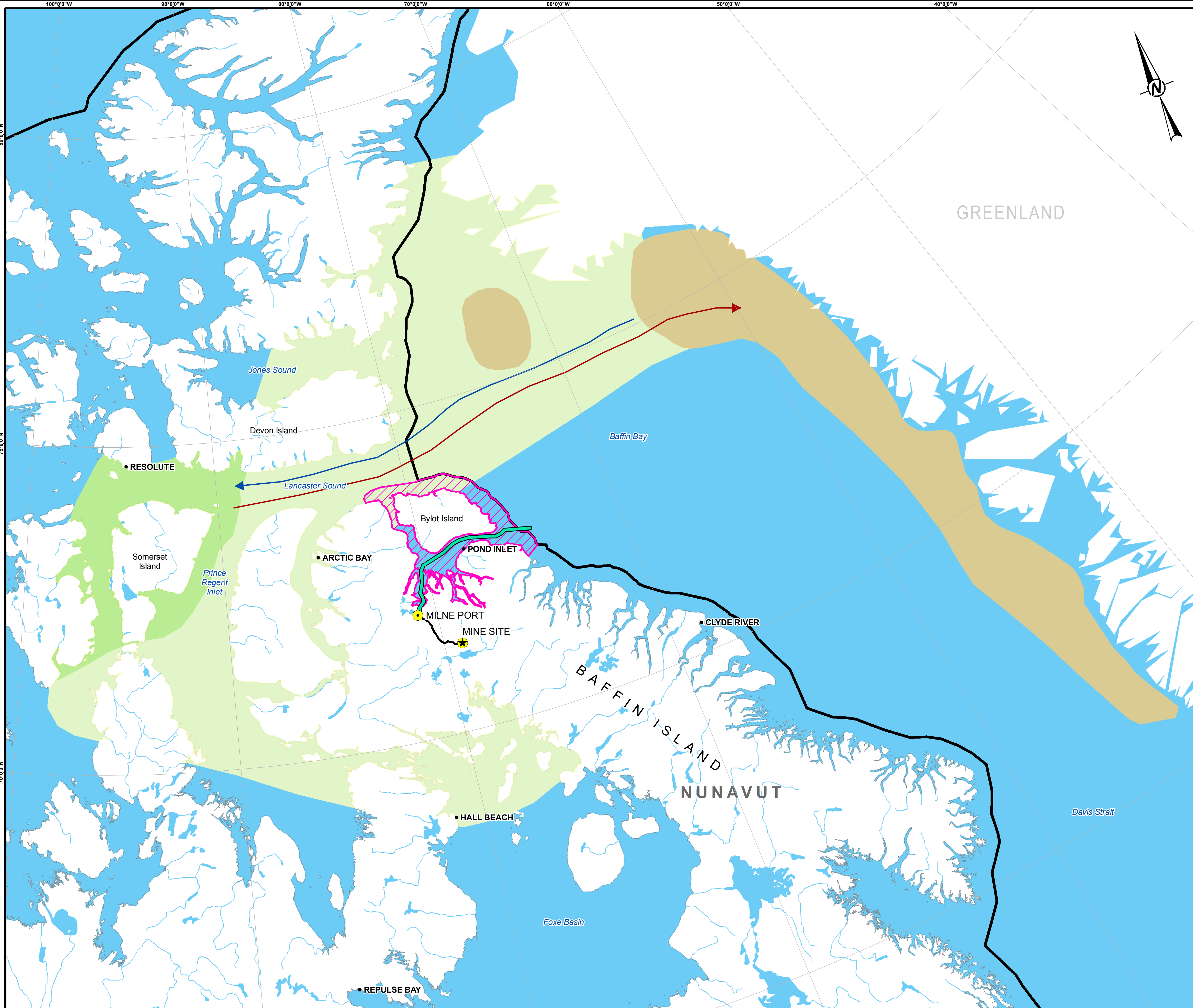
3.1.2.3 Geographic and Seasonal Distribution

In winter, belugas of the Eastern High Arctic - Baffin Bay population are found in areas of loose pack ice or polynyas along the west coast of Greenland south of Disko Island and in the North Water Polynya in northern Baffin Bay (Koski and Davis 1979; Davis and Finley 1979; McLaren and Davis 1983; Finley and Renaud 1980; Richard et al. 1998a, 2001a; Heide-Jørgensen et al. 2003b; COSEWIC 2004a). In early spring, belugas are found concentrated along ice edges as the fast ice breaks up, following leads into ice-covered areas near their summering locations (Stirling 1980). Beluga begin entering Lancaster Sound in late April or early May (Finley and Renaud 1980) with peak movements occurring in late June to July, depending on ice conditions (Koski and Davis 1979; Remnant and Thomas 1992; Stewart et al. 1995; Stewart 2001).

Belugas of the Eastern High Arctic - Baffin Bay population summer in the Canadian Arctic archipelago and are typically found along coastlines in shallow waters, and may be concentrated in estuaries or glacier fronts (Sergeant 1973; Finley and Renaud 1980; Michaud et al. 1990; Smith and Martin 1994; Richard et al. 1998a, 2001a; Lydersen et al. 2001; Heide-Jørgensen et al. 2003b). Summering areas are concentrated in the waters around Somerset Island (Remnant and Thomas 1992; COSEWIC 2004a), although a small number of whales occasionally move into Eclipse Sound and the Milne Inlet area, apparently to feed and calve (Remnant and Thomas 1992). Beginning in mid-August, belugas move to offshore areas, presumably to feed on deep-water fish (Smith and Martin 1994; Richard et al. 2001b).

Belugas migrate rapidly out of the central High Arctic in mid- to late- September (Davis and Finley 1979; Koski and Davis 1979, 1980; Heide-Jørgensen et al. 2003b) and most of the population passes through Lancaster Sound in less than a week (Koski et al. 2002). In one study, tagged whales arrived in Jones Sound and northern Baffin Bay from late September to early October (Richard et al. 2001a; Heide-Jørgensen et al. 2003b). Seventeen of 20 tagged individuals travelled to the North Water and were recorded there until the last tag ceased transmitting, from mid-October to late November, and three continued on to coastal waters off southwestern Greenland (Richard et al. 2001a; Heide-Jørgensen et al. 2003b). In West Greenland, belugas winter along the coast from 67°N to 69°N, and mainly within 50 km of the coast (Heide-Jørgensen et al. 1993). Most whales leave in May but some remain until June or July (Heide-Jørgensen et al. 1994).

IQ collected by Remnant and Thomas (1992) indicated that small numbers of beluga are common in waters near Pond Inlet in spring, summer, and fall. The majority of beluga present at the mouths of the Pond and Navy Board inlets as the ice breaks up are thought to migrate further north and west into Admiralty Inlet or Barrow Strait (Remnant and Thomas 1992). One hunter suggested that beluga enter Navy Board Inlet only to avoid killer whales (Remnant and Thomas 1992).



LEGEND

- TERRITORY CAPITAL
- COMMUNITY
- MILNE PORT
- MINE SITE
- FALL MIGRATION
- SPRING MIGRATION
- SHIPPING ROUTE (APPROXIMATE)
- MILNE INLET TOTE ROAD
- NORTHERN SHIPPING ROUTE REGIONAL STUDY AREA
- NUNAVUT SETTLEMENT BOUNDARY
- KNOWN RANGE
- SUMMER CORE AREA
- WINTER CORE AREA

0 200 400

1:6,500,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. COUNTRY BASE DATA © ESRI AND ITS LICENSORS. USED UNDER LICENSE, ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012
PROJECTION: CANADA ALBERS EQUAL AREA CONIC DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
SEASONAL OCCURRENCE AND MIGRATION CORRIDORS FOR EASTERN HIGH ARCTIC–BAFFIN BAY BELUGA POPULATION

CONSULTANT GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	3.2

3.1.3 Narwhal (*Monodon monoceros*)

3.1.3.1 Population Status and Abundance

Narwhal are endemic to the Arctic, occurring in deep Arctic waters, primarily in Baffin Bay, the eastern Canadian Arctic, and the Greenland Sea (Reeves et al. 2012). Seldom present south of 61º N latitude (COSEWIC 2004b), two populations are recognized in Canadian waters; the Baffin Bay population and the northern Hudson Bay population (Watt et al. 2017). Of these, only the Baffin Bay population occurs seasonally along the Northern Shipping Route (Koski and Davis 1994; Dietz et al. 2001; Richard et al. 2010). A third recognized population of narwhal occurs in East Greenland and is not thought to enter Canadian waters (COSEWIC 2004b). The populations are distinguished by their summering distributions, as well as a significant difference in nuclear microsatellite markers indicating limited mixing of the populations (DFO 2011).

Currently, narwhals in Canada are assessed at the species level by COSEWIC (COSEWIC 2004b). Narwhals were designated Not at Risk in April 1986 and April 1987 and then, in September 2004, they were re-examined and designated as a species of Special Concern. COSEWIC (2004) noted that there is uncertainty about numbers, trends, life history parameters and levels of sustainable hunting of narwhal in Canadian waters.

For management purposes, Fisheries and Oceans Canada (DFO) has defined seven narwhal stocks (i.e., resource units subject to hunting) in Nunavut: Jones Sound, Smith Sound, Somerset Island, Admiralty Inlet, Eclipse Sound, East Baffin Island, and Northern Hudson Bay (Doniol-Valcroze et al. 2015a). These stocks were selected based on tracking data indicating geographic segregation in summer (year-round segregation from the others in the case of the northern Hudson Bay stock) and also on evidence from genetic and contaminants studies that supported this stock partitioning. Subdividing the management units was recommended as a precautionary approach that would reduce the risk of over-exploitation of a segregated unit with site fidelity in summer (Richard et al. 2010). Previous management had been on the basis of two narwhal stocks comparable to those considered in the COSEWIC (2004b) assessment: the High Arctic stock (also called Baffin Bay stock by the Joint Commission on Conservation and Management of Narwhal and Beluga [JCNB] working group or Eastern High Arctic-Baffin Bay stock by COSEWIC) and the Northern Hudson Bay stock.

There have been multiple attempts to estimate the abundance of narwhal in the Canadian Arctic either in total or for specific populations, but until recently no survey had covered the entire distribution range of narwhal in Canada. One of the earliest assessment attempts was that of Koski and Davis (1994) in which an estimated 34,363 (± SE 8,282) narwhal were found to be present in offshore areas of Baffin Bay from May to July 1979. This survey did not, however, account for submerged animals and did not cover eastern Baffin Bay. Specific to the Eclipse Sound area, Kingsley et al. (1994) reported on replicate aerial surveys of narwhal conducted from 1987 to 1993, in which approximately 600 animals were detected annually. This estimate was also not corrected for submerged animals and, after including a correction for narwhal diving behaviour, it is likely that more than 1,500 narwhal could have been present (Kingsley et al. 1994). A re-analysis of 2002 to 2004 summer aerial surveys of narwhal estimated that there were more than 63,000 narwhal in the Canadian High Arctic (NAMMCO 2010a) and approximately 20,211 individuals in the Eclipse Sound area. DFO (2015c) also provided abundance estimates of narwhal based on aerial surveys with diving correction conducted in the Canadian Arctic, and estimated that narwhal abundance in Eclipse Sound was approximately 20,000 individuals between 2002 and 2004. Confidence intervals for these years were large, however, and an abundance estimate of approximately half as many narwhal in 2013 (n = 10,489) was likely not representative of actual numbers.

The Canadian High Arctic Cetacean Survey conducted by DFO in August 2013 was the first complete survey of six major narwhal summering aggregations in the Canadian High Arctic (DFO 2015c). The total abundance estimate, corrected for diving and observer bias, was 141,909 narwhal. Coefficients of variation ranged from 20% 65% for the different stocks and the corrected estimate for the Eclipse Sound area was 10,489 narwhal with a coefficient of variation of 24%. Annual variation in narwhal stock estimates between adjacent summering areas, Eclipse Sound and Admiralty Inlet, indicate that there is possible movement between these two summering ground locations (Thomas et al. 2015). IQ collected in northern Baffin Island communities suggest that narwhal numbers are increasing (Stewart 2001). For example, it was reported that, until the 1970’s, narwhal in Clyde River were predominantly fall migrants whereas now, the whales tend to stay in the region from spring until fall (Stewart 2001). However, community workshop participants from Pond Inlet did not note any visible change to narwhal populations from year to year or changes to the abundance of narwhal in Eclipse Sound (JPCS 2017).

3.1.3.2 General Biology

Female narwhal are believed to mature at 5 to 8 years and produce their first young at 7 to 13 years of age (COSEWIC 2004b) while males mature at 11 to16 years of age (COSEWIC 2004b). Pond Inlet hunters reported that narwhal mating activity occurs in areas off the northern coast of Bylot Island and at the mouths of Navy Board and Pond inlets at the floe edge. Eclipse Sound, Tremblay Sound, Milne Inlet, and Koluktoo Bay have also been reported as mating areas (Remnant and Thomas 1992). At least one presumed mating event has been observed from the Bruce Head observation platform in southern Milne Inlet during summer. Conception generally occurs between late March and late May but narwhals have also been observed mating in June at the Admiralty Inlet floe edge and in August in western Admiralty Inlet (Stewart 2001). Calving then takes place within inlets, bays, fjords, sounds, mouths of rivers, and the open water at the floe edge, however IQ indicates that calving can occur anywhere. Calving is known to occur in Pond Inlet, Navy Board Inlet, Eclipse Sound, Milne Inlet, and Koluktoo Bay (Remnant and Thomas 1992). On average, females are thought to produce a single calf approximately every three years until about 23 years of age (COSEWIC 2004b), though many Inuit believe that narwhals give birth more frequently, perhaps annually (COSEWIC 2004b). Gestation for narwhal is on the order of 14-15 months (COSEWIC 2004b) with IQ suggesting 15 months based on fetuses observed (Fugal and Laing 2012). Newborn calves are primarily born between May and August each year and measure 140 to 170 cm in length, approximately 1/3 the body length of an adult female (Charry 2017). Typically newborn calves travel less than one body length away from their mother and were found to travel in mean group sizes of 5 individuals (5.0 ± 3.03 Standard Deviation [SD]) in Eclipse Sound and in mean groups sizes of 2 individuals (2.0 ± 0.0 SD) in east Baffin Island (Charry 2017). Calves are generally weaned at 1-2 years of age (COSEWIC 2004).

Finley and Gibb (1982) surveyed the diet of 73 narwhal near Pond Inlet in June through September (1978-1979) and found food remains in 92% of the stomachs analyzed. Feeding was found to be most intensive at the floe edge and leads in spring with limited feeding occurring in fiords in late summer. Diet consisted of pelagic and benthic species including Arctic cod (*Boreogadus saida*) (found in 88% of stomachs), Greenland halibut (*Reinhardtius hippoglossoides*), squid (Gonatus fabricii), redfish (Sebastes marinus), and polar cod (*Arctogadus glacialis*) with foraging occurring at depths greater than 500 m (Finley and Gibb 1982; Watt et al. 2017). Tracking data from tagged narwhal shows differences in narwhal diet and dive behaviour between the summering and wintering areas as well as between the two wintering areas. Surface dives (0 to 50 m) and the time spent at the surface is higher in the summering areas and lower in the wintering areas (Richard et al. 2014). In the northern wintering area, narwhal primarily dive to depths between 200 and 400 m and have a smaller proportion of

Greenland halibut in their diet. In the southern wintering area, narwhal primarily dive to depths over 1,000 m and have a larger proportion of their diet composed of Greenland halibut (Richard et al. 2014). As narwhal travel to the floe edge on their summer migration, stomachs contained mainly Arctic cod but there was a shift toward Greenland halibut as the narwhal moved through Pond Inlet (Finley and Gibb 1982). Deep diving in marine mammals is energetically costly and requires lipid-rich prey or abundant food sources to support this activity (Watt et al. 2017). Narwhal are well adapted to deep diving and are known to prey on deep-water fish species (Finley and Gibb 1982; Watt et al. 2015) to meet their dietary requirements (Watt et al. 2015; 2017). Previous studies suggested that narwhal spend less time feeding while at their summering grounds compared to feeding in the winter or spring (Mansfield et al. 1975; Finley and Gibb 1982; Laidre et al. 2004; Laidre and Heide Jørgensen 2005). Targeted deep dives in narwhal was used as a proxy to indicate important foraging areas or other important areas for other life-history traits in both summering and wintering areas (Watt et al. 2017). Watt et al. (2017) found that Eclipse Sound narwhal spent approximately 75% of their summer range deep diving, suggesting that foraging was occurring, countering the argument that narwhal spend limited time feeding during this time as evidenced from empty stomachs. Satellite tracking of 21 narwhal from both the Baffin Bay (whales tagged in Tremblay Sound in 2010 and 2011) and northern Hudson Bay (whales tagged in Lyon Inlet in 2006 and Repulse Bay in 2007) populations provided information on diving behaviour (Watt et al. 2017). A kernel density analysis indicted that important deep foraging areas for the Baffin Bay population are in Eclipse Sound in summer and in Davis Strait in winter. Important deep foraging areas for the northern Hudson Bay population are in northwestern Hudson Bay in summer and the eastern side of the Hudson Strait entrance in winter (Watt et al. 2017). The authors hypothesized that the Baffin Bay narwhal population would spend equal amounts of time at both mid-water and deep water foraging locations; however, summering narwhal spent less time foraging in mid-water (approximately 15%) compared to deep zones (approximately 25%) with dives ranging from 75 to 100% of total bottom depth. Thus, narwhal spent some of their time foraging throughout their summering range as well as spent much of their time foraging to deep zones. Narwhal also spent the majority of their time on the surface, likely recovering from deep dives (Watt et al. 2017) and engaging in other activities.

DFO closed NAFO Division 0A, which represents the core of the narwhal overwintering ground in central Baffin Bay based on satellite tracking of narwhals, to the Greenland halibut fishery (DFO 2007). Effort restrictions were first established in 1998 due to concerns that bottom trawl fishing could lead to habitat destruction and local depletion of Greenland halibut in this area which is important habitat for narwhals. The area is also known to contain sensitive deep sea corals. Eclipse Sound narwhals, as well as those from Admiralty Inlet and Melville Bay (Greenland) overwinter in this now closed area. In this area, narwhal were found to spend over three hours per day feeding at depths >800 m, with 13 minutes on average per round trip (DFO 2007). The maximum recorded dive duration for a narwhal is 24.8 minutes, based on satellite tags placed on three juvenile narwhals off northeast Svalbard, Norway, in August 1998 (Lydersen et al. 2007).

Killer whales are well known to prey on narwhal. Laidre et al. (2006) observed an attack on tagged narwhal in Admiralty Inlet in August 2005 in which at least 4 narwhal were killed by 12 to 15 killer whales within 6 hours. Before the attack but in the immediate presence of killer whales, narwhal moved slowly and quietly, travelling close to the beach (often within 2 m of the shore) in very shallow water, and formed tight groups at the surface (Laidre et al. 2006). During the attack, narwhal beached themselves in sandy areas and made tail slaps. During the five days after the attack, the narwhal were widely dispersed and spatial use doubled from the pre-attack home ranges of 347 km^2 to 767 km^2. Shore observers determined that normal observable behaviour resumed approximately 1 hour after the killer whales left the area (Laidre et al. 2006). Similar results were observed for a satellite telemetry tagged killer whale group (12 to 20 individuals) and narwhal (7 individuals) in Admiralty Inlet in

August 2009 (Breed et al. 2017). When the killer whale group entered the Inlet and were within approximately 100 km, narwhal maintained close proximity (within 500 m) to the shoreline. When the killer whale group retreated, narwhal moved offshore, generally between 4 and 10 km from the shoreline (Breed et al. 2017). Narwhal dive behaviour was affected when killer whale were present, with narwhal diving more frequently to deeper depths and for shorter durations than when killer whales were not present (Breed et al. 2017). Polar bears and sharks may also prey opportunistically on narwhal, as unsuccessful attacks by both species have been reported by Inuit (Stewart 2001).In Milne Inlet, narwhal are usually observed in small groups or clusters[2] but may occur in herds of up to several hundred individuals. Visual observations from Bruce Head indicate that narwhal travel in clusters of 3.5 individuals (range: 1 to 25), and that they generally enter Koluktoo Bay in larger clusters than when they exit the bay (Marcoux et al. 2009). Marcoux et al. (2009) counted up to 642 such clusters making up a herd, with an average number of 22.4 clusters/herd. These observations are similar to IQ that indicate narwhal travel in groups of 10-20 individuals (Fugal and Laing 2012).

3.1.3.3 Geographic and Seasonal Distribution

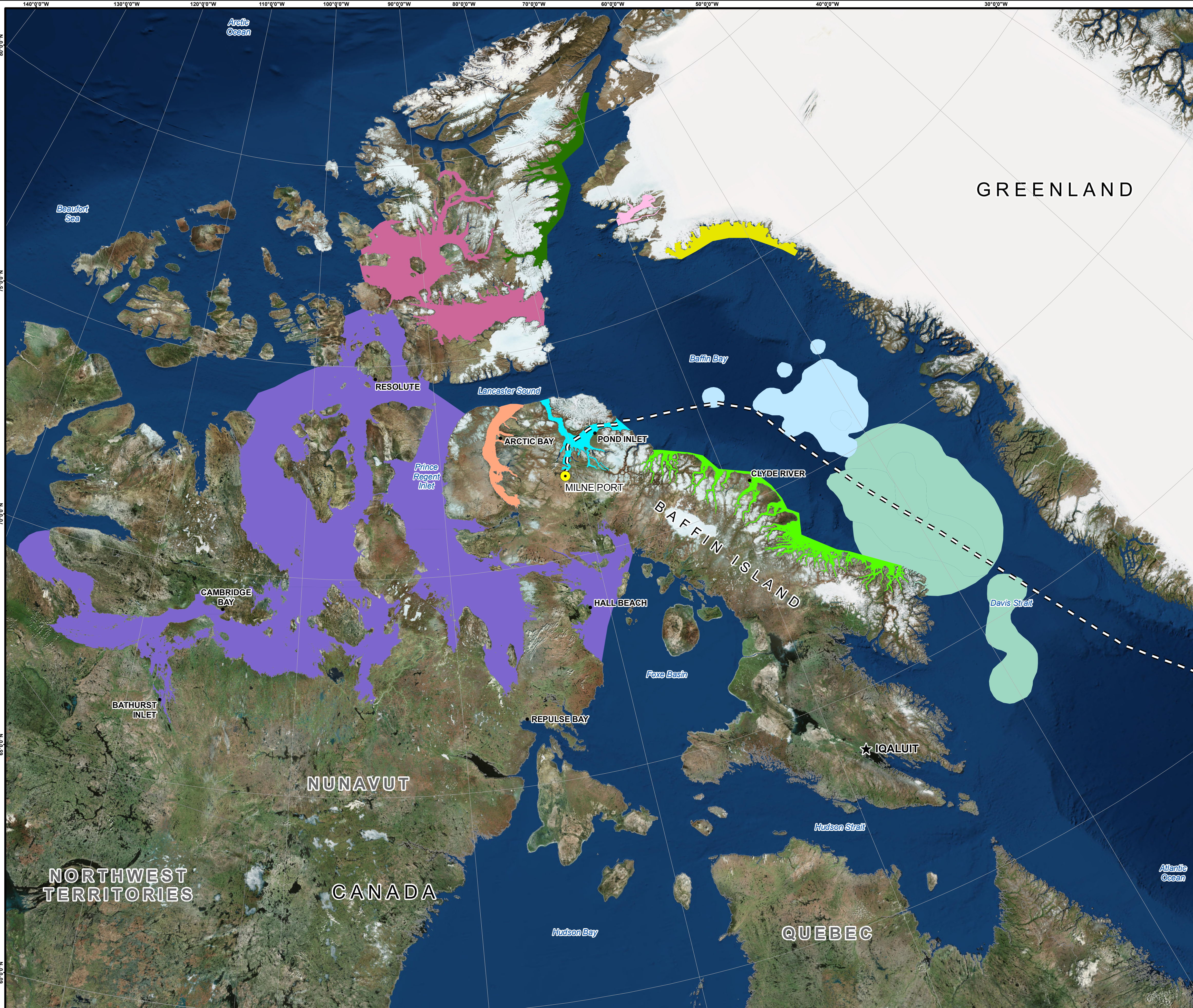
Narwhal show high levels of site fidelity, annually returning to well-defined summering and wintering areas (Figure 2-1) (Laidre et al. 2004; Richard et al. 2014). During summer, narwhal tend to remain in deep-water coastal areas that are thought to provide protection from the wind (Kingsley et al. 1994; Koski and Davis 1994; Richard et al. 1994). In winter, narwhal move onto feeding grounds located in deep fjords and the continental slope where water depths are 1000 to 1500 m, and where upwelling increases biological productivity and supports abundant prey species including squid, flatfish (i.e., turbot), and Greenland halibut (Dietz and Heide-Jørgensen 1995; Dietz et al. 2001; Richard et al. 2014). IQ indicates that narwhal enter leads into Eclipse Sound in July with large males ahead of females and calves (JPCS 2017). Eclipse Sound is considered a particularly important summering area (Koski and Davis 1994; DFO 2015) and satellite tracking studies of narwhal summering in Tremblay Sound have shown that summering narwhal remain in a relatively small area including western Eclipse Sound and inlets during August (Dietz and Heide-Jørgensen 1995; Dietz et al. 2001). The distribution of narwhal in Eclipse Sound, Milne Inlet, Koluktoo Bay, and Tremblay Sound during summer is thought to be determined by the presence and distribution of ice and by the presence of killer whales (Kingsley et al. 1994).

Narwhal generally begin migrating out of their summering areas in late September (Koski and Davis 1994). IQ indicates that narwhal migrate in October and November through Eclipse Sound and Pond Inlet to overwintering areas in Baffin Bay and Davis Strait. Narwhal migratory routes to their overwintering grounds will change from year to year depending on ice conditions (JPCS 2017). Individuals exiting Eclipse Sound and Pond Inlet migrate down the east coast of Baffin Island in late September (Dietz et al. 2001). Individuals summering near Somerset Island enter Baffin Bay north of Bylot Island in mid- to late October (Heide-Jørgensen et al. 2003). By mid- to late October, narwhal leave Melville Bay and migrate southward along the west coast of Greenland in water depths of 500 to 1000 m (Dietz and Heide-Jørgensen 1995). Narwhal generally arrive at their wintering grounds in Baffin Bay and Davis Strait during November (Heide-Jørgensen et al. 2003) where they associate closely with heavy pack ice comprised of 90 to 99% ice cover (Koski and Davis 1994). Elders have indicated that while the majority of narwhal overwinter in Baffin Bay, some animals remain along the floe edges at Pond Inlet and Navy Board Inlet (DEIS 2010). Narwhal tracking data have identified two distinct wintering areas for the Baffin Bay population. One

[2] A cluster was defined as a group with no individual more than 10 body lengths apart from any other. The end of a herd was defined as the point when no narwhal were seen passing a shore-based observation point for 30 minutes (Marcoux et al. 2009).

wintering area is located in northern Davis Strait / southern Baffin Bay (referred to as the southern wintering area) is frequented by. Canadian narwhal summering stocks from Admiralty Inlet and Eclipse Sound, and the Greenland narwhal stock from Melville Bay. The second wintering area is located in central Baffin Bay (referred to as the northern wintering area) is used by narwhal from the Somerset Island summering stock (Richard et al. 2014).

IQ indicates that between April and June, narwhal migrate from their Baffin Bay wintering areas to the Pond Inlet floe edge, northern coast of Bylot Island, navy Board Inlet floe edge, and eastern Lancaster Sound (JPCS 2017). As ice conditions permit (usually late June and July), narwhal move into summering areas in Barrow Strait, Peel Sound, Prince Regent Inlet, Admiralty Inlet, and Eclipse Sound (Cosens and Dueck 1991; Remnant and Thomas 1992; Kingsley et al. 1994; Koski and Davis 1994; Richard et al. 1994).



LEGEND

- ★ TERRITORY CAPITAL
- • COMMUNITY
- MILNE PORT
- SHIPPING ROUTE (APPROXIMATE)

SUMMER AGGREGATION AREA

- ADMIRALTY INLET
- EAST BAFFIN ISLAND
- ECLIPSE SOUND
- INGLEFIELD BREDNING
- JONES SOUND
- MELVILLE BAY
- SMITH SOUND
- SOMERSET ISLAND

WINTER AGGREGATION AREA

- NORTHERN WINTERING AREA
- SOUTHERN WINTERING AREA

0 200 400

1:10,000,000 KILOMETRES

REFERENCE(S)

NARWHAL POPULATION RANGES DIGITIZED FROM DFO FIGURE 1 'MAP OF HIGH ARCTIC NARWHAL SUMMER AGGREGATIONS' (SOURCE: AMMCO/SC/21-JCNB/SWG/14-05). NARWHAL WINTERING AREAS DIGITIZED FROM RICHARD ET AL. (2014) FIGURE 3 PUBLISHED WINTER HOME RANGES OF TRACKED BAFFIN BAY NARWHAL. SHYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. COUNTRY BASE DATA © ESRI AND ITS LICENSORS. USED UNDER LICENSE, ALL RIGHTS RESERVED. SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY
PROJECTION: CANADA ALBERS EQUAL AREA CONIC DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
NARWHAL SUMMERING AND WINTERING AREAS – BAFFIN BAY POPULATION

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	EG
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	3.3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

3.1.4 Killer Whale (*Orcinus orca*)

3.1.4.1 Population Status and Abundance

Killer whales (*Orcinus orca*) occur in all oceans of the world (Ford 2002) and five designatable units are currently recognized in Canada based on morphology, genetics, range, distribution, movements, acoustic behavior, and feeding ecology: four in the coastal and offshore waters of British Columbia and one, the Northwestern Atlantic / Eastern Arctic population, in eastern and northern Canada (COSEWIC 2008a). The Northwest Atlantic / Eastern Arctic population of killer whale is known to occur within the RSA and was considered as Data Deficient by COSEWIC in April 1999 and again in November 2001. In November 2008, this population of killer whale was re-examined and designated as a species of Special Concern (COSEWIC 2008a), though most of what is known about this population is derived from relatively limited records. Between 1850 and 2008, 450 killer whale sightings were recorded in the Canadian Arctic (Higdon et al. 2012). Since 1850, the number of sightings per decade have increased substantially and this is especially true of killer whales in the eastern Canadian Arctic (Higdon et al. 2012).

Worldwide, there is a minimum population estimate of 50,000 killer whales (Forney and Wade 2007). There are no population estimates of killer whales in the northwest Atlantic Ocean or eastern Canadian Arctic. A photo identification study of killer whales in the Canadian Arctic from 2004 to 2009 identified 53 distinct individuals, of which 42 were sighted off northern and eastern Baffin Island (Young et al. 2011). At least 15 sightings of groups comprising more than 40 killer whales have been reported in the Canadian Arctic (Higdon 2007). The limited IQ that is available for killer whales in the eastern Canadian Arctic suggests that the presence of killer whales has been increasing. Elders in Pond Inlet have indicated that pod size of killer whales has also increased significantly in recent years (DEIS 2010). It is thought that declining summer ice in the Arctic has allowed killer whales to expand their range further north in recent years (COSEWIC 2008a).

3.1.4.2 General Biology

Killer whales are sexually dimorphic. Adult males are larger than females and are easily identified by their large dorsal fin (Baird 2001). What is currently known about killer whale gestation and calving is based largely on populations of the Pacific Northwest, which are the most well studied populations in Canada. Gestation for killer whales in the Pacific Northwest lasts 12 to 17 months, and weaning is thought to occur at 1 to 2 years of age. Calving is known to occur year-round and females generally calve every 2 to 12 years (Olesiuk et al. 1990). Little information regarding killer whale reproduction has been recorded by IQ, but it was indicated that some calving has been observed near Pond and Milne inlets (DEIS 2010).

Worldwide, killer whales prey on a wide range of animals, including squid, fish, and a number of marine mammals (Baird 2001). Monodontids (i.e., narwhal and beluga) are the most frequently observed prey of killer whales in the Arctic, followed by bowheads, phocids and groups of mixed mammal prey (Higdon et al. 2012). IQ also reports that killer whales are often observed hunting seals, narwhal, beluga, bowhead and fish in open water (DEIS 2010). While the only definitively reported prey of killer whales in the Canadian Arctic are marine mammals, these events are relatively easy to observe. Stomach contents of killer whales in Greenland have been shown to contain fish such as lumpsuckers, Greenland halibut, and cephalopods so it is possible that killer whales in the Canadian Arctic feed on prey other than marine mammals (Higdon et al. 2012).

It is thought that when killer whales detect prey, they emit high-pitched calls and when other marine mammals hear the calls, they flee to shallow water where they are easily captured. This avoidance behaviour by Arctic seals and certain whale species is well-known to Inuit (Westdal et al. 2013). Similarly, Marcoux et al. (2009) observed narwhals exiting Koluktoo Bay by swimming very near to shore after the arrival of a pod of about 12 killer whales, and an Inuit from Pond Inlet observed narwhals waiting for four days in the shallows for killer whales to leave Milne Inlet in the 1970s (Ferguson et al. 2012). During one such event reported in Arctic Bay, many narwhals were close enough to shore to avoid killer whales that people were able to touch them from land (Ferguson et al. 2012). Killer whales have also been observed to cooperatively wash seals off ice floes, forcing their prey into the water (Brody 1976).

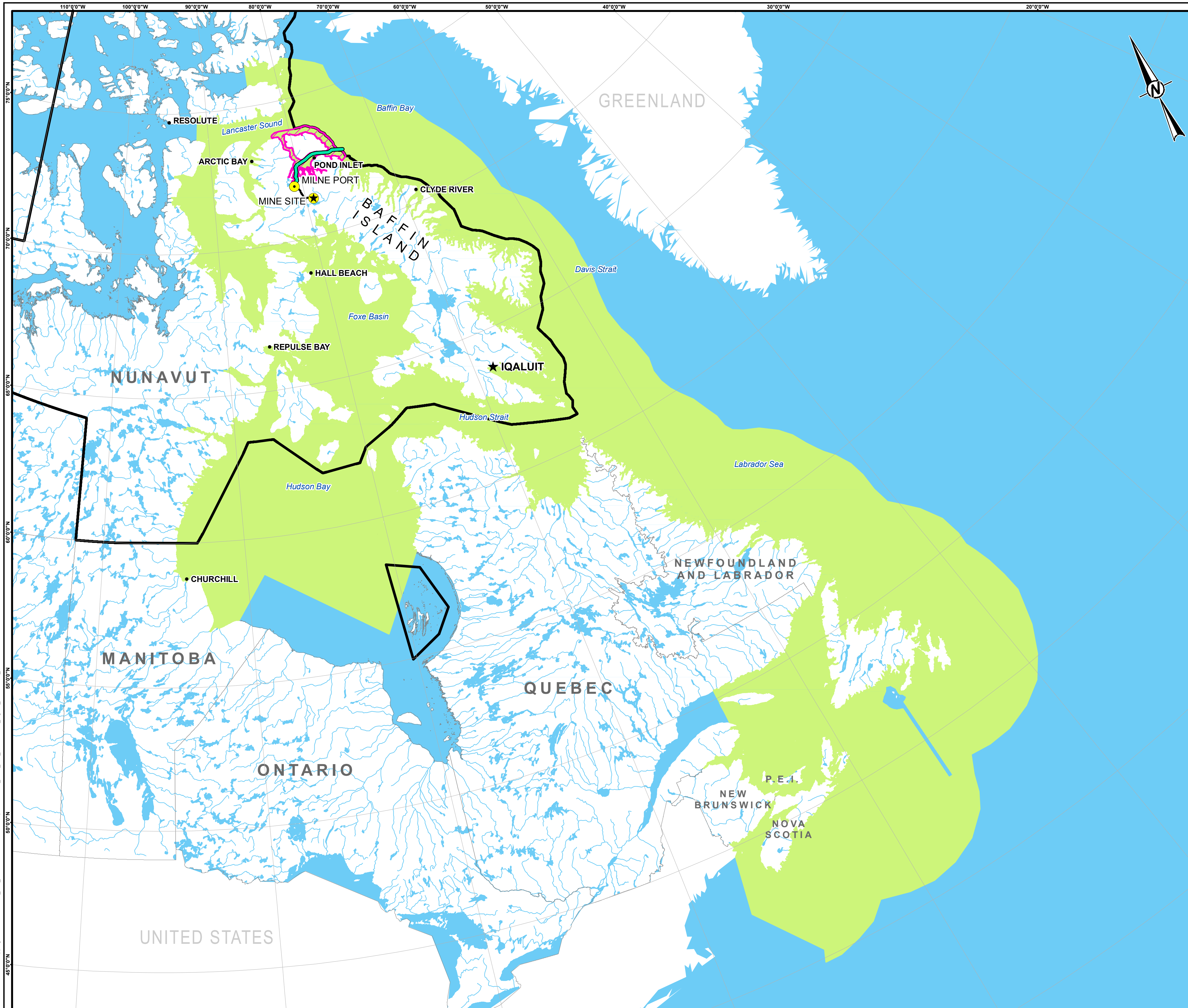
As a result of the increasing presence of killer whales in the Arctic, some Inuit have noted a decrease in other marine mammal species in some areas. For example, Elders in Igloolik indicated that seals in one offshore area near their community had disappeared because of predation by killer whales (DEIS 2010). Furthermore, in Hudson Bay, killer whales seasonally concentrate their feeding activities on bowheads and it has been suggested that this may delay or prevent the recovery of the bowhead populations (Ferguson et al. 2012). Bowhead calves and juveniles in particular are vulnerable to killer whale predation (Mehta et al 2007). Rake marks from killer whale teeth were found on 10.2% of 598 EC-WG bowheads whose flukes were examined; higher incidence was found on older bowheads and was interpreted as an indication that smaller individuals might not survive killer whale attacks (Reinhart et al. 2013).

3.1.4.3 Geographic and Seasonal Distribution

The range of the Northwest Atlantic / Eastern Arctic population of killer whale extends from the Atlantic Ocean as far north as Lancaster Sound (Baird 2001). During the Arctic ice-free season, killer whale groups travel extensively throughout the eastern Canadian Arctic (Ferguson et al. 2012). Sightings of killer whales in the Canadian Arctic have been reported throughout the year with the majority (87%) occurring during summer (Higdon 2007). Earlier studies found that killer whales were uncommon in northern Baffin Bay and Lancaster Sound from August to October (Koski and Davis 1979) but by 2001, regular sightings were occurring in Cumberland Sound, Lancaster Sound, and Pond Inlet (Baird 2001). Of note, regular occurrences of killer whales have been reported in Pond Inlet in spring, summer, and fall, with most sightings (n=24) reported during July–August (Higdon 2007). Killer whales have also been observed in and around Eclipse Sound and Tremblay Sound (Campbell et al. 1988; Marcoux et al 2009) and in Milne Inlet and Koluktoo Bay on several occasions when they were observed hunting narwhals (Ferguson et al. 2012). Killer whales are found only rarely along or within pack ice (Reeves et al. 2002) so it is thought that they remain in northern areas until forced south by pack ice formation (APP 1982). Winter sightings have also been reported for Disko Bay (Higdon 2007).

Satellite tagging in Admiralty Inlet in August 2009 resulted in tracking of one killer whale for 90 days (Matthews et al. 2011). The whale remained in Admiralty and Prince Regent Inlets from mid-August to early October. During that time, the animal travelled 96.1±45.3 km/d (maximum 162.6 km/d) while in Admiralty Inlet and 120.1±44.5 km/d (maximum 192.7 km/d) while in Prince Regent Inlet. The killer whale left the area in early October before heavy ice formation and travelled along the east coast of Baffin Island, reaching the North Atlantic by mid-November. This whale travelled more than 5,400 km in that month at a mean speed of 159.4±44.8 km/d (maximum 252.0 km/d). Pack ice of ~30% cover was navigated during this period, while the animal crossed Lancaster Sound to reach the ice-free water east of Baffin Island. While in Baffin Bay and Davis Strait, prolonged directed swimming persisted despite passing known aggregations of bowhead and beluga in areas such as Isabella Bay and Cumberland Sound.

There is no evidence of large scale north/south migrations by the northwestern Atlantic / eastern Canadian Arctic population of killer whale (COSEWIC 2008a). The distribution and movement patterns of killer whales in Polar Regions are, however, likely influenced by the presence of pack ice during the winter months (Reeves and Mitchell 1988). Climate induced reductions in the duration and extent of sea ice cover in the eastern Canadian Arctic are also likely responsible, in part, for the apparent increase in killer whale sightings in the region (COSEWIC 2008a).



LEGEND

- TERRITORY CAPITAL
- COMMUNITY
- MILNE PORT
- MINE SITE
- SHIPPING ROUTE (APPROXIMATE)
- MILNE INLET TOTE ROAD
- NORTHERN SHIPPING ROUTE REGIONAL STUDY AREA
- NUNAVUT SETTLEMENT BOUNDARY
- KILLER WHALE DISTRIBUTION AREA

0 400 800
1:15,000,000 KILOMETRES

REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. COUNTRY BASE DATA © ESRI AND ITS LICENSORS. USED UNDER LICENSE, ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012
PROJECTION: CANADA ALBERS EQUAL AREA CONIC DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
DISTRIBUTION OF THE NORTHWEST ATLANTIC / EASTERN ARCTIC KILLER WHALE POPULATION

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	3.4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

3.1.5 Atlantic Walrus (*Odobenus rosmarus*)

3.1.5.1 Population Status and Abundance

Atlantic walrus (*Odobenus rosmarus*) have a discontinuous circumpolar distribution, occurring from the northeastern coastal waters of Canada and Greenland to the Western Kara Sea north of Russia, including Svalbard and Franz Josef Land. Originally treated by COSEWIC as two separate populations, the Eastern Arctic population was assessed as Not At Risk in April 1987 and again in May 2000, and the Northwest Atlantic population was assessed as Extirpated in April 1987 and again in May 2000. In April 2006, COSEWIC combined both populations into a single unit for Atlantic walrus in Canada and the species was designated as a species of Special Concern (COSEWIC 2006b). Based on geographical distribution, genetics, and lead isotope data, four populations or ‘stocks’ ranging from Nova Scotia to the high Arctic have been recognized for management purposes in Canada (COSEWIC 2006b). These populations inhabit 1) South and East Hudson Bay, 2) Northern Hudson Bay-Davis Strait, 3) Foxe Basin, and 4) Baffin Bay (High Arctic). It is the Baffin Bay (High Arctic) population of Atlantic Walrus that is expected to occur within the RSA.

According to COSEWIC (2006b), the population size of the Baffin Bay (High Arctic) was estimated to be between 1,700 and 2,000 in the 1970s and 80s, with summering populations numbering approximately 100 in Kane Basin, 300 in Buchanan and Princess Marie bays on Ellesmere Island, 300 to 600 in Jones Sound and along eastern Ellesmere Island, and 1,000 in the Lancaster Sound Barrow Strait area (Born et al. 1995, COSEWIC 2006b). COSEWIC (2006b) noted, however, that the data on population structure was insufficient to assess each population as a separate designatable unit. Furthermore, no recent population estimates currently exist for the Altlantic walrus (Stewart 2008). Despite this paucity of abundance and trend data, observations suggest that most walrus stocks are declining; this conclusion is based on shifts in walrus distribution, abandonment of main haulout sites, and increased areas over which hunters must now travel to access walrus (Stewart 2002).

3.1.5.2 General Biology

Atlantic walrus feed on benthic organisms, primarily bivalve molluscs, as well as euphausiids, eels, kettlefish, and other small fish (COSEWIC 2006b). Walrus are sensitive to sea ice conditions as they use it seasonally to reach bivalve beds that are too far from shore to otherwise reach, and also give birth and mate on sea ice. All walruses are dependent on this benthic-pelagic coupling that results in rich benthic communities of bivalves, which are fed in part by vertical flux from ice algae and ice-associated pelagic algal blooms (Kovacs et al. 2011). Some adult walrus are also known to kill and eat ringed and bearded seals, squids and seabirds such as thick-billed murres (Mansfield 1958, Mallory et al. 2004, COSEWIC 2006b)

Adult male walrus have a mean length of 315 cm, and females are generally smaller, averaging approximately 277 cm in length (DFO 2002). Both sexes have tusks and all walruses haul out in all seasons but segregate by age and sex for most of the year (COSEWIC 2006b). Distribution of Atlantic walrus is determined by the availability of haul out sites and shallow water given that most feeding takes place within 100 m from the surface. Walruses are, however, capable of diving deeper if necessary (DFO 2002).

Atlantic walrus are highly polygynous and typically mate between January and April, with implantation in the uterus being delayed until late June-early July (DFO 2002). Following 11 months of gestation, walrus calves are then born between May and early June (COSEWIC 2006b). Ice conditions are important for calving, and calves are typically born along the floe edge or on moving pack ice. In the North Baffin area, calving locations were identified in Admiralty Inlet, near the outlet of Navy Board Inlet, and off the north coast of Bylot Island (DEIS

2010). Lactation lasts up to 25 to 27 months (Fisher and Stewart 1997), with calves being able to nurse in the water and accompany females when they forage (Kovacs and Lavigne 1992; Loughrey 1959; Miller and Boness 1983). The calving interval for Atlantic walrus is around 3 years.

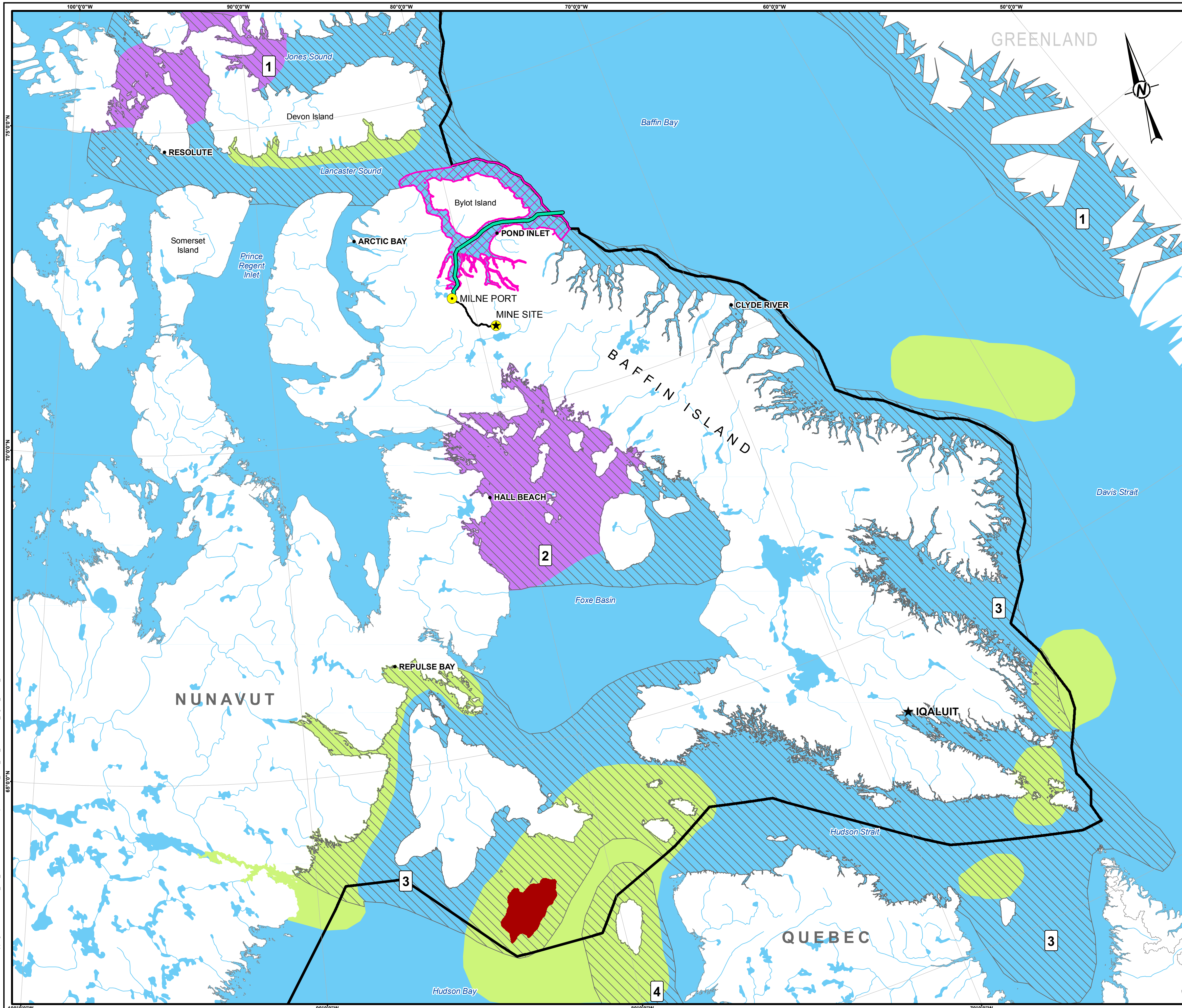
The effect of mechanical disturbance by helicopters, fixed wing aircraft, and small zodiac vessels with outboard motors on Atlantic walrus hauled out on shore was studied in summer (24 July – 23 August 1997) at Bathurst Island, Nunavut (Salter 1979). Disturbances occurred on average once every three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

3.1.5.3 Geographic and Seasonal Distribution

Atlantic walrus are associated with moving pack ice over shallow waters of the Arctic coast for much of the year (McLaren and Davis 1982; King 1983). When ice is lacking in summer and fall, walrus tend to congregate and haul out on land sites situated on low, rocky shores with steep or shelving subtidal zones where they have easy access to the water (Mansfield 1959; Salter 1979; Miller and Boness 1983). As walrus are primarily benthic feeders, they are generally confined to shallow coastal waters 80 to 100 m deep (Vibe 1950; Outridge et al. 2003; NAMMCO 2005, 2006). However, they may also use sea ice to access shallow waters far from shore.

The Baffin Bay (High Arctic) population of Atlantic walrus is known to inhabit northwest Baffin Bay from Pond Inlet north to Kane Basin, and extends into Lancaster Sound, Barrow Strait, and Jones Sound in the Canadian Arctic archipelago (Vibe 1967; Davis et al. 1978; DFO 2002; COSEWIC 2006b). This is consistent with IQ that indicates that small numbers of walrus occur near the mouth of Navy Board Inlet and in Lancaster Sound to the west of Admiralty Inlet (DEIS 2010). The population's distribution along the west coast of Greenland extends south to the Sisimiut Region at ~67ºN (Richard and Campbell 1988; Born et al. 1995; COSEWIC 2006b). Atlantic walrus migrate south as the sea ice advances in fall and north as it recedes in spring (Fay 1981). They tend to winter in the offshore pack ice of Davis Strait and along the west Greenland coast between 66 to 69ºN (Vibe 1967; Davis et al. 1980; APP 1982; McLaren and Davis 1982), the North Water Polynya and the polynya off eastern Devon Island, northern Labrador (Loughrey 1959; Boles et al. 1980), and also in Foxe Basin ranging from the floe edge along the north side of Rowley Island to about 67.5ºN, parallel to the Melville Peninsula (COSEWIC 2006b).

In May and June, walrus begin to migrate to summering areas in the Canadian Arctic archipelago (Davis et al. 1978), the east coast of Baffin Island from Cape Dyer north to ~67ºN (Mallory and Fontaine 2004), Cumberland Sound (Haller et al. 1967; Mallory and Fontaine 2004), the coast of Hall Peninsula (Meldrum 1975; MMI 1979), and along the west coast of Greenland around Disko Island and the Thule District (Mansfield 1973). By late July to early August, most walrus have arrived at their summering areas (Gunn 1949; Lawrie 1950; Finley et al. 1974).



LEGEND

- TERRITORY CAPITAL
- COMMUNITY
- MILNE PORT
- MINE SITE
- SHIPPING ROUTE (APPROXIMATE)
- MILNE INLET TOTE ROAD
- NORTHERN SHIPPING ROUTE REGIONAL STUDY AREA
- NUNAVUT SETTLEMENT BOUNDARY
- ISLAND WITH LARGEST KNOWN HAUL-OUT SITE
- STOCK DISTRIBUTION
- SUMMER CONCENTRATION
- YEAR ROUND CONCENTRATION

0 200 400

1:6,500,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. COUNTRY BASE DATA © ESRI AND ITS LICENSORS. USED UNDER LICENSE, ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012
PROJECTION: CANADA ALBERS EQUAL AREA CONIC DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
DISTRIBUTION OF PUTATIVE WALRUS STOCKS: BAFFIN BAY (HIGH ARCTIC) (1), FOXE BASIN (2), NORTHERN HUDSON BAY DAVIS STRAIT (3), AND SOUTH AND EAST HUDSON BAY (4)

CONSULTANT

GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	3.5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

PATH: I:\2016\1663724\Mapping\MXD\Wildlife\3000_304_MarineMammalBaselineReport\1663724_3000_304_MMBaseline_Fig3-5_Walrus_Rev0.mxd PRINTED ON: 2018-06-22 AT: 3:30:24 PM

3.1.6 Bearded Seal (*Erignathus barbatus*)

3.1.6.1 Population Status and Abundance

The bearded seal (*Erignathus barbatus*) has a patchy circumpolar distribution ranging as far north as 85ºN (Burns 1981). In April 1994, the bearded seal was designated by COSEWIC as Not at Risk and in April 2007 the species was re-assessed and placed in the Data Deficient category. The global bearded seal population is estimated to be >500,000 (Riedman 1990). Discrete populations of bearded seals have not been delineated in Canadian waters, but strong site fidelity to breeding sites is thought to occur (Cleator et al. 1989). Davis et al. (2008) reported overall limited gene flow among bearded seal populations in the Atlantic, although no significant differentiation was found between walrus sampled in Qaanaaq and the Labrador Sea. Though there is no reliable abundance estimate for bearded seals in Canadian waters, Cleator (1996) suggested an estimate of >190,000.

Limited IQ has been collected regarding the overall abundance of bearded seals, but some Elders in the Baffin region have observed a decrease in bearded seal abundance since the advent of firearms and motorized transportation (DEIS 2010). In contrast, one Elder noted that bearded seals were rare near Pond Inlet in the past, but are now more frequently observed. Hunters from Cape Dorset also suggested an increase in the abundance of bearded seals (DEIS 2010).

3.1.6.2 General Biology

The preferred habitat of bearded seals is in areas where the sea ice shifts and is thinned, or is kept open by strong currents (Kingsley and Stirling 1991). Bearded seals are benthic feeders and generally live in areas where the water depth is <200 m so that they can easily reach the sea bottom (Burns and Frost 1979). A diet study of 13 bearded seals captured around Pond inlet found that sculpins were the most common prey items, contained in 49% of all stomachs sampled and accounting for 81% of food consumed (Finley and Evans 1983). Other fish including polar cod, Arctic cod, eelpouts, and lumpfish were also commonly consumed by bearded seals in this study, as well as snails (*Buccinum* spp.), shrimp (Crangonidae), and cephalopods (*Bathypolypus arcticus, Gonatus* sp.). Invertebrates that made up a smaller proportion of the diet included other shrimp (Hippolytidae), clams, anemones, sea cucumber, and polychaetes (Finley and Evans 1983). Squids were primarily represented by indigestible parts such as beaks, rather than soft tissue, suggesting that this may not have been recent consumption.

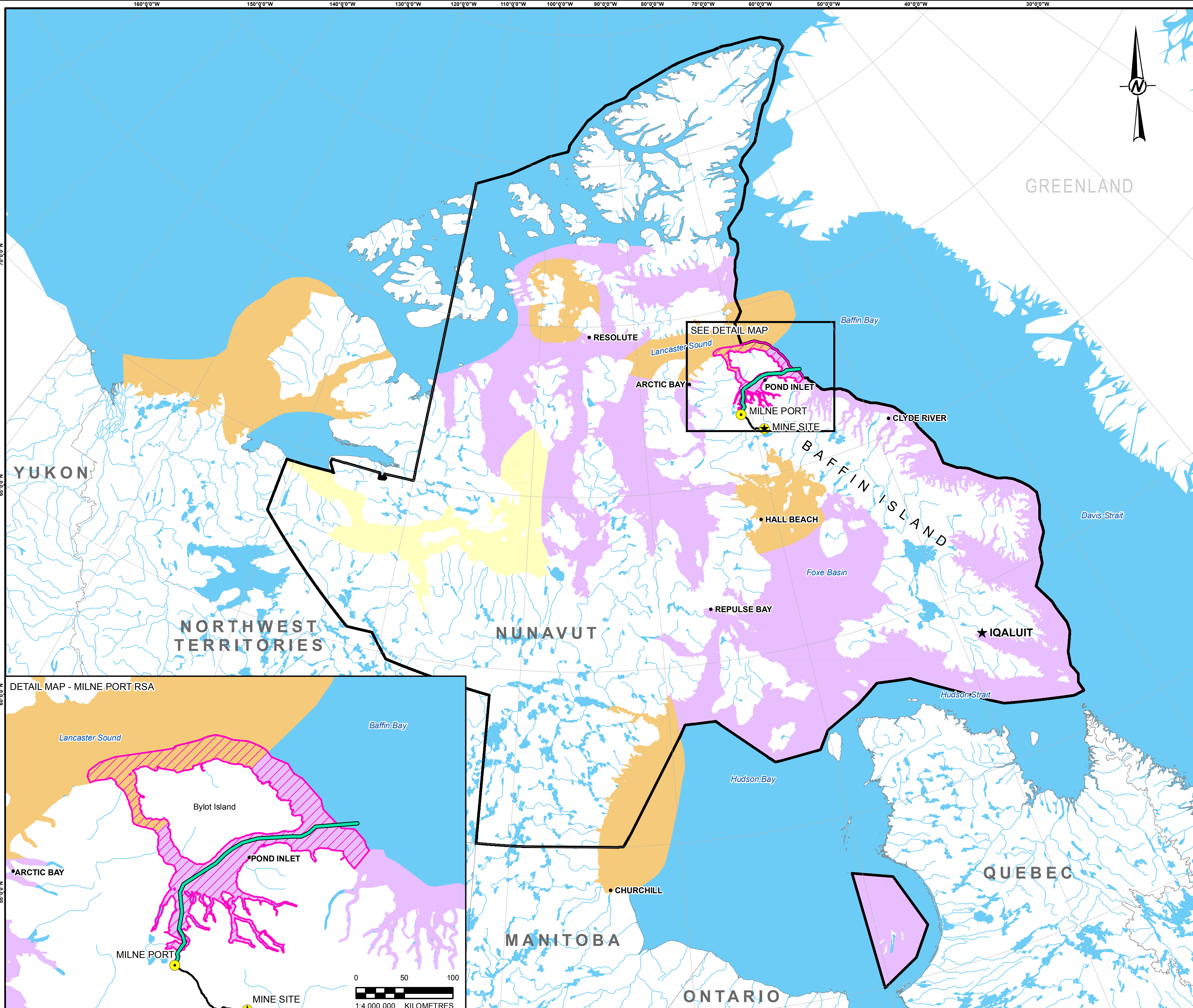
Bearded seals are largely solitary animals but may occur in small groups in late spring and early summer during the breeding and molting periods (Kovacs et al. 2011). Bearded seals are highly vocal, and males use underwater vocalizations to establish breeding territories and advertise breeding condition (Stirling et al. 1983; Cleator et al. 1989). Peaks in calling occur in spring during the mating period, and calls generally cease in late June-early July until vocal activitiy increases again with the formation of pack ice in winter (Frouin-Mouy et al. 2016). Specific call types increase in proportion and duration during the mating period, suggesting that males advertise their breeding condition by producing longer trills (Frouin-Mouy et al. 2016). Mating is believed to occur in the pack ice and not on fast ice (DEIS 2010). Although bearded seals do not develop haul-out or birth lairs like those of ringed seals and are less capable of maintaining breathing holes in solid ice, they are able to maintain breathing holes under snow drifts in fast ice (Stirling 1977). Pups are born on the moving pack ice between late April and early May, usually along the floe edge over areas of shallow water, and tend to remain on the exposed ice. Pups are typically weaned after 12 to 18 days.

Bearded seals begin shedding their winter coats in spring, and haul out on the sea ice to bask during this period and into the summer (Kingsley and Stirling 1991). When hauling out, bearded seals usually turn to face the water at the edges of wide leads or on the points of small floes, in order to gain a good field of view of predators and a choice of escape directions (Kingsley and Stirling 1991). Bearded seals are preyed upon by polar bears and often have scars attributed to escapes, or to intraspecific fights. Breathing holes that are maintained by bearded seals have a large diameter (54-66 cm) and do not exclude polar bears from entering (Kingsley and Stirling 1991). Polar bears may also follow bearded seals into the water.

3.1.6.3 Geographic and Seasonal Distribution

The distribution of bearded seals is largely determined by the presence of shallow water and distribution of ice (Burns 1981; Finley and Evans 1983; Kingsley 1986; Harwood et al. 2005; Kovacs et al. 2011). Bearded seals generally move into inlets and bays <200 m deep in order to feed during open-water periods, and return to areas offshore of the floe edge in the fall once landfast ice has formed (Burns and Frost 1979). They are rarely found in fast ice areas, but and are widely dispersed in open-water areas of pack ice where leads and cracks are frequent and where ice pans are sufficient for haul-out sites (McLaren and Davis 1982). While bearded seals are excluded from large areas of the High Arctic Archipelago by fast ice for much of the year, they are widely distributed (though in small numbers) through this area during the summer (Finley and Evans 1983; Kovacs et al. 2011).

Large numbers of bearded seals occur around northeastern Baffin Island and in Lancaster Sound (Cleator 1996; Kovacs 2002). In the north Baffin region, bearded seals are abundant throughout Admiralty Inlet and along the northwest coast of Baffin Island. This is consistent with IQ reports indicating that bearded seals inhabit inlets and nearshore areas along the floe edge in the region. Pupping is also known to occur throughout the region, as well as along the northern coast of Bylot Island (DEIS 2010). Bearded seals have a strong affinity for ice, generally preferring to haul out on moving multi-year ice rather than moving inland to haul out on beaches or shoals. Coastal movements also occur throughout the open-water period, as reported by Inuit in Cape Dorset and Kimmirut, wherein westward movements through Hudson Strait take place during spring and eastward movements take place during fall.



LEGEND

- ★ TERRITORY CAPITAL
- • COMMUNITY
- MILNE PORT
- MINE SITE
- SHIPPING ROUTE (APPROXIMATE)
- MILNE INLET TOTE ROAD
- NORTHERN SHIPPING ROUTE REGIONAL STUDY AREA
- NUNAVUT SETTLEMENT BOUNDARY
- HIGH OR LIKELY HIGH DENSITY
- KNOWN RANGE
- LIKELY RANGE

0 400 800
1:12,500,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. COUNTRY BASE DATA © ESRI AND ITS LICENSORS. USED UNDER LICENSE, ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012
PROJECTION: CANADA ALBERS EQUAL AREA CONIC DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
DISTRIBUTION AND RELATIVE DENSITY OF BEARDED SEAL IN NUNAVUT

CONSULTANT

GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	3.6

3.1.7 Ringed Seal (*Pusa hispida*)

3.1.7.1 Population Status and Abundance

Ringed seals (*Pusa hispida*) occur throughout most of the Arctic and are year-round residents in the regions around Baffin Island. The population of ringed seals in the Canadian Arctic is estimated to be at least a few million (Stirling and Calvert 1979, Reeves 1998, NAMMCO 2010b) and was considered Not At Risk by COSEWIC in April 1989.

3.1.7.2 General Biology

The life history of ringed seal is strongly dependent on ice dynamics. Ringed seals haul out on sea ice to moult, rest, breed and give birth and rarely, if ever, haul out on land (Stirling 1977). They prefer to breed on landfast ice (McLaren 1958; Kelly 1988) but will also breed in pack ice (Finley et al. 1983; Kelly 1988; Koski and Davis 1979; McLaren and Davis 1982). The main adaptation of ringed seals for occupying ice-covered areas is the ability to use the claws of the foreflippers to maintain breathing holes (Smith and Stirling 1975).

From summer to early spring, ringed seals spend most of the time in the water feeding (Mansfield 1970). Ringed seals are omnivorous, with their diet consisting primarily of fish such as Arctic cod, as well as capelin, sand lance, sculpin, clams, mussels, and herbivorous and carnivorous invertebrates (mysids, euphausiids, amphipods, decapods) (Yurkowski et al. 2016). In offshore areas, ringed seals may feed extensively on zooplankton (Stirling 1977). There is a modest ontogenetic diet shift such that adults consume more fish (~80% of diet) than juveniles (~60% of diet) (Yurkowski et al. 2016). The major prey are ice-associated, and low ice years may result in low body condition indices for female ringed seals, with ovulation rates as low as 50% of the norm in extreme low ice years (Harwood et al. 2000). Ringed seals on the west coast of Svalbard have not had sufficient ice for normal breeding since 2005 (Kovacs et al. 2011).

Ringed seal pupping begins in April with the majority of pups being born in May in snow dens that the female excavates on the ice (Stirling 1977). Wind and ice pressure create pressure ridges and ice hummocks in certain areas, forming cracks associated with pressured ice which are used as breathing holes. As the ice solidifies, the seals keep breathing holes open by abrading ice with the claws of the fore-flippers. Breathing holes are then maintained overwinter, often in ice >2 m in thickness (Smith and Stirling 1975). Breathing holes where little snow accumulates appear at the surface as very small ice domes approximately 4 cm high and 15-25 cm in diameter with a hole of about 1 cm diameter at the apex if the hole is being used actively (Smith and Stirling 1975). Up to four ringed seals may be observed below a breathing hole. In areas where snow forms, subnivean lairs are formed, and it is common to find lairs in almost every sizeable drift in the area (Smith and Stirling 1975). Smith and Stirling (1975) differentiated two kinds of lairs: haul-out lairs (a single chamber, of a round or elongate shape) and birth lairs (a larger chamber probably originating as a haulout lair, but with an extensive series of tunnels thought to be dug by the pup). Occasionally a very large lair, 6 m x 3 m, was located and seemed to be used by many seals for hauling out. The Inuit also differentiate suckling (a large haulout lair enlarged by the female) and escape / learning (a small lair near the birth lair for the young pup to swim to and from) lairs within the haul-out category.

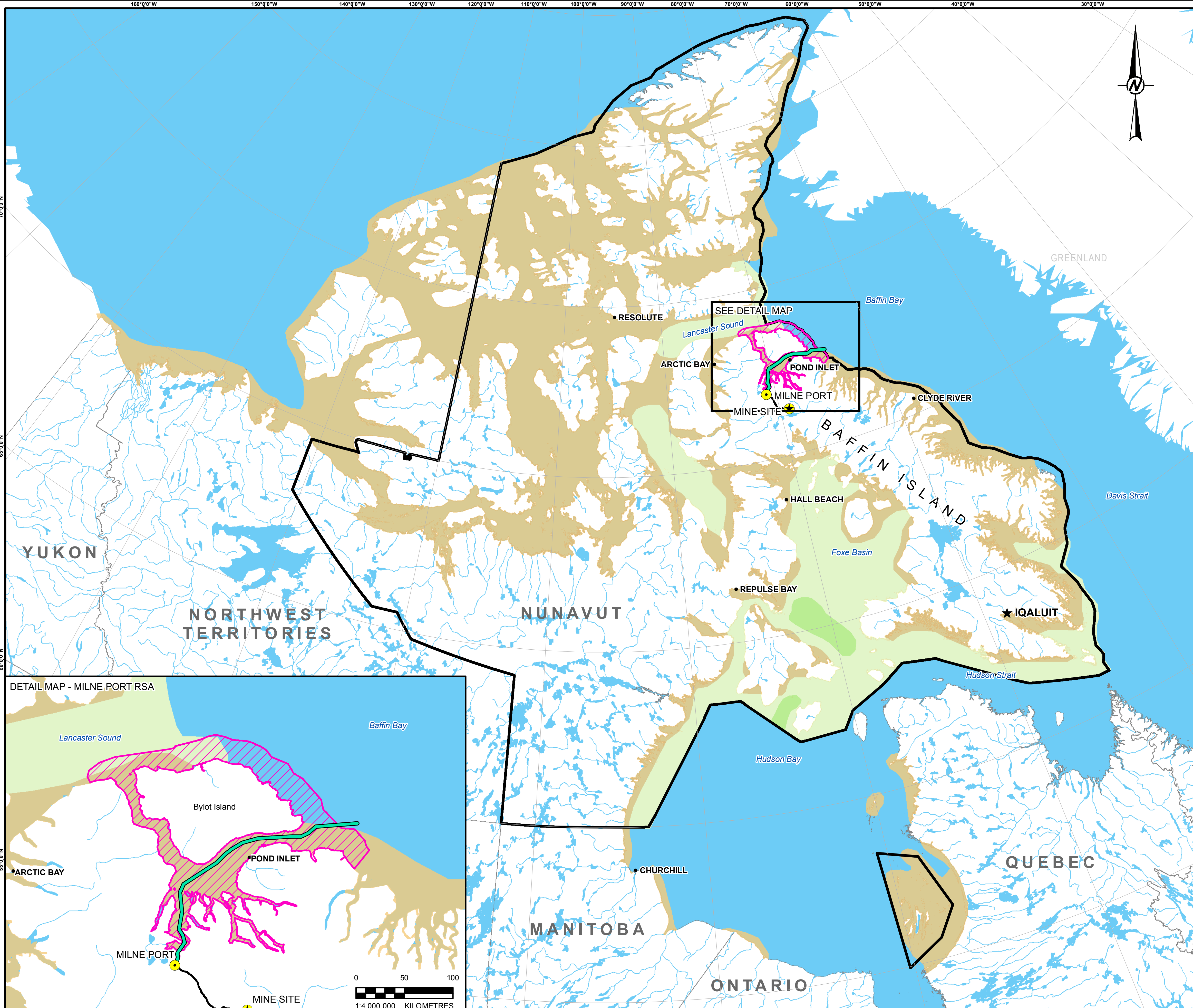
IQ suggests that ringed seal dens will not be constructed on moving pack ice in areas of strong ocean currents because the ice will pile up on itself, crushing the dens (Baffinland 2010). This agrees with observations of McLaren (1958) that breeding in fast ice allows a longer weaning period due to the stability of habitat. In pack ice there is a risk of ice breaking up prematurely, leading to pup mortality as a result of being crushed in moving ice, exposure to predators, and separation from the mother during periods of her absence. Most denning in the north Baffin region is thought to occur in areas of fast ice such as Eclipse Sound or Admiralty Inlet (Baffinland 2010). Pregnant ringed seals frequently occur in close proximity to dens excavated in areas of fast ice.

Pups are about 4.5-4.9 kg in weight at birth (Smith and Stirling 1975; Stirling 1977) and nurse for 38 to 44 days (i.e. the longest suckling period of any seal) before being weaned prior to ice break-up in June (McLaren 1958; Smith and Stirling 1975; Smith et al. 1991). Newborn pups do not have a layer of blubber to protect them from the cold but rely on their white fur, high metabolic rates, and the birth lair for protection from the elements. Pups are subject to intense predation by foxes and polar bears (Smith 1976; Kingsley 1990; Pilford et al. 2014) and will enter the water to escape predation but must return to the birth lair to prevent hypothermia (Smith et al. 1991). In some areas, mortality from fox predation can be as high as 40% (Smith 1976). Lack of snow build up on the ice in autumn, or warm spring temperatures and rain can lead to reproductive failure of ringed seals due to high predation (Smith and Harwood 2001; Stirling and Smith 2004). For these reasons, about half of the pre-weaning time of ringed seal pups is spent in the water and the remainder in the lair (Ferguson et al. 2005).

3.1.7.3 Geographic and Seasonal Distribution

Ringed Seals are common throughout Baffin Bay (McLaren and Davis 1982) and West Greenland (Vibe 1950; McLaren and Davis 1982) and large concentrations of ringed seals hauled out on ice have been observed throughout Eclipse Sound (Baffinland 2010). In general, ringed seals are abundant in the LSA and the broader RSA. Waters inland of Bylot Island provide important habitat during winter for pupping, mating, and moulting (Beckett et al. 2008). IQ indicates that ringed seals are distributed throughout the pack ice as well as fast ice areas and frequent polynyas, but are not dependent on them because they are able to maintain breathing holes in the ice.

Ringed seals are considered non-migratory although seasonal shifts in distribution likely do occur (Stirling 1977; Smith 1987; Heide-Jørgenson et al. 1992; Teilmann et al. 1999; Harwood and Smith 2003). IQ also suggests that ringed seals may make seasonal movements, usually in response to changes in distribution of sea ice (Baffinland 2010). During winter and early spring, ringed seals concentrate on stable landfast ice and then move into offshore areas in the spring and early summer as the ice breaks up, returning again in the fall to bays and inlets as new ice forms. In areas where landfast ice is limited, such as Baffin Bay, numbers of seals occupying the offshore pack ice may, however, exceed those on landfast ice (Burns 1970; Stirling et al. 1982; Finley et al. 1983). As ice breaks up during summer, ringed seals disperse as solitary animals or small groups throughout open-water areas (Moulton and Lawson 2002; Williams et al. 2004) or to coastal areas (MacLaren 1958; Smith 1973, 1987; McLaren and Davis 1982; Harwood and Stirling 1992). Satellite telemetry has shown that there is some movement by seals between the Thule area of west Greenland and Lancaster Sound, but the extent to which this occurs is not known (Born et al. 2002).



LEGEND

- TERRITORY CAPITAL
- COMMUNITY
- MILNE PORT
- MINE SITE
- SHIPPING ROUTE (APPROXIMATE)
- MILNE INLET TOTE ROAD
- NORTHERN SHIPPING ROUTE REGIONAL STUDY AREA
- NUNAVUT SETTLEMENT BOUNDARY
- LIKELY ABUNDANT
- KNOWN OR EXPECTED RANGE
- COMMON IN WINTER

0 250 500
1:12,500,000 KILOMETRES

REFERENCE(S)

MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. COUNTRY BASE DATA © ESRI AND ITS LICENSORS. USED UNDER LICENSE, ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012
PROJECTION: CANADA ALBERS EQUAL AREA CONIC DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
DISTRIBUTION AND RELATIVE DENSITY OF RINGED SEAL IN NUNAVUT

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	3.7

3.1.8 Harp Seal (*Pagophilus groenlandicus*)

3.1.8.1 Population Status and Abundance

Harp seals (*Pagophilus groenlandicus*) occur in the northern Atlantic and Arctic oceans below 84ºN (Ronald and Healy 1981; Riedman 1990). The conservation status of harp seals has not yet been classified by COSEWIC. Three geographically distinct populations occur in the North Atlantic Basin (McLaren and Davis 1982), of which none have had their conservation status classified by COSEWIC. Of the three populations, only the Northwest Atlantic population occurs in the RSA, though in low abundance compared to other seal species in the region, with little IQ available (Baffinland 2010; Jason Prno Consulting 2017). The Northwest Atlantic harp seal population is the largest population, located primarily off Newfoundland and Labrador and in the Gulf of St. Lawrence, including a total of ~5.9 million animals (SE ± 747,000) with an annual production of 991,400 pups (SE ± 58,200; ICES 2005). This population spends the summer off west Greenland and in the Canadian Arctic (NAMMCO 2001).

3.1.8.2 General Biology

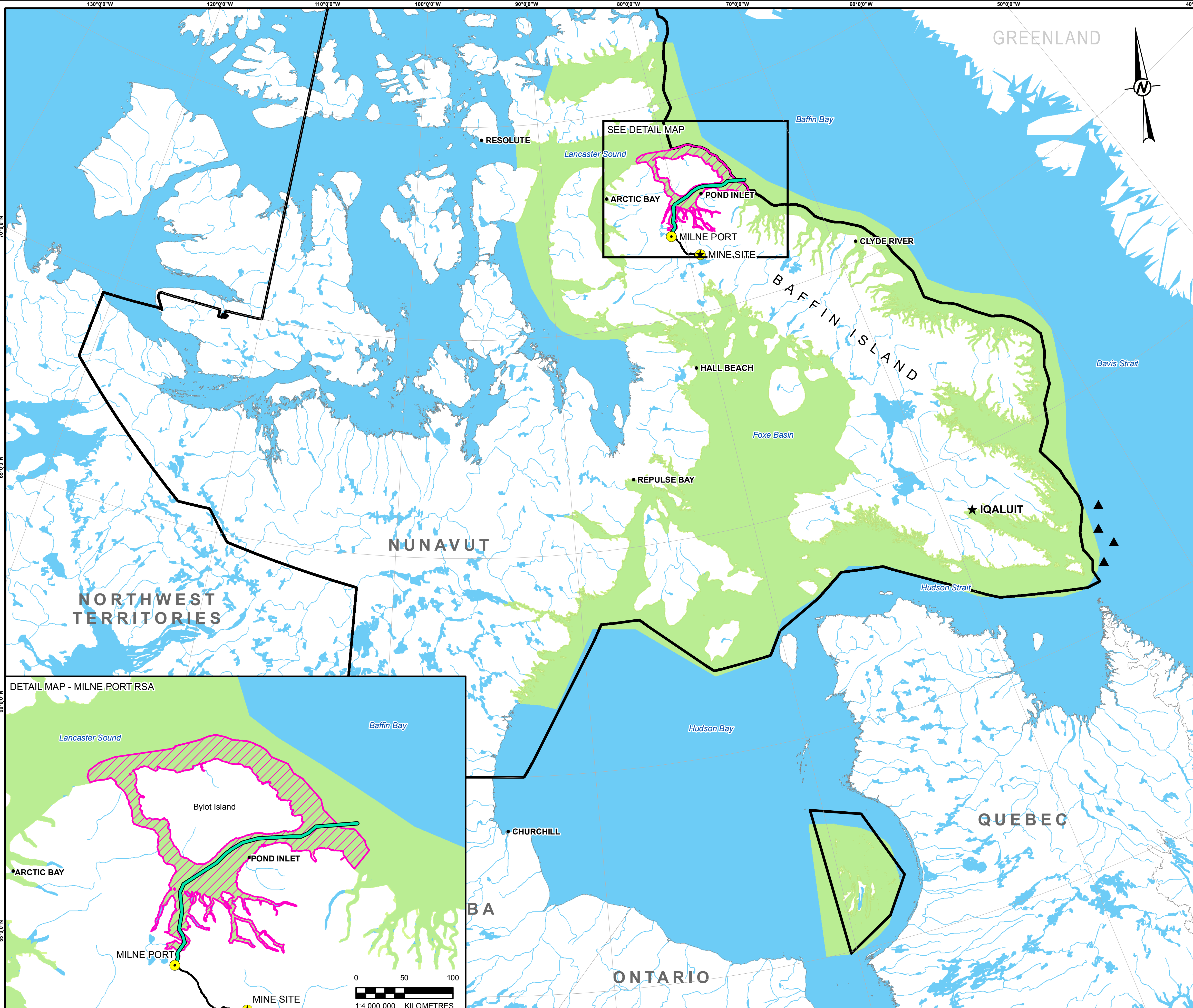
Harp seals are known to migrate to coastal areas and fiords in the open-water season to exploit the same prey as ringed seals (Born et al. 2004). Harp seals consume a broad range of foods, including a variety of small fishes and invertebrates. They favour lipid-rich schooling fishes such as polar cod, Arctic cod and capelin (Kovacs et al. 2011). Harp seals dive for an average of 16 minutes (Jefferson et al. 2008) and, whereas most foraging dives occur at depths of 90 m or less (Reeves et al. 2002), dives have been recorded to a maximum depth of 370 m (Jefferson et al. 2008). Although harp seals normally haul out only on ice, they can spend long periods pelagically in areas without ice.

Pack ice must be available, however, in late winter and early spring for pupping in regions where food will subsequently be available for the weaned young (Kovacs et al. 2011). Harp seal whelping occurs from late February to mid-March (Jefferson et al. 2008), on the local first-year ice or landfast ice (APP 1982), and lactation lasts ~12 days (Kovacs and Lavigne 1986; Lydersen and Kovacs 1996; Oftedal et al. 1996). Females remain with their young for the first two to three weeks of life, until they are able to swim (Kovacs and Lavigne 1986). Breeding then takes place on pack ice, but in areas south of the RSA, in late March or early April after pups have weaned and before the moult in April and May (King 1983).

3.1.8.3 Geographic and Seasonal Distribution

Harp seals are seasonal visitors to the Arctic, arriving along the southwest coast of Greenland in late May and June (APP 1982) and then entering Lancaster Sound in July and August (Johnson et al. 1976; Greendale and Brousseau-Greendale 1976; APP 1982). In arriving here, harp seals use migration routes along the fast-ice edge off east Baffin Island (Koski and Davis 1979) or across Baffin Bay from Greenland (Degerbøl and Freuchen 1935; Sergeant 1965). Most young-of-the-year and subadults spend the summer in inshore areas between Disko Bay and Upernavik (Sergeant 1976a), whereas adults generally continue up the west Greenland coast, reaching as far north as the Qaanaaq area in June and July (Vibe 1950; Sergeant 1965; APP 1982). Harp seals tend to enter Pond Inlet and Navy board Inlet at the end of July (Miller 1955) and then concentrate at the mouth of Navy Board Inlet and occasionally in Eclipse Sound throughout August and September (Miller 1955; Beckett et al. 2008). The number of adult harp seals entering Lancaster and Eclipse Sound varies annually (Greendale and Brousseau-Greendale 1976; Johnson et al. 1976; Riewe 1977, APP 1982). For example, one study by Tuck (1957) estimated that 150,000 harp seals moved west past Cape Hay, Bylot Island, in late June to August 1957, but Greendale and Brousseau-Greendale (1976) counted only 16,000 passing the same area in mid-June to July 1976.

Harp seals generally exit Lancaster Sound in September, proceeding along the north coasts of Devon and Ellesmere islands, and then either across Smith Sound to Greenland, or along the east coast of Baffin Island (Koski and Davis 1979, 1980; APP 1982). By October, most harp seals have left the Canadian High Arctic and Greenland waters, although small numbers may remain near the southwest Greenland coast until March (Anderson 1934; Sergeant 1965; Evans 1968; APP 1982; McLaren and Davis 1982). In January, most adults arrive to their wintering areas south of the RSA and can be present as far north as the pack ice edge in southwest Davis Strait (approximately 54ºN) (MAL 1977; APP 1982). In these northern waters, harp seals whelp over several hundred square kilometres throughout the pack ice (Bergflødt 1977; APP 1982; McLaren and Davis 1982). Some individual harp seals have been reported to occur throughout the edge of the pack ice north to ~63ºN in February and March (MAL 1977; MMI 1979; McLaren and Davis 1982).



LEGEND

- TERRITORY CAPITAL
- COMMUNITY
- MILNE PORT
- MINE SITE
- WHELPING AREA
- SHIPPING ROUTE (APPROXIMATE)
- MILNE INLET TOTE ROAD
- NORTHERN SHIPPING ROUTE REGIONAL STUDY AREA
- NUNAVUT SETTLEMENT BOUNDARY
- KNOWN SUMMER RANGE

0 250 500
1:10,000,000 KILOMETRES

REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. COUNTRY BASE DATA © ESRI AND ITS LICENSORS. USED UNDER LICENSE, ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012
PROJECTION: CANADA ALBERS EQUAL AREA CONIC DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
SEASONAL DISTRIBUTION OF HARP SEALS IN NUNAVUT

CONSULTANT

GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
1663724	3000-304	0	3.8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm 0

3.1.9 Hooded Seal (*Cystophora cristata*)

3.1.9.1 Population Status and Abundance

The hooded seal (*Cystophora cristata*) is limited to Arctic and subarctic North Atlantic Ocean waters, usually south of 85ºN (Reeves and Ling 1981), and was designated as Not At Risk by COSEWIC in April 1986. The global hooded seal population is estimated at 592,000 individuals and has been divided by ICES into three individual stocks, each associated with a specific breeding site (Kovacs and Lavigne 1986; ICES 2006). These include the Greenland Sea stock, the White Sea stock, and the Western North Atlantic stock. Only the Western North Atlantic stock is known to whelp off the coast of eastern Canada, although not within the RSA. Within the Western North Atlantic stock, there are three known whelping areas including the Gulf of St. Lawrence, the coast of Newfoundland and Labrador, and Davis Strait (Folkow and Blix 1995). The most northerly whelping area is located between 62ºN and 64ºN in Davis Strait along the eastern border of the pack ice and varies annually with the position of the ice (APP 1982). The total population size of this whelping area is estimated at 34,000 to 42,000 (MMI 1979), with a breeding population of ~20,000 to 30,000, including 10,000 to 20,000 whelping adults (APP 1982).

3.1.9.2 General Biology

Hooded seals are solitary animals, typically found drifting in offshore pack ice ranging from 25 to 99% ice cover (McLaren and Davis 1982). Although hooded seals normally haul out only on ice, they can spend long periods pelagically when no ice is available (Kovacs et al. 2011) and typically dive to depths of 100 to 600 m for 5 to 15 minutes to forage (Folkow and Blix 1995; Folkow et al. 1996). The diet of the hooded seal is quite broad, preying primarily on lipid-rich schooling fishes such as polar cod, Arctic cod and capelin, but also on larger prey such as Greenland halibut, redfish and cephalopods (Haug et al. 2007 cited in Kovacs et al. 2011).

Females are known to gather in the spring at their usual breeding ground on pack ice where they stay for 2-3 weeks and produce offspring (Bergflødt 1977; Thompson et al. 1998). Once born, pups are quickly weaned with lactation lasting only 3 to 5 days (Atkinson 1997). Mating of hooded seals usually takes place on heavy, large floes of pack ice in March, after pups have weaned and before the moult in April (King 1983; Kovacs et al. 2011).

3.1.9.3 Geographic and Seasonal Distribution

Hooded seals are a highly migratory species that tend to occur further offshore than harp seals. In late February and March, hooded seals begin to assemble for whelping, followed by breeding, at their respective whelping areas (APP 1982). By early April, they then begin their northward migration toward Davis Strait and the coastal waters of southwest and central Greenland (Rasmussen 1960; Mansfield 1967; Kapel 1975; cf. Sergeant 1976b; APP 1982; McLaren and Davis 1982). Some animals remain off southern and southwestern Greenland during the moulting period (Rasmussen 1960; Kapel 1975; APP 1982), whereas others proceed to Denmark Strait, or move across Baffin Bay. Hooded seals are rarely found north of northwest Greenland (Vibe 1950; APP 1982).

The route of the northward migration of hooded seals is poorly known, but it is believed that they follow the edge of the offshore pack ice (IOL et al. 1978; APP 1982), along the eastern side of Baffin Island through Davis Strait (APP 1982). Small numbers of hooded seals appear in Lancaster Sound and northwest Baffin Bay during July and August and they are occasionally sighted along the northeast coast of Bylot Island during the fall. Hooded seals are rare in Eclipse Sound (Koski and Davis 1979) and generally remain in northwest Baffin Bay until

October (Koski and Davis 1979; Koski 1980). The southward migration has been observed in late September and is presumed to retrace the routes used during the northward movement (Mansfield 1967). Occasional hooded seals have been observed in eastern Lancaster Sound during early winter (Rasmussen 1960; Johnson et al. 1976).

3.1.10 Polar Bear (*Ursus maritimus*)

3.1.10.1 Population Status and Abundance

The polar bear (*Ursus maritimus*) has a circumpolar distribution throughout the northern hemisphere and occurs in relatively low densities throughout most ice-covered areas as far north as 88°N (DeMaster and Stirling 1981; Durner and Amstrup 1995). The southern limit of its distribution varies annually depending on the distribution of the seasonal pack ice during winter (Stirling 1988). The polar bear is the only marine mammal in the RSA to be listed as a Schedule 1 species under SARA, officially designated a species of Special Concern in April 1991 and then confirmed in April 1999, November 2002, and again in April 2008 (COSEWIC 2008b). COSEWIC had originally classified the polar bear as Not at Risk in April 1986. The global polar bear population is estimated at 22,000 to 25,000, of which at least 15,500 are in Canada or in subpopulations shared with Canada (COSEWIC 2008b).

COSEWIC assesses the polar bear as a single unit, but abundance and trends appear to vary substantially between subpopulations defined both globally and within Canada, with declines attributable to overharvesting and climate change. Globally, 19 polar bear subpopulation or management units have been defined, of which 14 fall within Canadian territory and two, the Baffin Bay and Lancaster Sound subpopulations, overlap with the RSA (Figure 3.9). Mark-recapture analysis of the Baffin Bay subpopulation from 1994 to 1997 estimated the abundance at 2,074 ± 266, including 1,017 ±192 females and 1057 ± 124 males (Taylor et al. 2005). Mark-recapture analysis of the Lancaster Sound subpopulation based on data from 1995 to 1997 estimated the abundance at 2,541 ± 391 (Taylor et al. 2008).

Although the trend in abundance is not certain, the potential effects on polar bear populations of increased length of the open-water season throughout the Arctic is of concern (COSEWIC 2008b). In addition, COSEWIC (2008b) expressed concern that hunting levels may continue to deplete polar bear abundance. By contrast, IQ collected in the north Baffin region suggests that most Inuit agree that the number of polar bears has increased since the 1960’s (Baffinland 2010). In the past, polar bears were found only by the floe edge, but now tend to be more widely dispersed and frequently enter Inuit camps and communities. According to IQ, this apparent increase in number of polar bears is attributed to a decrease in multi-year ice and a decreased fear of humans and dogs. Most Elders also believe that polar bear numbers have increased as a result of government-imposed hunting quotas. One Elder suggested that it is the female bear population that is increasing as regulations only permit the hunting of male polar bears.

3.1.10.2 General Biology

Polar bears are apex predators in the Arctic (Thiemann et al. 2008). They feed primarily on ringed seals (Stirling and Archibald 1977) but also on bearded seals, harp seals, walrus, Arctic cod, geese and their eggs, caribou, and other marine mammals (Stirling and McEwan 1975; Stirling and Archibald 1977; Smith 1980, 1985; Calvert and Stirling 1990; Jefferson et al. 1993; Smith and Hill 1996; Derocher et al. 2000). In the eastern Arctic, bearded seals and harp seals are a dominant food item though the latter are only available during the open water season (Ferguson et al. 2001; Thiemann et al. 2008). Adult male polar bears are twice the size of females, and the size of polar bears has an important effect on their diet. Larger and older males may feed on large bearded seals and walrus and have the highest diet diversity, while younger males and females focus on smaller species such as ringed and harp seals (Thiemann et al. 2008). Belugas are another important food source for polar bears in the High Arctic, whereas narwhals and walrus are rarely preyed upon (Thiemann et al. 2008).

Polar bears forage over thousands of kilometers and do not defend individual territories (Thiemann et al. 2008). Seasonal changes in sea ice influence the movements of polar bears as they rely heavily on seal availability throughout the year (Ferguson et al. 2001). The distribution and population size of polar bears may be regulated by the distribution and numbers of ringed seals specifically (Stirling and Øritsland 1995). Of note, polar bears prey heavily on newly weaned ringed seal pups, which have 40-50% body fat by wet mass (Thiemann et al. 2008). During spring in the Canadian High Arctic, an adult polar bear kills a ringed seal every 2-4 days, and in summer every 5 days (Kingsley and Stirling 1991). No live ringed seals with old scars from polar bear claws have ever been recorded, suggesting that none escape once contact is made. Bearded seals with scars, however, do exist and it is therefore thought that this species can escape (Kingsley and Stirling 1991). IQ describes how polar bears hunt seals usually along floe edges or cracks in the ice where the ice is rough and contains snow (Baffinland 2010). IQ also describes how polar bears are known to prey on walrus and whales, sometimes travelling back and forth along cracks in the ice waiting for whales to surface. Additionally, polar bears have been known to feed on eider ducks and their eggs, fish in riverine environments, and some types of vegetation (leaves, berries, seaweed), all which are consumed when food is scarce (Baffinland 2010). Before entering their dens, bears are believed to eat moss to block their bowels during hibernation.

In the spring during the seal pupping season, polar bears hunt for ringed seals in subnivean lairs and at breathing holes (Smith 1980). In the summer, when seals moult and juvenile seals are weaned, polar bear hunting success declines (Smith 1980) and by the late fall, pregnant females begin digging maternity dens in deep snow often on the south side of hills or cliffs. Male and non-pregnant female polar bears may also build more temporary shelter dens while awaiting the return of favorable foraging conditions (Ferguson et al. 2000; Ferguson et al. 2001; Baffinland 2010). Over most of their range, pregnant females den during the winter on land near the coast and, in some areas, on drifting pack ice (Ramsay and Stirling 1990; Stirling and Andriashek 1992; Amstrup and Gardner 1994, Richardson et al. 2005). Non-pregnant females, juveniles, and adult males remain active on the pack ice throughout the year, often moving considerable distances with the ice (Garner et al. 1994; Amstrup et al. 2000). Polar bears are generally less active during the winter in consolidated ice areas when prey are less accessible (Ferguson et al. 2001). For example, radiotelemetry of 160 adult females between 1989 and 1999 indicated that polar bears moved 11.8±0.6 km/d on average while on active ice and 7.9±1.1 km/d on consolidated ice (Ferguson et al. 2001). In this same study, polar bears were found to exhibit the greatest movements in the spring and summer when seals were most plentiful.

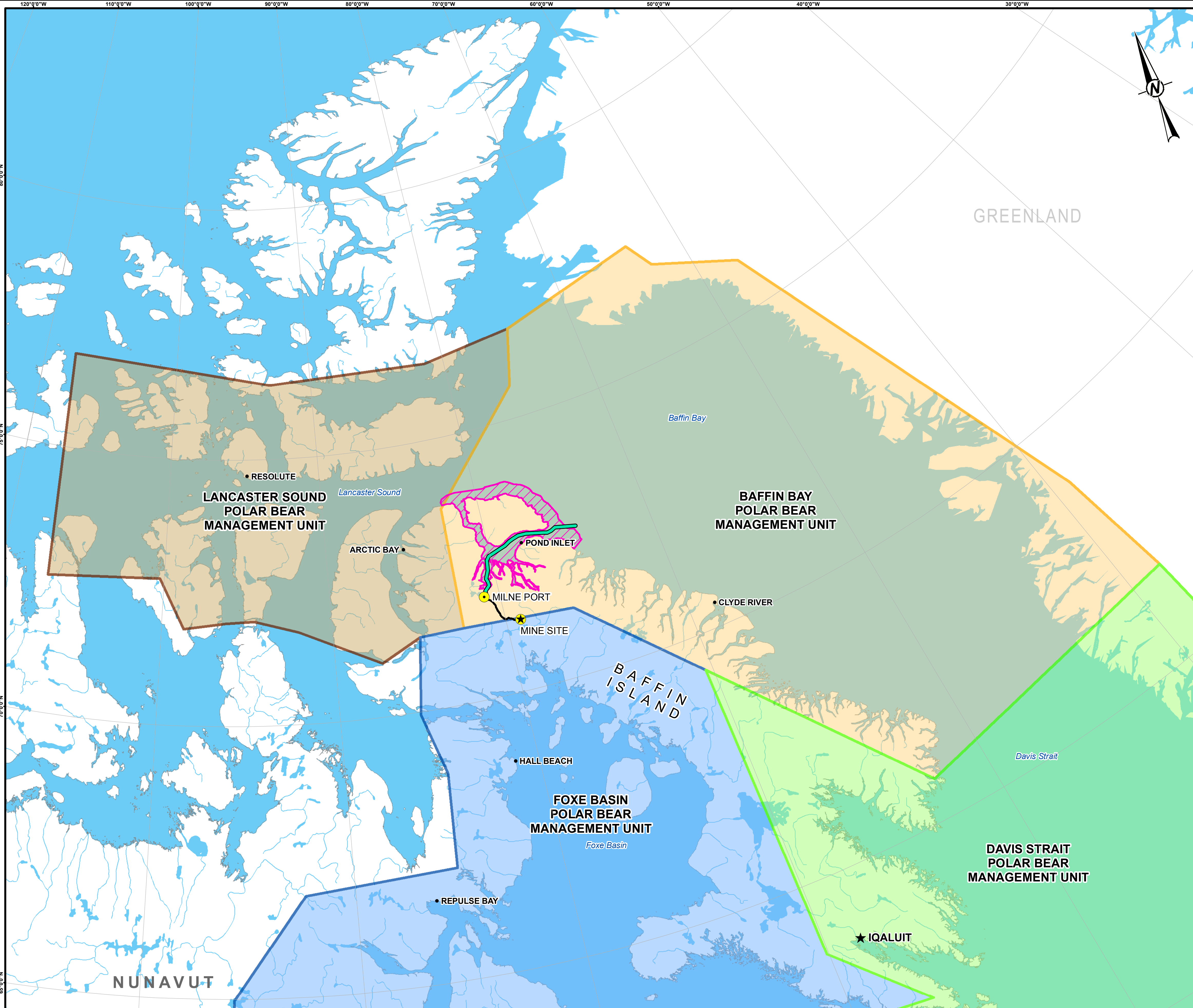
Mating between polar bears occurs from April to June, although implantation of the fertilized egg does not take place until October. The following December or January, the pregnant female will give birth in a maternity den (Harington 1968; Stirling and Andriashek 1992; Amstrup and Gardner 1994) to 1 to 3 cubs (mean 1.7; Stirling et al. 1975) at an average interval of 3 to 4 years (mean 3.6; Lentfer et al. 1980; Jefferson et al. 1993). The cubs are nursed inside the den until April, at which point they leave their dens with their mother, corresponding to the appearance of seal pups (COSEWIC 2008b; Baffinland 2012). Cubs remain with their mothers for 1.4 to 3.4 years (Stirling et al. 1975; Ramsay and Stirling 1988; Derocher et al. 1993).

In some areas, such as parts of the High Arctic and eastern Baffin Island, sea ice melts completely during summer and polar bears are forced ashore to wait until ice reforms in the fall (Schweinsburg and Lee 1982; Derocher and Stirling 1990; Ferguson et al. 1997; Lunn et al. 1997). As sea ice is the platform from which polar bears hunt ringed seals and bearded seals, large-scale changes in the ice regime attributable to climatic warming or other causes can reduce a polar bear's opportunity to access food and can have negative effects on individuals and populations (Stirling and Derocher 1993; Stirling et al. 1999).

3.1.10.3 Geographic and Seasonal Distribution

Polar bears are common in the RSA and throughout most of the Canadian Arctic archipelago. The seasonal extent of polar bears is largely determined by the distribution and extent of sea ice. The home range of polar bears tends to be smaller when living in areas of low food availability and larger when prey is readily available and the dispersion of food sources unpredictable (Ferguson et al. 1999, 2000). Polar bears occur throughout the Arctic basin, but tend to be more abundant along shore lead systems and polynyas during winter, where less-consolidated ice cover provides habitat for young ringed seals and other prey (Stirling and McEwan 1975; Stirling and Smith 1975; Smith 1980; Stirling et al. 1993; Stirling 1997; Amstrup et al. 2000). Tagged female polar bears have been observed to follow the seasonal changes in ice, in spring selecting landfast ice adjacent to areas where most seal pupping would occur (Ferguson et al. 2000).

Polar bears from the Baffin Bay population occupy drifting pack ice and landfast ice between Baffin Island and west Greenland during winter, but can be concentrated along the Lancaster Sound fast-ice edge (Koski 1980; Ferguson et al. 2000; Ferguson et al. 2001). Polar bears are also concentrated along landfast ice edges across Pond Inlet and Navy Board Inlet during spring. During the open-water period in September–October, polar bears are forced ashore by the absence of ice (Taylor and Lee 1995) and spend this period on Bylot and Baffin islands (Lunn et al. 2002). Denning activity by pregnant females is concentrated along the northern coast of Bylot Island and coastal Baffin Island in the vicinity of Pond, Admiralty, and Navy Board inlets (Baffinland 2010). Only males and subadults are found in offshore waters while females with young are rarely seen in the pack ice (APP 1982). Polar bears also frequent fast-ice edges in this area (APP 1982). Polar bears from the Lancaster Sound subpopulation tend to occupy the central and eastern part of their range during winter, but move westward during spring to summer on multi-year pack ice in eastern Viscount Melville Sound (Schweinsburg et al. 1982).



REFERENCE(S)
MILNE PORT INFRASTRUCTURE DATA BY HATCH, JANUARY 25, 2017, RETRIEVED FROM KNIGHT PIESOLD LTD. FULCRUM DATA MANAGEMENT SITE MAY 19, 2017. HYDROGRAPHY, POPULATED PLACE, AND PROVINCIAL BOUNDARY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. COUNTRY BASE DATA © ESRI AND ITS LICENSORS. USED UNDER LICENSE, ALL RIGHTS RESERVED. NUNAVUT SETTLEMENT AREA DATA OBTAINED FROM NUNAVUT TUNNGAVIK INC., OCTOBER 9, 2012
PROJECTION: CANADA ALBERS EQUAL AREA CONIC DATUM: NAD 83

CLIENT
BAFFINLAND IRON MINES CORPORATION

PROJECT
MARY RIVER PROJECT – PHASE 2 PROPOSAL

TITLE
GEOGRAPHIC RANGE OF POLAR BEAR POPULATIONS IN NUNAVUT

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-22
DESIGNED	AA
PREPARED	AA
REVIEWED	EG
APPROVED	PR

PROJECT NO.	CONTROL	REV.	FIGURE
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4.0 BASELINE STUDIES AND MONITORING PROGRAMS

Marine mammal baseline studies and environmental effects monitoring (EEM) programs developed for the Mary River Project were designed to address the following targeted research questions:

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?

The above questions served to formulate hypotheses for the development of the EEM programs. Results of the baseline and monitoring programs conducted to date are presented below, and have been organized according to the research questions to which they pertain.

4.1 Change in Marine Mammal Distribution and Abundance

Results presented in this section pertain to the following research question:

- **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 the following sub-component questions:

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

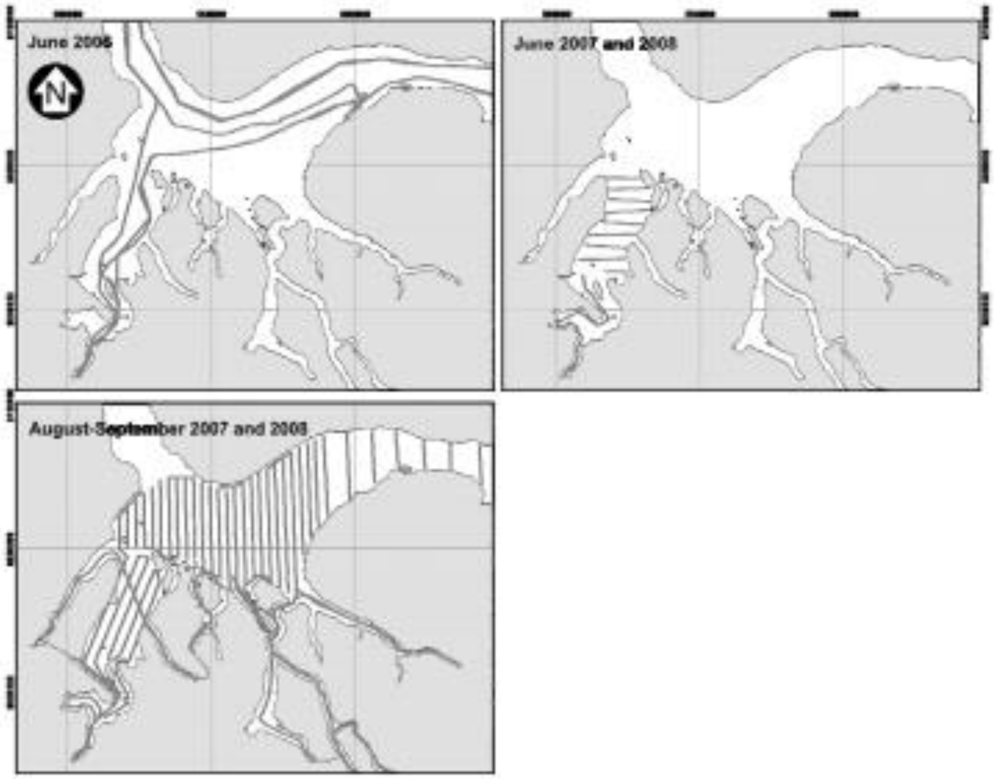
Aerial surveys were conducted along the Northern Shipping Route in 2006, 2007, 2008, 2013, 2014, and 2015 (Figure 4.1 through Figure 4.4) to characterize marine mammal abundance and distribution in this region during the open-water season. Surveys conducted between 2006 and 2014 represented baseline conditions, while surveys conducted in 2015 and 2016 represented post-Project conditions. The regional survey area was divided into thirteen geographic strata for description of spatial trends in the data (Figure 4.5). It should be noted that the survey design changed from year to year, which has limited the ability to conduct year-to-year comparisons.

4.1.1.1 Narwhal

Narwhal were shown to occur in highest numbers in the RSA from mid-August to mid-September, and in highest densities in Tremblay Sound, Eclipse Sound West, Milne Inlet, and Koluktoo Bay (Figure 4.6 through Figure 4.8). Narwhal occurred in lower numbers in Eclipse Sound East, Pond Inlet and Navy Board Inlet throughout the open-water survey period. Relatively few narwhal remained in Tremblay Sound, Milne Inlet and Koluktoo Bay past late September, while sightings persisted in Navy Board Inlet and Eclipse Sound until mid- to late October.

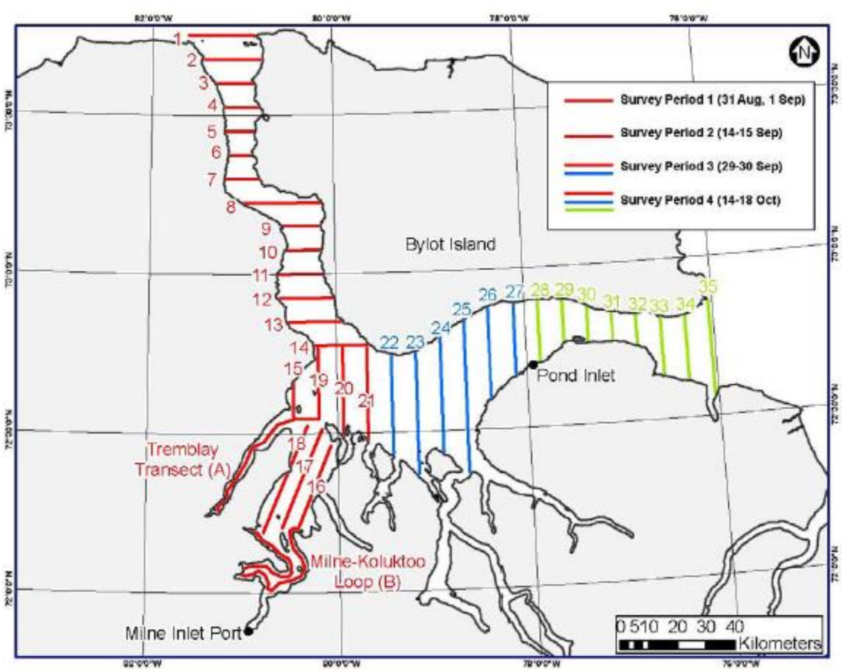
Aerial survey results were consistent with local IQ information on narwhal seasonal distribution, which indicates that narwhal begin their migration into Eclipse Sound through Pond Inlet and Navy Board Inlet during the initial ice break-up in July, then remain in the Milne Inlet area from August to early October, and then migrate back out through Eclipse Sound and Pond Inlet to their traditional overwintering grounds in Baffin Bay during late October / early November (Appendix A). Seasonal distribution patterns observed in the aerial surveys were also consistent with results from several narwhal tagging studies conducted by Dietz et al. (2001) and Watt et al. (2012). When comparing survey results between the different geographic strata, narwhal abundance was shown to be highly variable both within and among years (Figure 4.9 and Figure 4.10). Variability was also high between replicate surveys within each stratum (replicate surveys were typically separated by one day, and 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 difference between the two replicates ranged from 0.06 to 70.0 (Figure 4.11).

A statistical analysis of the 2013 and 2014 aerial survey data 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 DFO conducts narwhal stock assessment (DFO 2015c). Given their high mobility and extensive range during summer (347 to 767 km^2 over a 5-day period as reported by 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 4.2) appear to be well within the normal short-term space occupancy for the species.



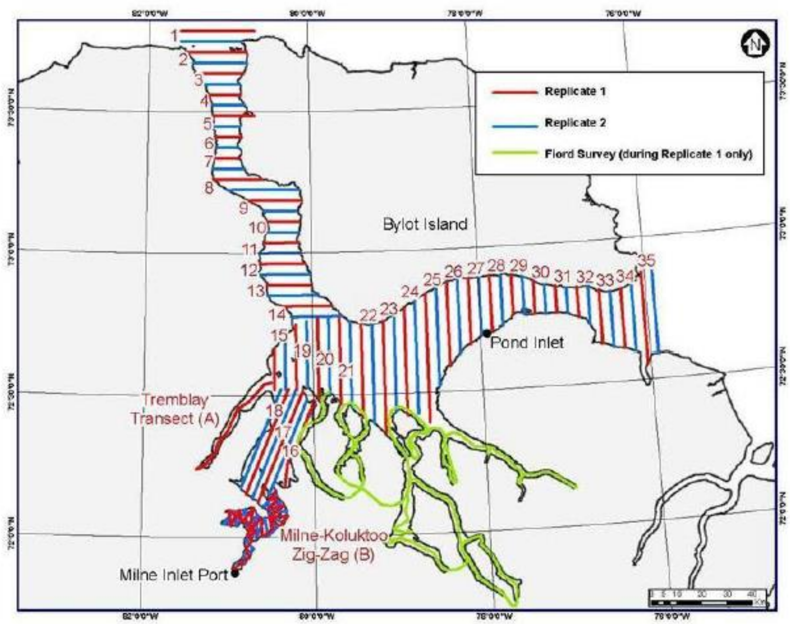
Source: Baffinland (2012a)

Figure 4.1 Aerial survey transect design for narwhal monitoring in 2006, 2007 and 2008.



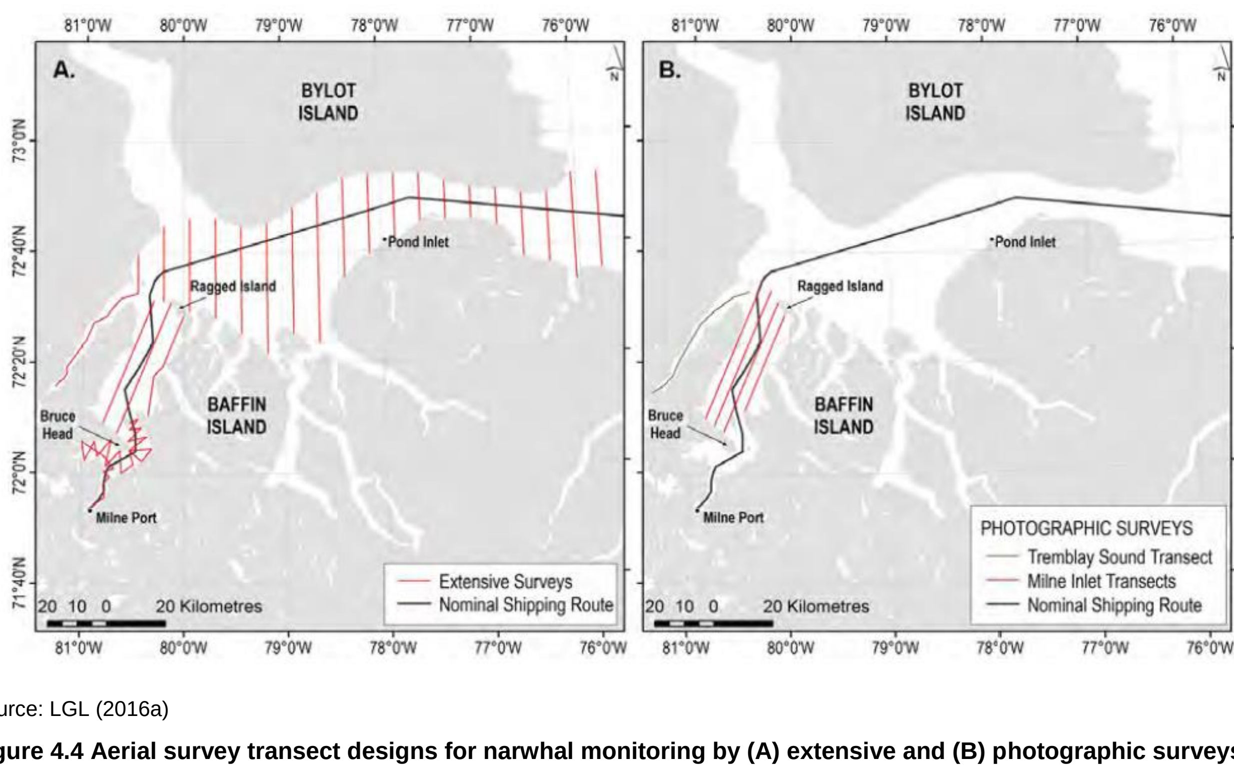
Source: LGL (2015a)

Figure 4.2 Aerial survey transect design for marine mammal monitoring in 2013.



Source: LGL (2015b)

Figure 4.3 Aerial survey transect design for narwhal monitoring in 2014.



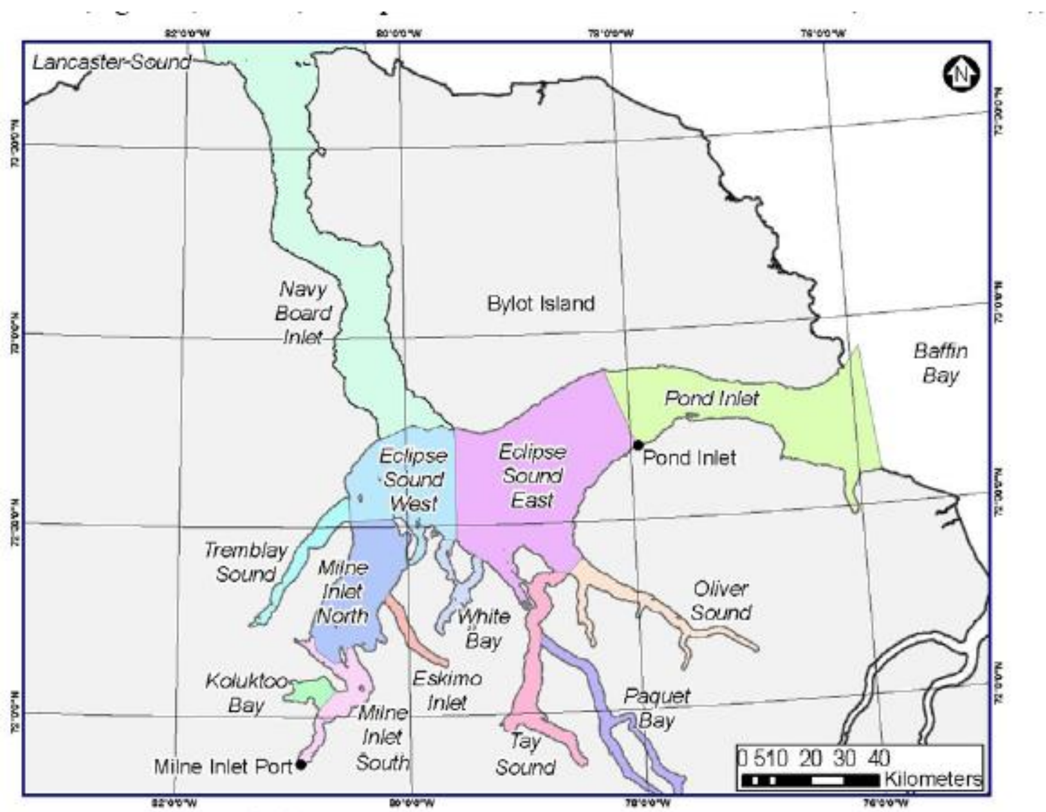
Source: LGL (2016a)

Figure 4.4 Aerial survey transect designs for narwhal monitoring by (A) extensive and (B) photographic surveys in 2015.

Table 4.1: Dates of aerial surveys conducted for marine mammals between 2006 and 2015

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	-

Notes: 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.



Source: LGL (2015a)

Figure 4.5 Thirteen geographic strata used for aerial survey data analysis.

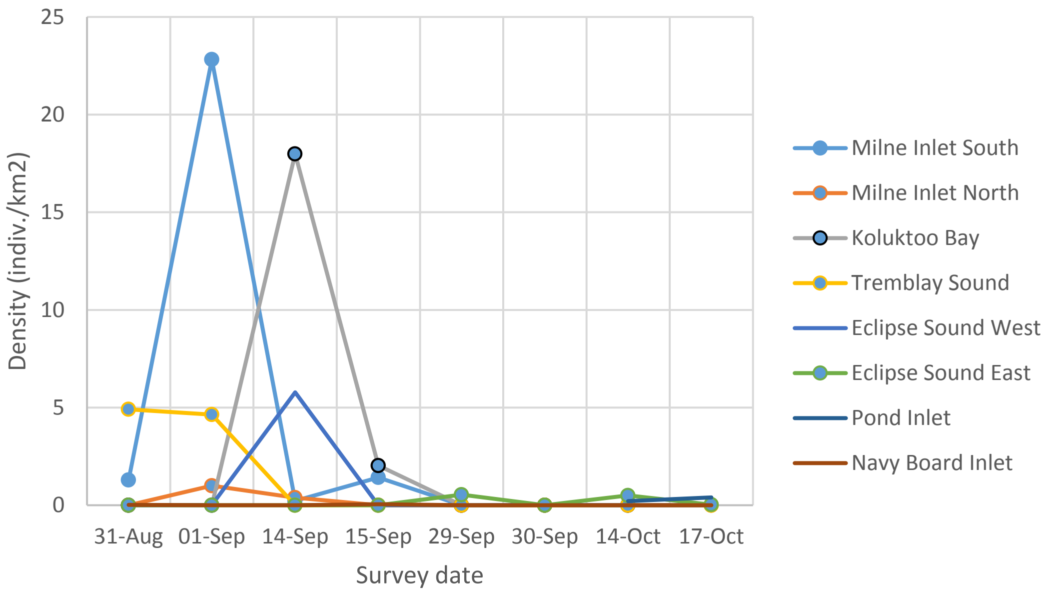


Figure 4.6 Spatial and temporal trends in narwhal density determined from aerial surveys in 2013.

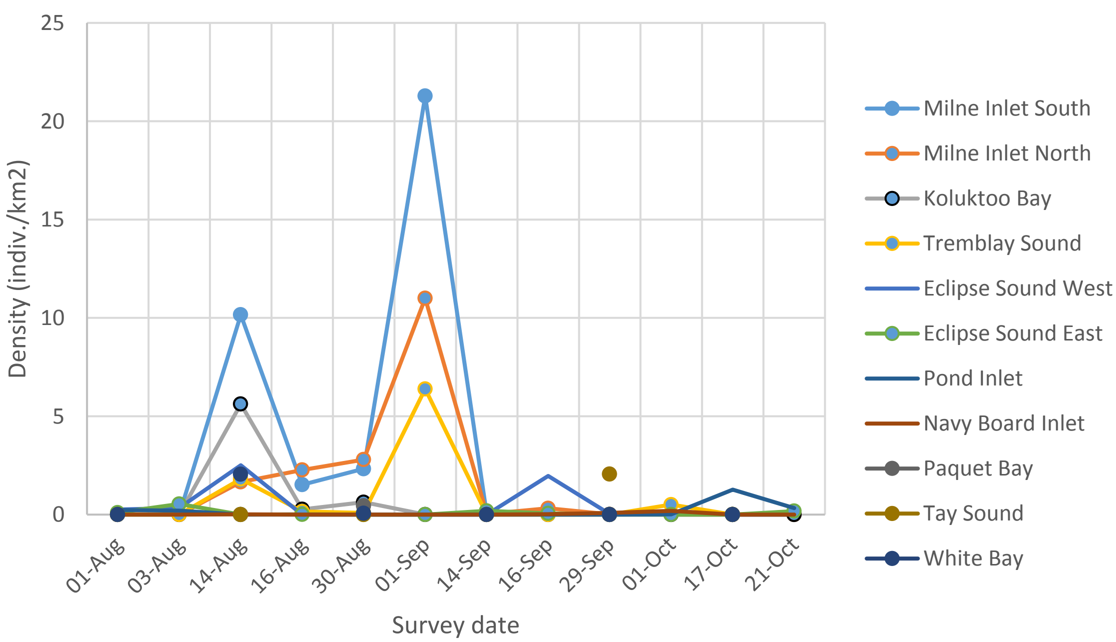


Figure 4.7 Spatial and temporal trends in narwhal density determined from aerial surveys in 2014.

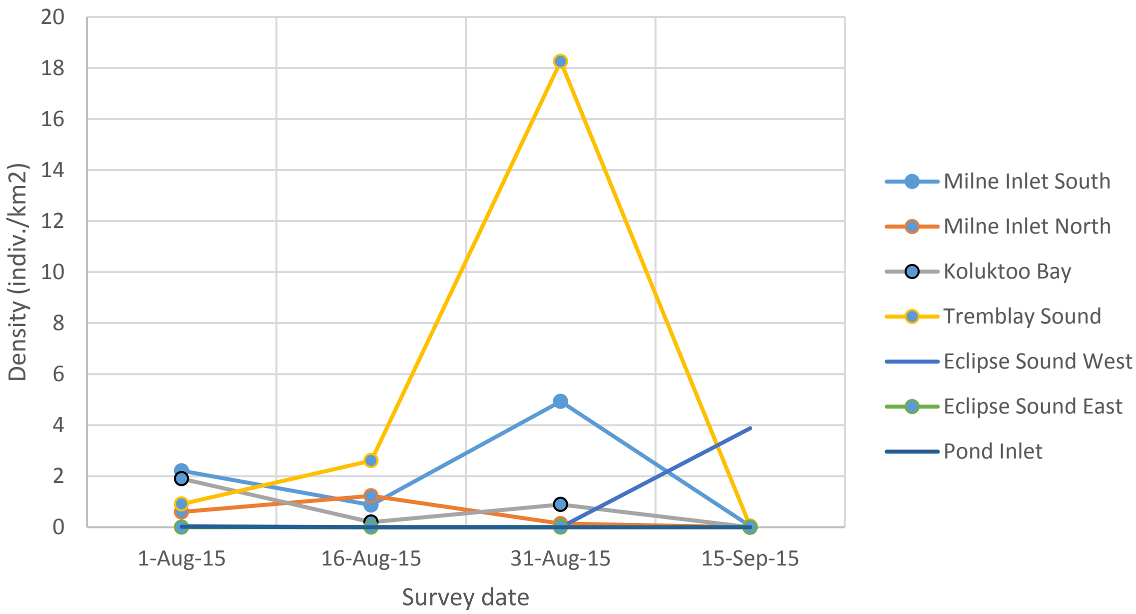


Figure 4.8Spatial and temporal trends in narwhal density determined from aerial surveys in 2015.

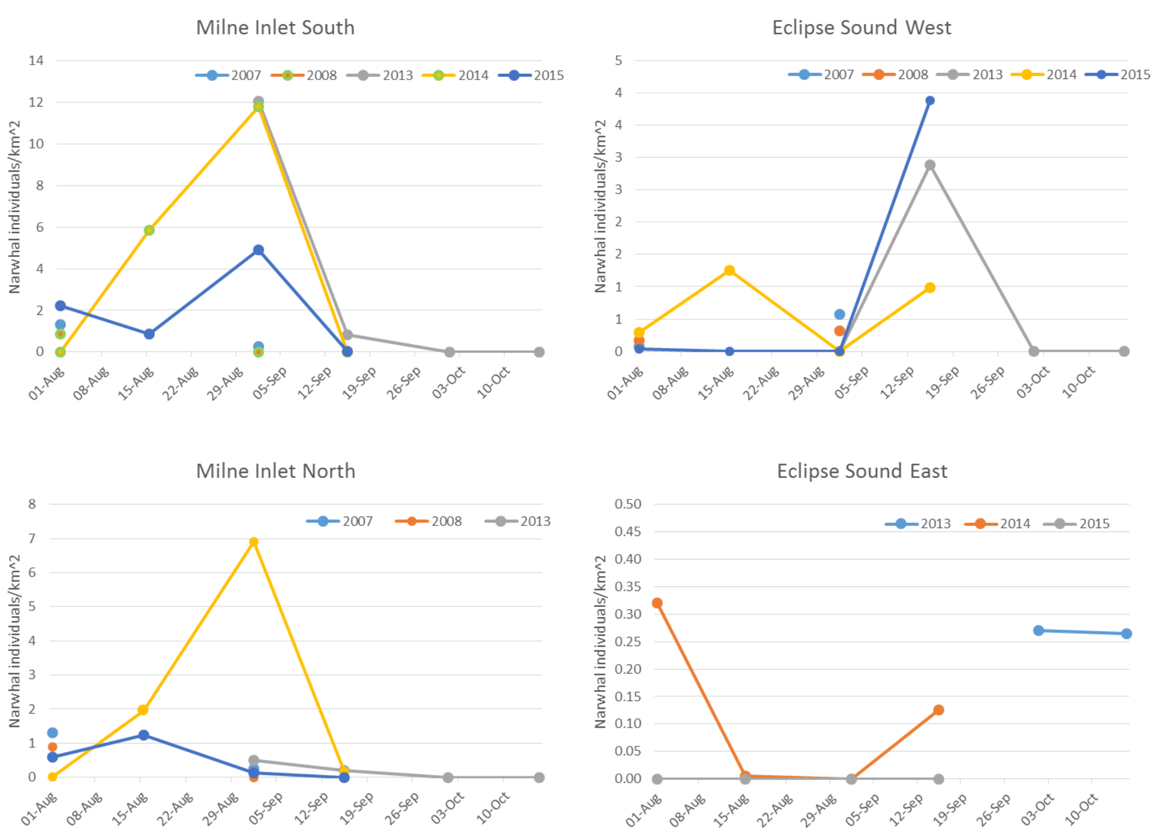


Figure 4.9 Comparison of narwhal densities (mean density per survey period) determined from aerial surveys in 2007, 2008, 2013, 2014 and 2015 (part 1 of 2).

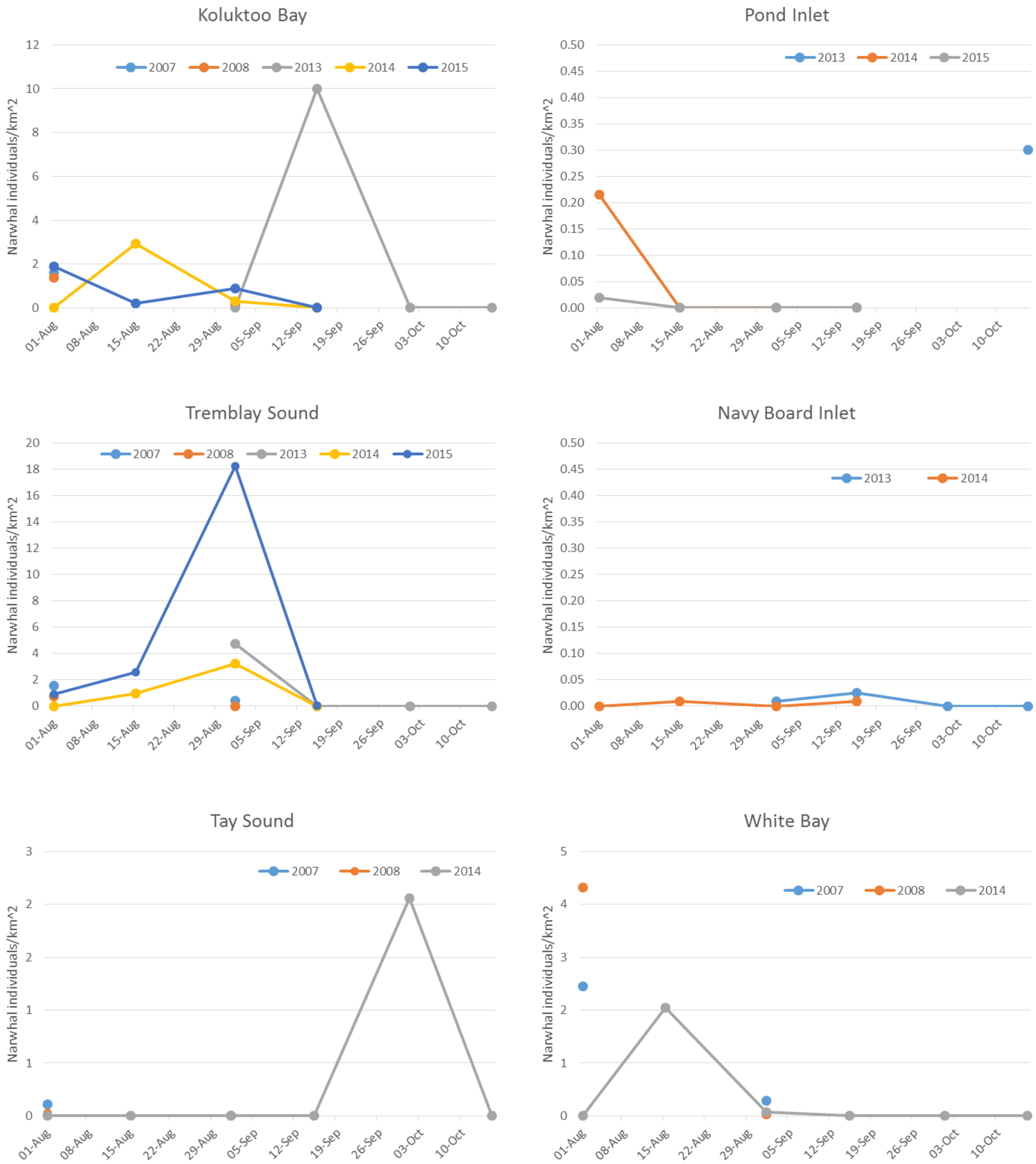


Figure 4.10 Comparison of narwhal densities (mean density per survey period) determined from aerial surveys in 2007, 2008, 2013, 2014 and 2015 (part 2 of 2).

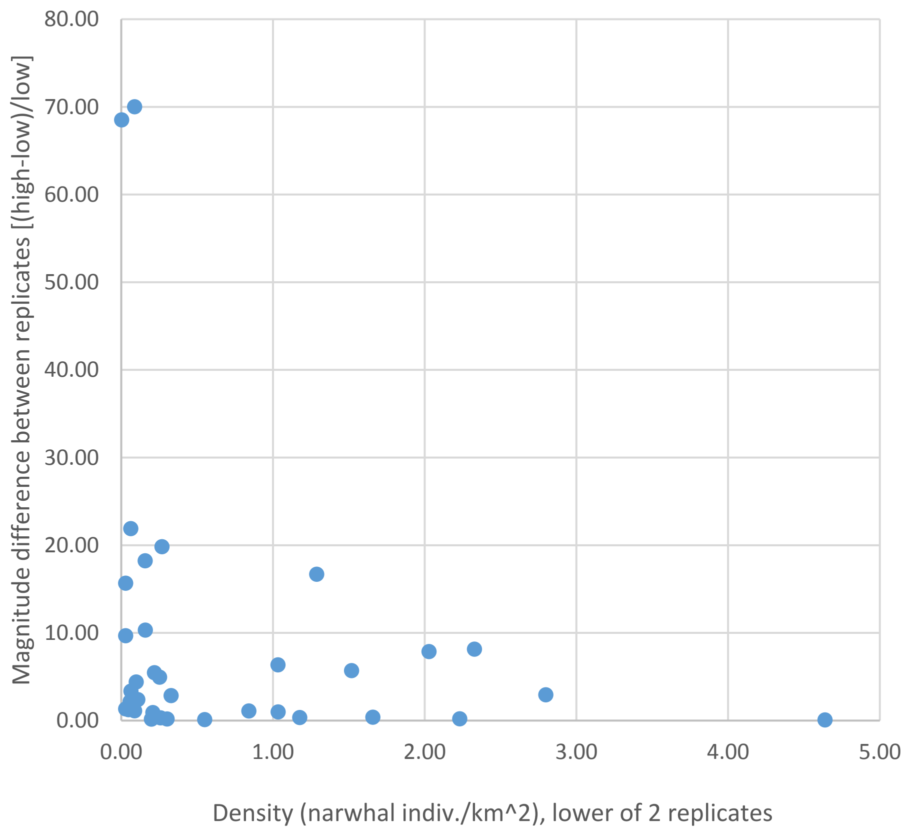


Figure 4.11 Magnitude of difference in narwhal densities measured by replicate aerial surveys in 2013 and 2014.

Table 4.2 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

In 2017, Golder undertook an analysis of aerial survey data collected by DFO during the 2016 open-water season in the North Baffin Region. A total of nine aerial photography surveys were undertaken by DFO in the North Baffin area between August 3 and 21, 2016. The purpose of the surveys was to update abundance estimates for the narwhal population in the Pond Inlet and Arctic Bay community areas. Golder undertook an analysis of the aerial photographs collected over two survey days (August 15 and 21, 2016) that corresponded with Baffinland's primary study area in Milne Inlet, Eclipse Sound and Tremblay Sound. Narwhal abundance and density estimates were generated for both survey days using conventional distance analysis methodology. Density and abundance estimates (corrected for availability bias), including associated variation and confidence intervals, are presented for each survey day in Table 4.3. A comparison of the 2016 narwhal density estimates (uncorrected for availability bias) to those reported in previous years is presented in Table 4.4. Narwhal densities calculated for 2016 typically fell within the range recorded during previous surveys conducted in August or early September in the same region. The only exception was for Eclipse Sound East on August 15 (2.33/km^2), which was higher than the previous reported maximum (0.54 km^2). The data does indicate a wide range of density values in each survey strata during the same season, indicating an inconsistent and patchy distribution of narwhal in the overall survey area during this period.

Table 4.3: Marine mammal density and abundance estimates* on Northern Shipping Route - 2016 DFO Aerial Survey

Species - Season	% Coefficient of Variation	Density Estimate ($\widehat{D}$)		Abundance Estimate ($\widehat{N}$)	
		Value (# / km^2)	95% Confidence Intervals	Value	95% Confidence Intervals
August 15, 2016					
Koluktoo Bay and Milne Inlet South	29.76	22.06	9.94-48.94	6,258	2,820-13,888
Milne Inlet North	54.04	1.187	0.239-5.88	832	168-4,123
Tremblay	8.32	17.99	14.06-23.02	2,820	2,204-3,609
Eclipse Sound East	97.52	7.402	0.0909-60.26	10,141	1,246-82,553
Eclipse Sound West	63.20	0.04213	0.0108-0.1651	42	11-166
Total	**56.58**	**5.962**	**3.72-26.96**	**20,093**	**6,449-104,339**
August 21, 2016					
Koluktoo Bay and Milne Inlet South	11.67	13.98	10.45-18.71	3,968	2,965-5,310
Milne Inlet North	49.17	5.334	0.761-37.41	3,739	533-26,220
Tremblay	10.30	30.82	23.45-40.50	4,832	3,677-6,350
Eclipse Sound East	95.18	0.02089	0.00294-0.149	41	6-292
Eclipse Sound West	24.21	0.3751	0.199-0.706	376	200-708
Total	**15.93**	**3.1521**	**1.76-5.64**	**12,955**	**7,245-23,166**

* includes correction for availability bias (when an animals is not detectable because it is underwater)

Table 4.4 Comparison of Narwhal Density Estimates from Different Studies along the Northern Shipping Route

Data Source	Data Collection		Uncorrected Density Estimate (# individuals / km²)				
	Year	Date	Koluktoo and Milne Inlet South[1]	Milne Inlet North	Tremblay Sound	Eclipse Sound West	Eclipse Sound East
DFO 2017	2016	15 Aug	6.94	0.38	5.66	0.013	2.33
DFO 2017	2016	21 Aug	4.40	1.68	9.69	0.12	0.066
LGL 2015a	2013	31 Aug	1.29/0	0	4.91	0.00	-
LGL 2015a	2013	1 Sept	22.82/0	1	4.64	0.01	-
LGL 2015b	2014	1-2Aug	0/0	0.02	0	0.26	0.1
LGL 2015b	2014	3-4 Aug	0/0	0	0	0.34	0.54
LGL 2015b	2014	14-15 Aug	10.16/5.62	1.66	1.81	2.51	0
LGL 2015b	2014	16-17 Aug	1.52/0.27	2.27	0.16	0	0.01
LGL 2015b	2014	30-31 Aug	2.33/0.63	2.8	0.09	0	0
LGL 2015b	2014	1-2 Sep	21.28/0	11	6.39	0	0
LGL 2016	2015	1 Aug	2.21/1.90	0.6	0.91	0.04	0
LGL 2016	2015	16-17 Aug	0.87/0.20	1.23	2.61	0	0
LGL 2016	2015	31 Aug	4.93/0.89	0.14	18.26	0	0
LGL 2016, Photo graphic survey	2015	August	Not collected	Not available	Not available	Not collected	Not collected
Richard et al. 2010	2002	August	Not available	Not available	Not available	Not available	Not available
Doniol-Valcroze et al. 2015	2013	August	0.56	0.56	0.88	0.56/0.01	0.01

4.1.1.2 Other Marine Mammals

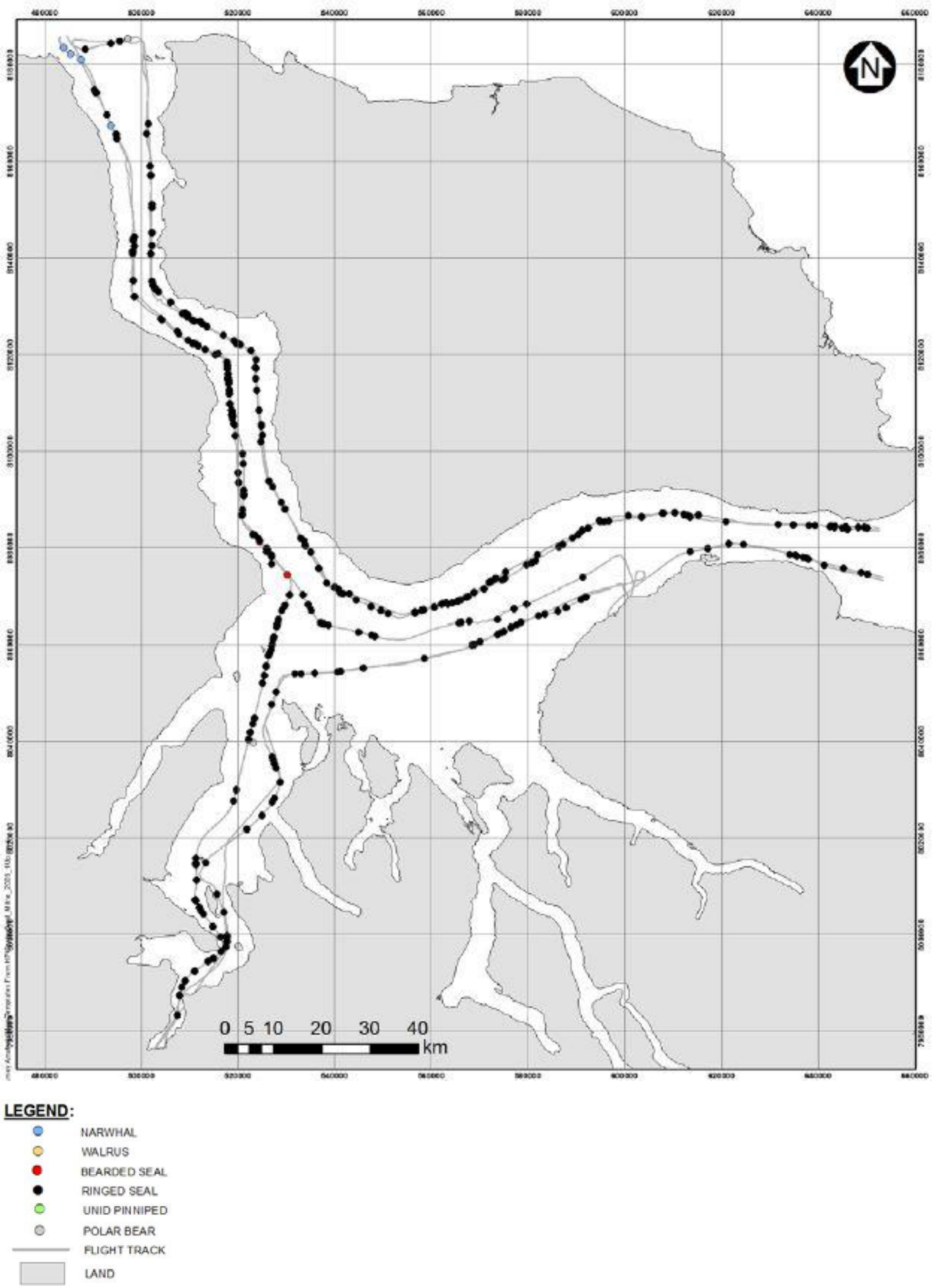
Other marine mammals observed during baseline aerial surveys (2006-2008) are presented in Figure 4.12 through Figure 4.17. Sightings included bowhead, beluga, killer whale, walrus, bearded seal, ringed seal, harp seal, and polar bear. With the exception of larger pinniped species (e.g. walrus), aerial surveys can only effectively detect a small fraction of pinnipeds in water, and therefore the reported abundance of seals in the RSA is likely underestimated. Pinnipeds that occurred in large aggregations such as harp seal were more readily visible to the observer, and therefore more likely to be counted than seals that were solitary or in small groups.

Bowhead were not observed during the 2006 aerial surveys (June), but were present during both 2007 and 2008 surveys in Milne Inlet and Eclipse Sound, and to a lesser extent in Koluktoo Bay, Tremblay Sound and Tay Sound. A total of 14 bowhead were recorded along the Northern Shipping Route during three consecutive years of aerial surveys conducted between 2013 and 2015 (Elliott et al. 2015; Thomas et al. 2015; 2016). Based on the most recent High Arctic Cetacean Survey completed by DFO in the Project area, the predicted number of bowhead in Eclipse Sound during 2013 was 32 (Doniol-Valcroze et al. 2015).

Beluga were only recorded in small numbers during the 2008 surveys (August and September). No sightings of beluga occurred in 2006 or 2007 along the Northern Shipping Route. Similarly, no beluga were recorded during three consecutive years of aerial surveys conducted for Baffinland between 2013 and 2015 (Elliott et al. 2015; Thomas et al. 2015; 2016). Based on these results, beluga were considered unlikely to occur in the Milne Port area during the open-water season.

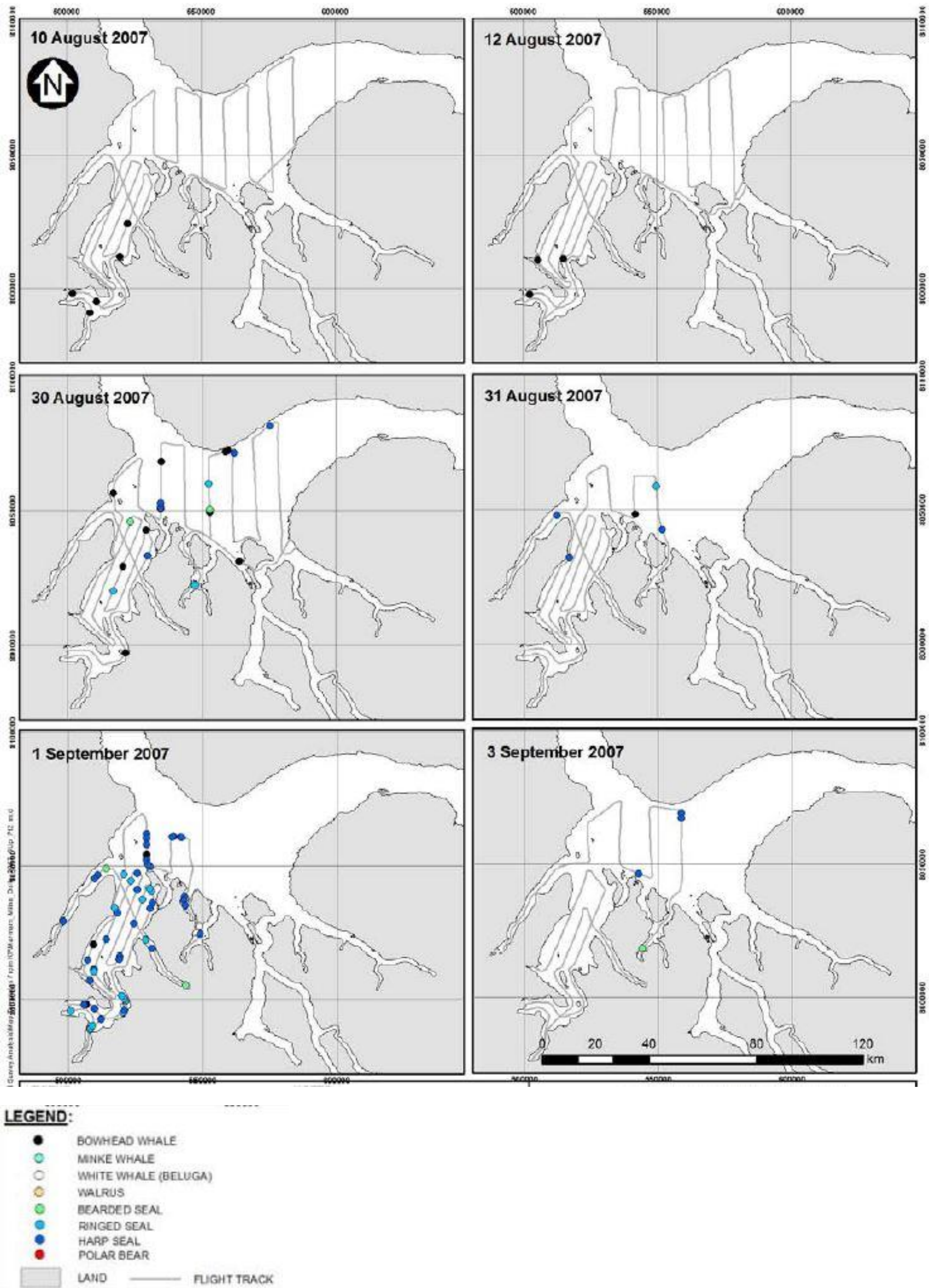
Walrus were not observed in the RSA during the 2006-2008 baseline aerial surveys. During three consecutive years of aerial surveys conducted for Baffinland between 2013 and 2015 (Elliott et al. 2015; Thomas et al. 2015; 2016), a total of five walrus sightings were recorded along the Northern Shipping Route.

Killer whales were recorded on one survey day (17 September 2007) during the 2006-2008 baseline aerial surveys.



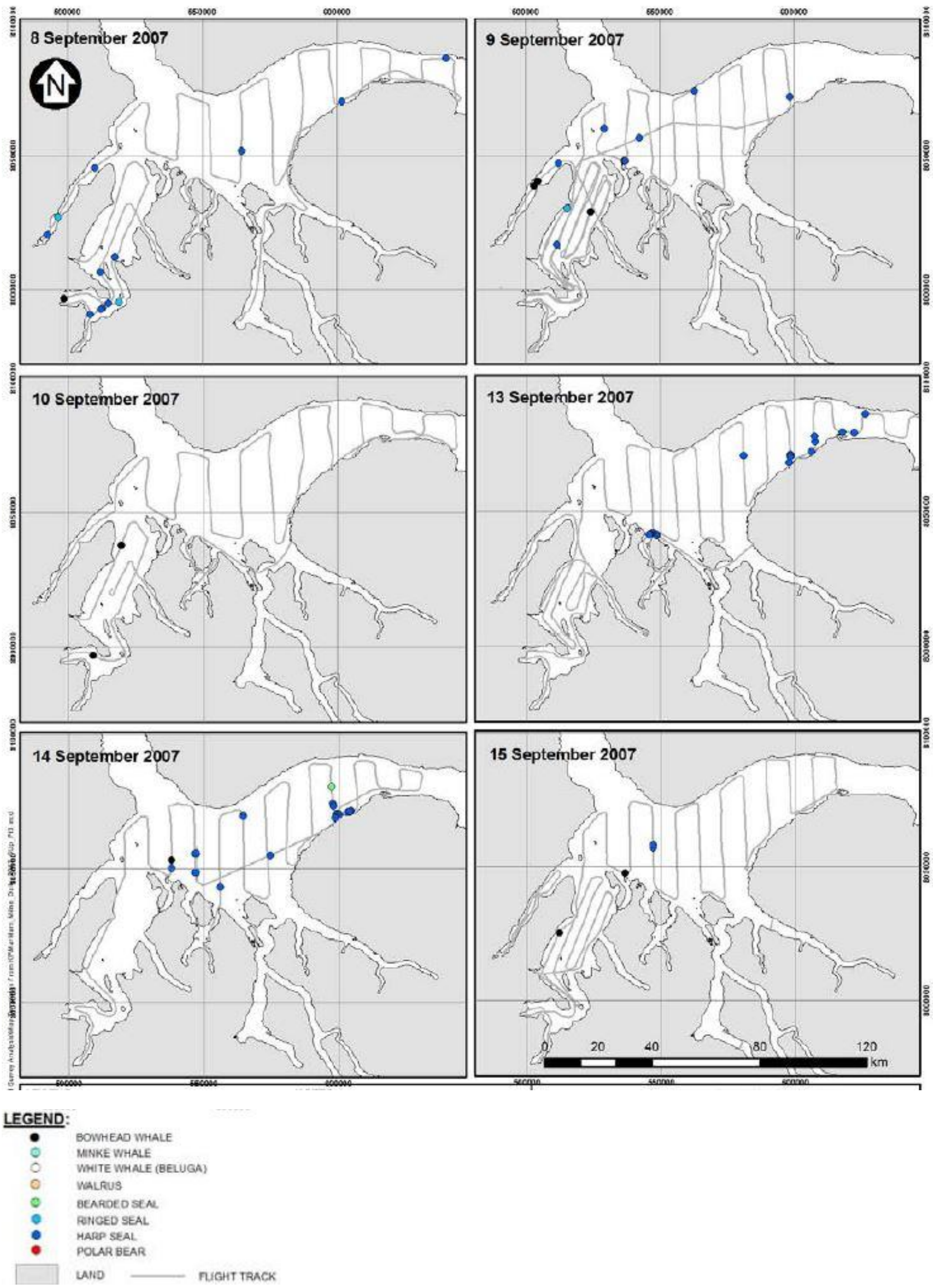
Source: Baffinland 2012a

Figure 4.12 Marine mammal sightings along aerial survey tracklines in RSA - June 2006.



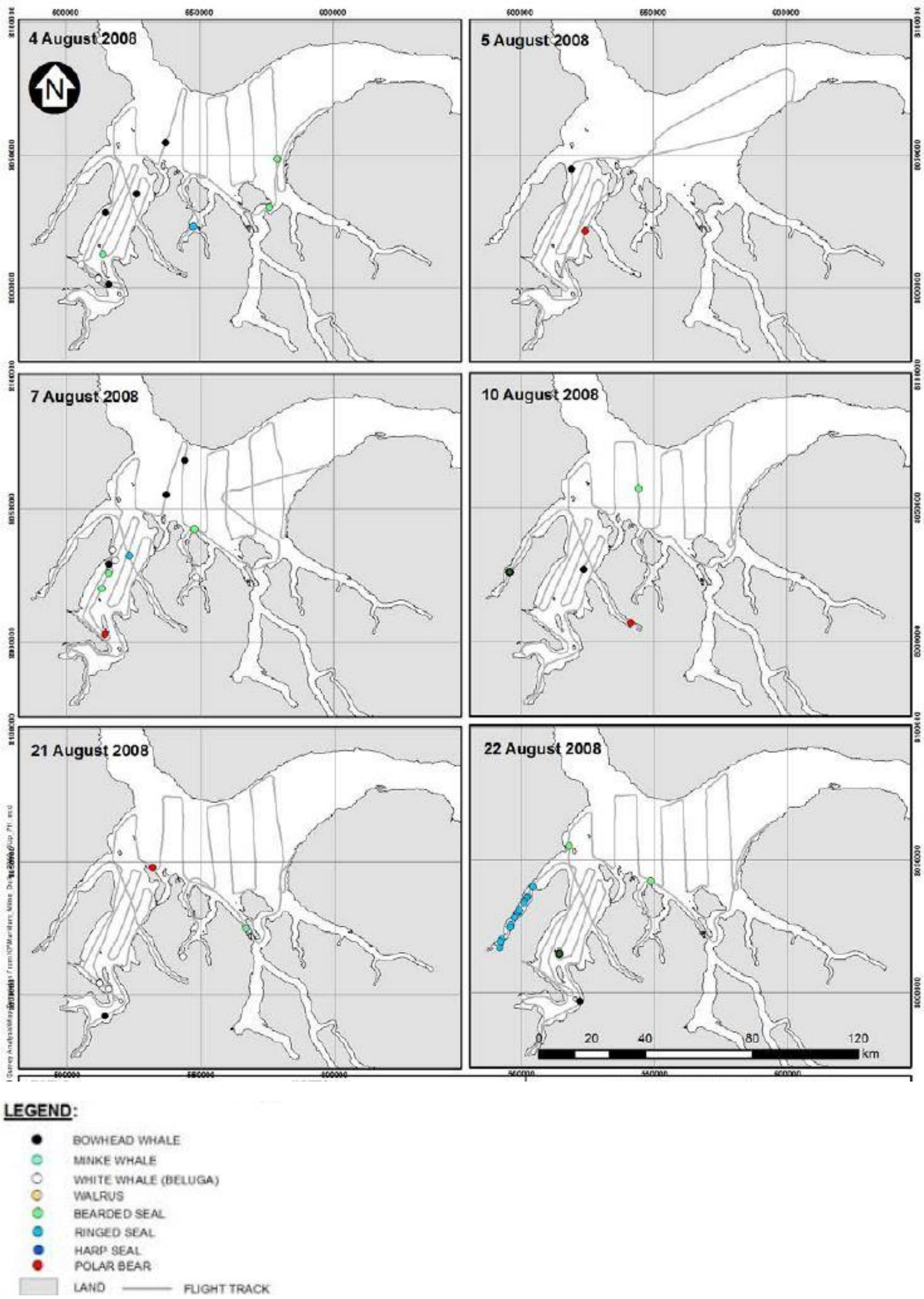
Source: Baffinland 2012a

Figure 4.13 Marine mammal sightings (narwhal excluded) along aerial survey tracklines in RSA - August and September 2007.



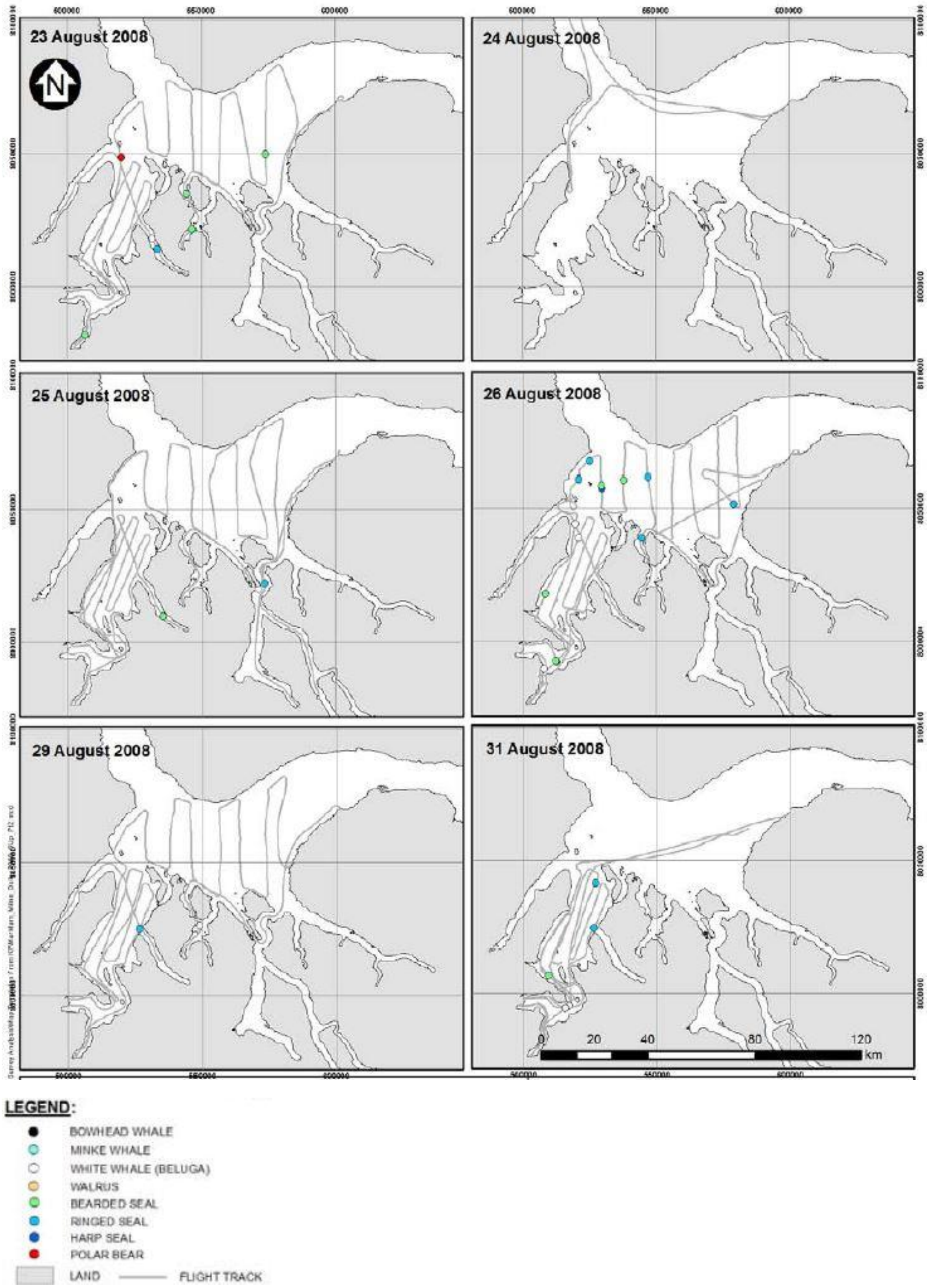
Source: Baffinland 2012a

Figure 4.14 Marine mammal sightings (narwhal excluded) along aerial survey tracklines in RSA - September 2007.



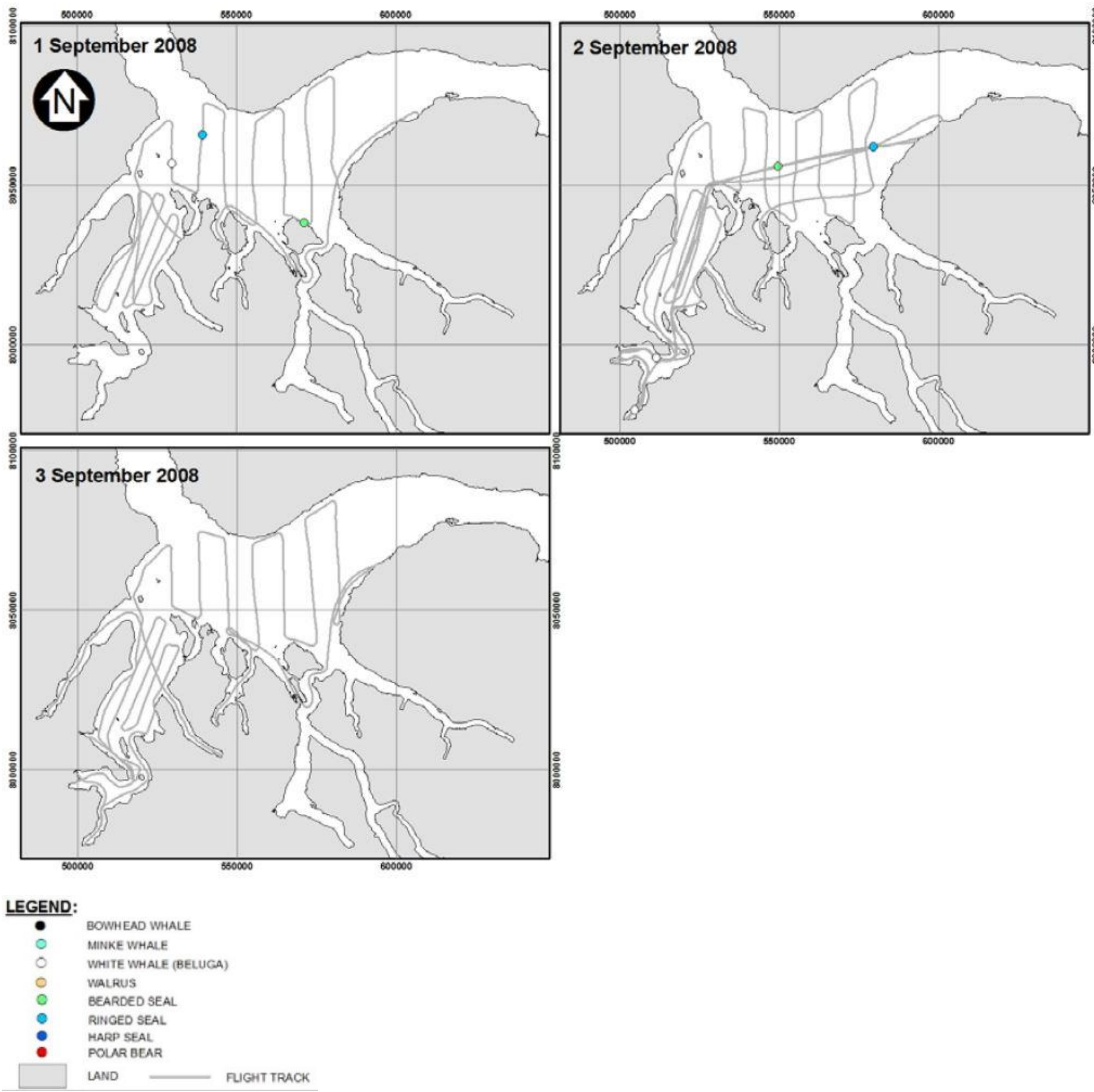
Source: Baffinland 2012a.

Figure 4.15 Marine mammal sightings (narwhal excluded) along aerial survey tracklines in RSA - August 2008 (part 1 of 2).



Source: Baffinland 2012a.

Figure 4.16 Marine mammal sightings (narwhal excluded) along aerial survey tracklines in RSA - August 2008 (part 2 of 2).



Source: Baffinland 2012a.

Figure 4.17 Marine mammal sightings (narwhal excluded) along aerial survey tracklines in RSA - September 2008.

4.1.2 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 4.1.2.1.

4.1.2.1 [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 was conducted by LGL in 2015, similar to the surveys undertaken in 2013 and 2014. This included collection and analysis of aerial photographs to compare narwhal densities Before/During/After a ship passage;
- Shore-based marine mammal monitoring was undertaken at Bruce Head from 2014-2017; and
- Passive Acoustic Monitoring was undertaken near Bruce Head in 2014 and 2015.

4.1.2.1.1 2015 Aerial Survey

Detailed results of the 2015 aerial survey are presented in LGL (2016a). Golder undertook a peer review of LGL’s 2015 aerial survey report, with results of the review presented in Baffinland (2016). A number of issues were identified with the survey methods and statistical analyses employed as part of the 2015 survey; and significant gaps were identified in the survey data with implications on the survey results. In general, existing study limitations, as outlined below, prevent any reasonable interpretation of the 2015 data with respect to potential narwhal responses to large ships along the Northern Shipping Route.

- 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 4.4) 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 previously stated, 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;

- 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 4.5); and
- Two of the four surveys had surveys conducted in matching time periods for both Milne Inlet and Tremblay Sound (highlighted rows in Table 4.6). There were no matched 'before' data for any of the surveys.

Table 4.5 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	-	-

Table 4.6 Narwhal densities determined from photographic surveys

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)
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

Notes: 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.

4.1.2.1.2 Shore-based Monitoring at Bruce Head (2014-2017)

Shore-based monitoring of narwhal was conducted by LGL at Bruce Head during the open-water seasons of 2014-2016. The main objective of the monitoring study was to identify potential changes in narwhal distribution, relative abundance, group composition and/or behaviour in Milne Inlet, as observed from Bruce Head, in response to large vessel traffic servicing Milne Port as part of the Mary River Project. Other variables considered in the study included tide, weather, time of day, small vessel movements and hunting activities. A secondary objective of the study was to determine if narwhal exhibited evidence of habituation following repeated exposure to ship traffic over the study period. Shore-based monitoring of narwhal was conducted from an observation platform located on the Bruce Head peninsula at ~215 m above sea level. Survey data for relative abundance and distribution (RAD) were collected in nine distinct geographic strata (26 substrata) extending across Milne Inlet, collectively referred to as the stratified study area (SSA). A generalized linear mixed model (GLMM) was used for conducting statistical analyses of the pooled RAD survey data. Group composition and behavioural data were collected within ~1000 m of shore (referred to as the Behavioural Study Area or BSA), as animals transited in front of the platform. Group size was assessed using a one-way ANOVA and post-hoc tests on trimmed means. Categorical group characteristics were investigated using a Pearson's Chi-square test. Detailed results of the 3-year monitoring study are presented in Smith et al. (2017), with key findings provided below:

- The number of narwhal in the SSA was significantly[3] (statistically) related to tide, time of day, and date. Relatively more narwhal were observed in the SSA during ebb tide events. Throughout a 24-hour period, narwhal counts in the SSA were highest around 14:00 EDT. Throughout the survey season, narwhal counts peaked in the SSA around 22 August;
- Results of the GLMM analysis indicate that narwhal respond differently to ore carrier traffic depending on the direction of ship travel in the SSA:
  - For northbound ore carriers travelling through the SSA, significantly higher numbers of narwhal (on average ~2.8x higher) were observed when ore carriers approached a given substratum compared to periods when no ore carriers were present. Significantly lower numbers of narwhal (on average ~1.8x lower) were observed during periods after a northbound ore carrier had departed from a given substrate compared to periods when no ore carriers were present. Results suggest that at least some narwhal demonstrate a localized avoidance response to northbound carriers; and
  - For southbound ore carriers travelling through the SSA, no significant difference in narwhal numbers was observed, regardless of whether the vessel was approaching or departing a given substratum.
- Despite increased vessel traffic during the ERP and localized, temporary displacement of narwhal in response to northbound ore carriers, there was no significant change in overall narwhal abundance in the SSA during the 3-year study period;
- Narwhal within the BSA tended to swim closer to shore (<300 m vs. >300 m) and at faster speeds when a large vessel was present in the SSA;
- Narwhal within the BSA occurred more often in a loose (rather than tight) and circular (rather than parallel) group formation when a large vessel was present in the SSA;

[3] Any reference to significance throughout this report relates to statistical significance unless otherwise noted. Statistically significant findings discussed herein do not necessarily equate to findings being ecologically significant.

- Narwhal group size and group composition (including groups with and without calves) was not significantly affected by the presence of a large vessel in the SSA. Groups with calves/yearlings accounted for 39.7% of the groups of known composition; and
- Observed behavioural responses to hunting activities (i.e., shooting) in the BSA included evasive diving behaviour and increased swim speed. Following a shooting event, narwhal returned to the area adjacent to the hunting camp within 30 minutes to >5 hours. GLMM results support visual observations with a statistically significant “time since shooting” effect identified. Narwhal counts tended to be zero or low during the first 2 to 3 hours following a shooting event, with numbers gradually increasing after a period of 4 to 9 hours.

In 2017, Golder conducted shore-based monitoring of narwhal at Bruce Head over 27 survey days between 31 July and 29 August. Survey methodology followed closely that used by LGL during the 2014-2016 surveys. Based on shore-based and satellite AIS datasets, a total of 32 large vessels made 58 one-way transits through the SSA on 23 of the 27 survey days. Of these, 43 transits were made by Project-related bulk (ore) carriers, 10 transits were made by Project-related cargo vessels, and 2 transits were made by Project-related oil tankers. Passenger vessel transits (n = 3) were the only non-Project-related large vessels that transited through the SSA. Large vessels were observed in the SSA on 16 of the 23 survey days and included 21 Project-related vessel transits and one passenger vessel (not Project-related).

Analysis of the 2017 shore-based visual data included two components – relative abundance and distribution (RAD) and group composition and behavioural data analyses, similar to previous years (Smith et al. 2015; Smith et al. 2016; Smith et al. 2017). A generalized linear mixed hurdle model was developed for RAD analysis to evaluate how the relative abundance of narwhal (expressed as total count per substratum) was affected by various explanatory variables, such as date, stratum, sightability, and effects related to large vessel presence. While evaluating the effect of shipping traffic was the main focus of the analysis, it was important to include other potential explanatory variables in the model, to account for spatial and temporal trends, observer bias due to environmental conditions, and confounding factors such as anthropogenic effects that are not large-vessel related. The hurdle modeling approach allowed for analysis of count data with high occurrence of zeroes, while specifying an explicit spatial autocorrelation – i.e., accounting for the fact that narwhal are not distributed randomly and that counts at adjacent substrata will likely be more similar than counts at substrata far apart. The models were used for inference of statistical significance based on P values of coefficients, and model predictions were plotted against the data to visualize the estimated relationships between narwhal counts and the various explanatory variables. One difference in the analysis relative to previous survey years (2014-2016) was the expression of large vessel effect as a continuous variable (vessel distance). This allowed for an evaluation of vessel effect as a continuous trend, therefore providing higher resolution data on the relationship between vessel movement and relative abundance of narwhal.

Golder’s analysis of the 2017 data on group composition and behaviour differed from the approach previously taken by LGL (Smith et al. 2017). While previous analyses included ANOVA and χ^2 tests relative to scenarios of anthropogenic activity, the 2017 data were used to construct a set of models, similar to the RAD model described above. Instead of estimating narwhal counts (as the RAD models), the models developed for analysis of behavioural and composition data examined changes in group size, group composition, spread, formation, direction, speed, and distance from shore. The explanatory variables used for these analyses were similar to those used for RAD models, with the addition of hunting activity effects. The models were examined for significant effects, and estimated predictions were plotted against the explanatory variables to visualize patterns.

Key findings from the 2017 Bruce Head Shore-based Monitoring Program were as follows:

- Relative abundance and distribution – Model results indicated that direction of travel of large vessels through Milne Inlet did not have a significant effect on narwhal presence/absence in the SSA. The orientation of large vessels relative to substrata centroids may have an effect on narwhal presence/absence in the SSA but further investigation in future years is warranted;
- Group size – Model results indicated that for narwhal observed within 15 km of a large vessel, vessel distance from the BSA did not have a significant effect on group size. Mean narwhal group sizes were smaller when large vessels were present within 15 km of the BSA compared to when no large vessels were present;
- Group composition - Model results indicated that distance of large vessels from the BSA and orientation of large vessels relative to the BSA (i.e., approaching/departing) were significant predictors of presence/absence of adult and mother/offspring groups in the BSA. At very close distances, adult groups >1 were estimated to be observed less and mother/offspring groups were estimated to be observed more when a large vessel was departing the BSA compared to when a large vessel was approaching the BSA;
- Group spread – Narwhal were more often observed in tight associations compared to loose associations under both vessel presence and vessel absence scenarios. During passage of a large vessel within 15 km of the BSA, loosely spread groups were more likely to occur when vessels were at greater distances from the BSA and exiting Milne Inlet compared to entering;
- Group formation – Narwhal were usually observed in parallel formation under both vessel presence and vessel absence scenarios. When large vessels were within 15 km of the BSA, the presence of linear groups, while rare, was estimated to increase with increasing distance of the vessel from the BSA, whereas parallel group formation was most likely to occur when large vessels were close to the BSA, according to model results;
- Group direction – Narwhal groups were predominantly observed travelling south through the BSA. When large vessels were within 15 km of the BSA, narwhal were most often observed travelling south when the vessel was exiting Milne Inlet, regardless of orientation of the vessel to the BSA. When a vessel was entering Milne Inlet, narwhal groups were observed travelling both north and south upon approach of the vessel, whereas groups were observed travelling predominantly north when vessels were entering Milne and departing the BSA, except for groups within ~2km of the vessel which were often observed travelling south. Narwhal tended to travel south in large groups and north in small groups;
- Travel speed – The majority of narwhal groups travelled at a medium speed, regardless of large vessel presence/absence. When large vessels were present within 15 km of the BSA, narwhal groups were most commonly observed travelling at a fast speed when vessels were exiting Milne Inlet and departing the BSA. Model results indicate that large groups were more likely to travel fast, while small groups were more likely to travel slowly; and
- Distance from Bruce Head shore - Narwhal groups were observed more often at a distance <300 m of the Bruce Head shore compared to groups >300 m offshore under both vessel presence and vessel absence scenarios. Model results indicate that, in the presence of large vessels, narwhal groups are more likely to be observed offshore (> 300 m) only when vessels are exiting Milne Inlet and approaching the BSA.

In order to effectively compare results between survey years (2014 – 2017), previous survey data collected by LGL is currently being amalgamated with the 2017 Bruce Head dataset, and will be analyzed using the 2017 RAD, group composition and behaviour models. Results of this analysis are scheduled to be completed in Q4 2018.

4.1.2.1.3 Passive Acoustic Monitoring at Bruce Head (2014 and 2015)

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; and
- 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 4.22) 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; and
- 18 September 2014: The cessation of narwhal calls is most likely due to seasonal migration.

Table 4.7 Density of narwhal (individuals/km^2) determined from aerial surveys conducted in 2014.

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

Modified from LGL (2015b)

4.1.2.2 Distance of response to vessels – narwhal

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; 2014; 2016). Twelve of the 13 narwhals observed were estimated to be within a distance of ≤100 m of the vessel (Figure 4.18). The reaction of the narwhals to the vessel was not recorded.

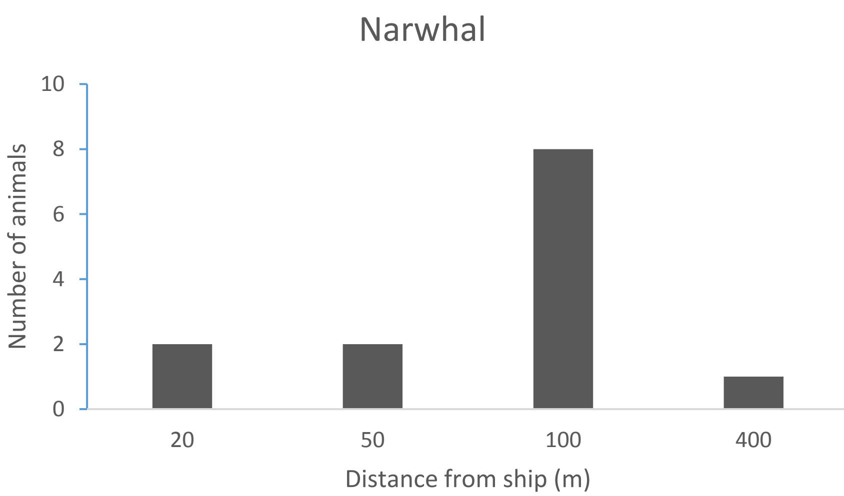
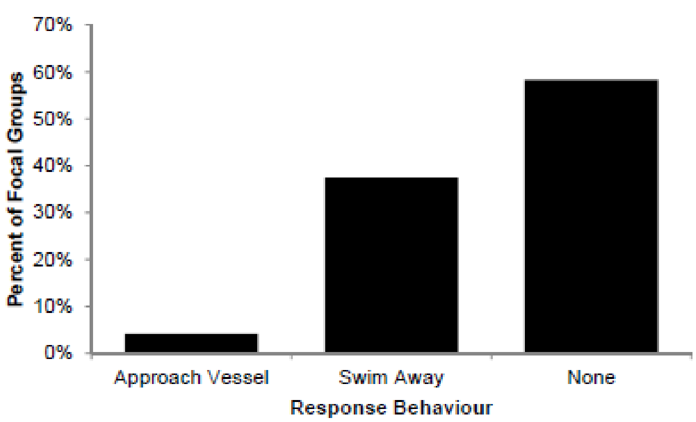


Figure 4.18 Estimated distance of narwhals from large vessel during shipboard observer surveys, 2013 to 2015.

More than half of the narwhal observed from Bruce Head in 2015 exhibited no observable response to the presence of large vessels (~58% of focal groups) (Figure 4.19). 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 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 narwhal in the presence of medium and small vessels (LGL 2016a).

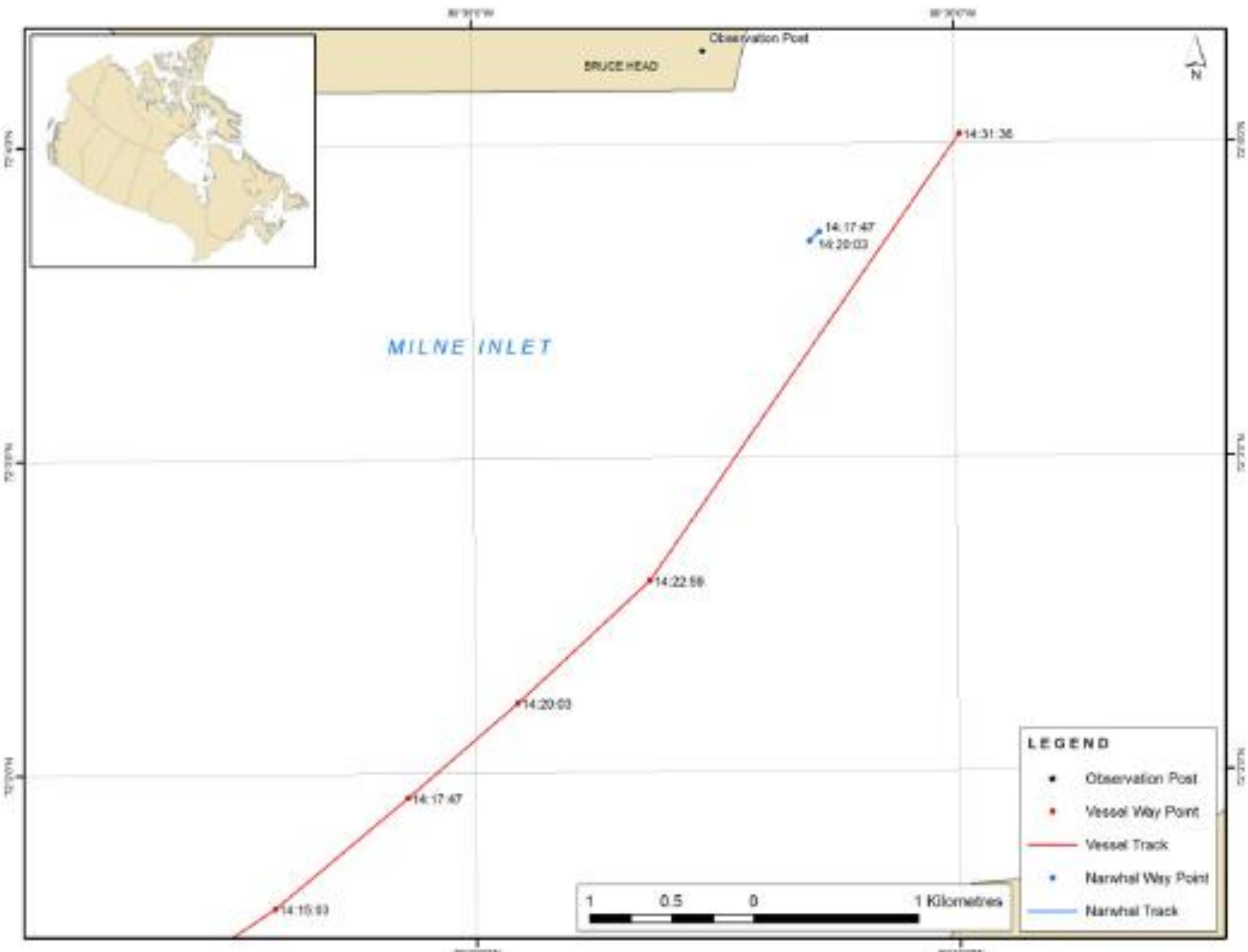


Source: LGL (2016a)

Figure 4.19 Behavioural response of narwhal focal groups to large vessel presence in 2015.

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 2014). 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”.

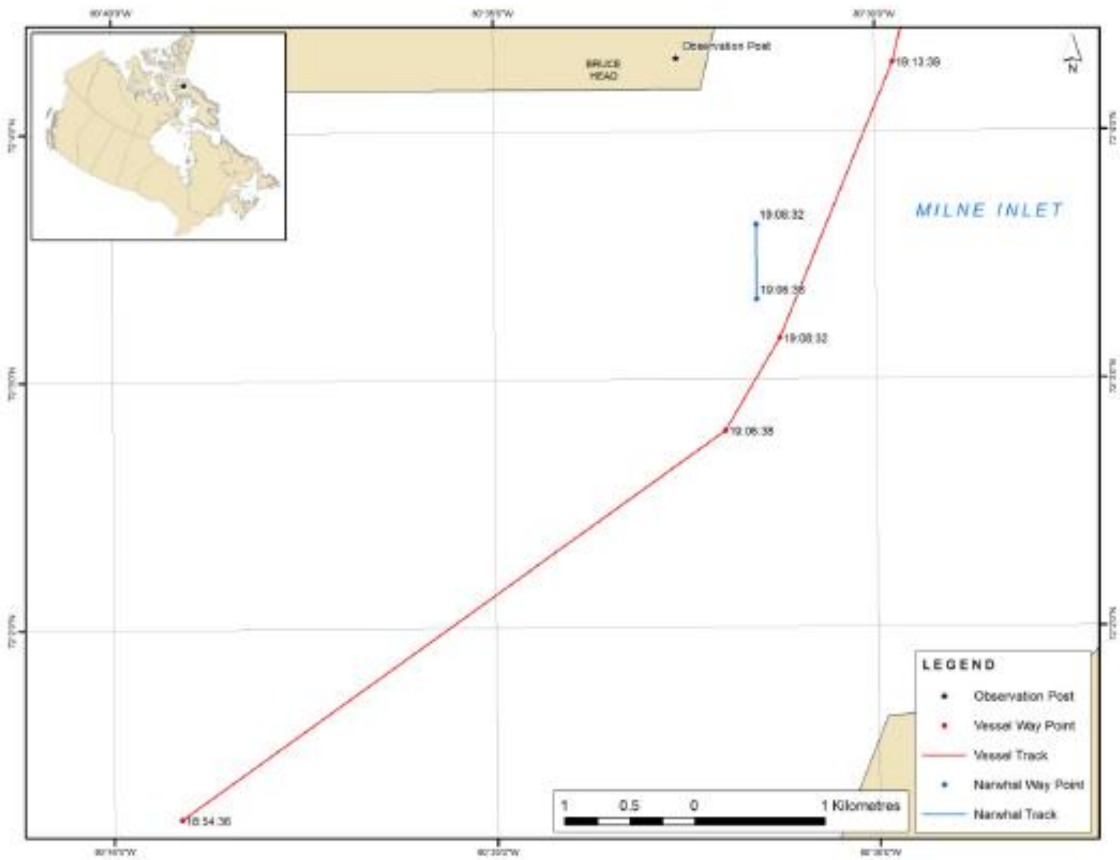
During a vessel transit on 14 August 2013 observed from Bruce Head, the cruise ship Sea Adventurer approached within 2-3 km of a group of narwhals before eliciting a reaction (Figure 4.20). The group turned perpendicular to the ship’s track and swam toward Bruce Head.



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)

Figure 4.20 Narwhal position relative to vessel observations near Bruce Head on 14 August 2013.

During another observation made from Bruce Head on 26 August 2013, the vessel approached within approximately 1 km of the narwhals before the end of the observation of this group (Figure 4.21). No information was provided on the response of the narwhals to the ship. Most focal group observations ended when the group dove, and that may be what occurred in this case.



Times are shown for the focal group and the vessel (Baffinland cargo vessel M/V Avataq) during the vessel transit.
Source: LGL (2016a)

Figure 4.21 Narwhal position relative to vessel observations on 26 August 2013 near Bruce Head.

4.1.2.3 Distance of response to vessels – ringed seal

Ringed seal were the only species other than narwhal for which distance data was collected by the shipboard observers (SEM 2013; 2014; 2016). Distance from the vessel was determined for 29 ringed seals (Figure 4.22). 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.

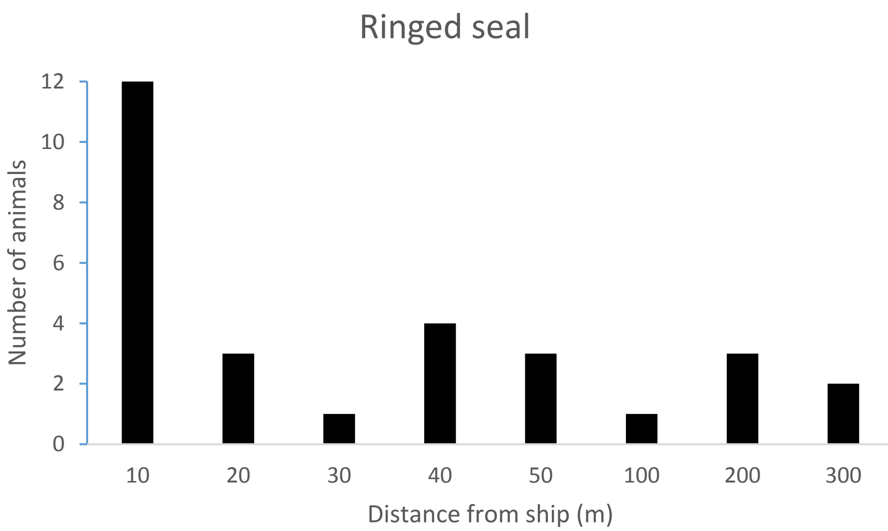


Figure 4.22 Estimated distance ringed seals from large vessel during shipboard observer surveys, 2013 through 2015

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

Data presently collected as part of Baffinland's marine mammal monitoring programs do not clearly address this research question. Given the difficulty in determining if avoidance behaviour is occurring due to ship traffic, the existing survey data do not presently allow for any quantifiable estimate of the duration of avoidance behaviour to ship passages. Qualitative and anecdotal observations are presented below.

Marine mammal observers at Bruce Head in 2013 (LGL 2014) suggested in logbook notes that narwhal would move away when a vessel was present and that narwhal would leave the study area for two hours. It was noted that this observation was similar to what has been reported by Inuit elders and other hunters. One observer noted that some narwhal travelled to a "safe place" when a vessel was present and that narwhal returned later for feeding. Logbook comments may represent previous observer experience or knowledge of narwhal behaviour when vessels were present, but do not appear to be specific to what was recorded during the study (observations are inconsistent with reported survey data).

4.1.4 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).

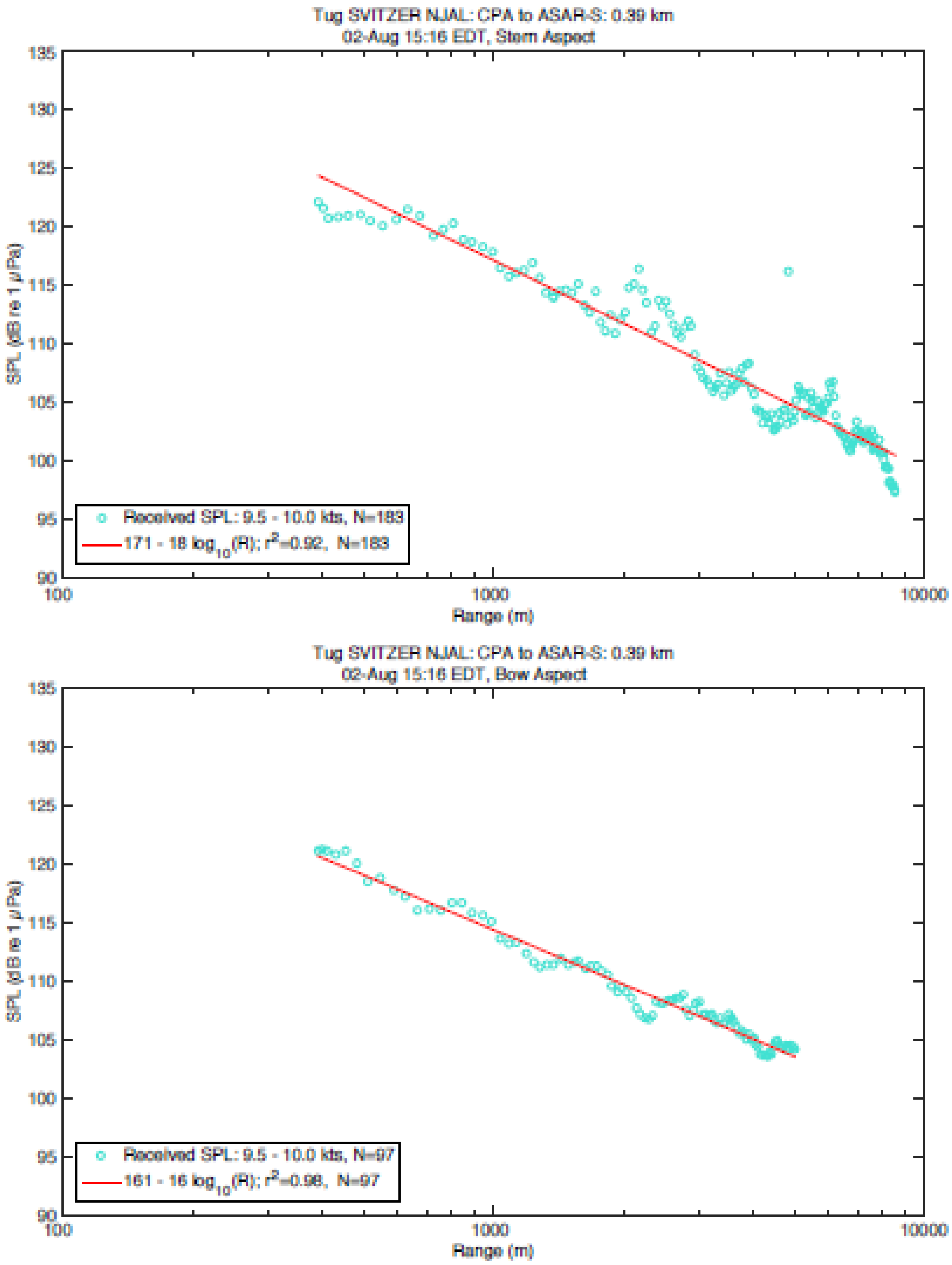
From published literature, the best estimates for narwhal response levels to continuous sound levels are 120 dB (rms) for disturbance onset is 120 dB (rms), avoidance at 135 dB (rms), and hearing impairment (TTS) sound levels of 175 dB (rms), 100 sec exposure (Baffinland 2012b).

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 4.23 through Figure 4.29). 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 4.8. 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 4.23 through Figure 4.29).

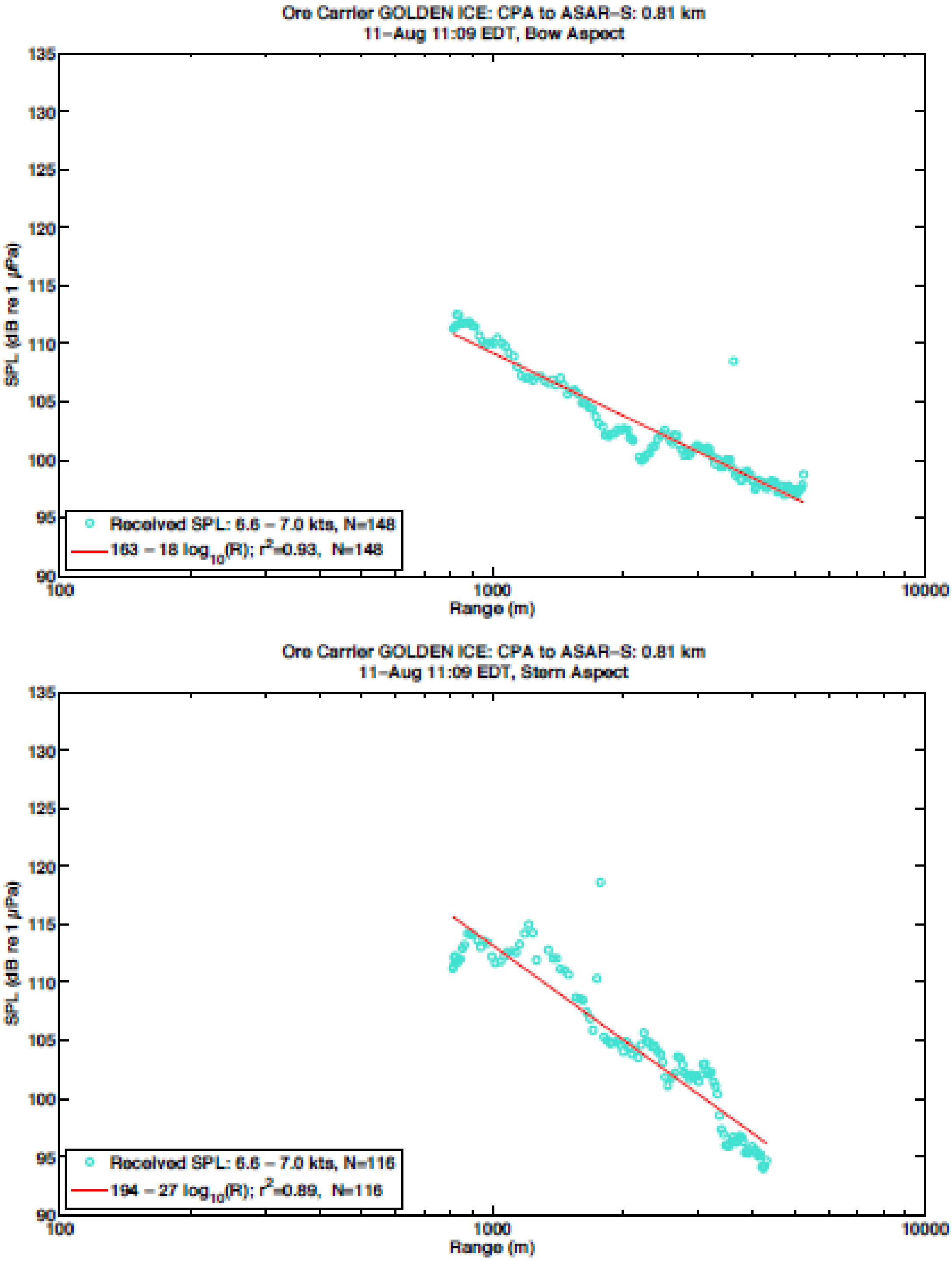
Table 4.8 Estimated distance from vessel where received sound level is reduced to 120 dB

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



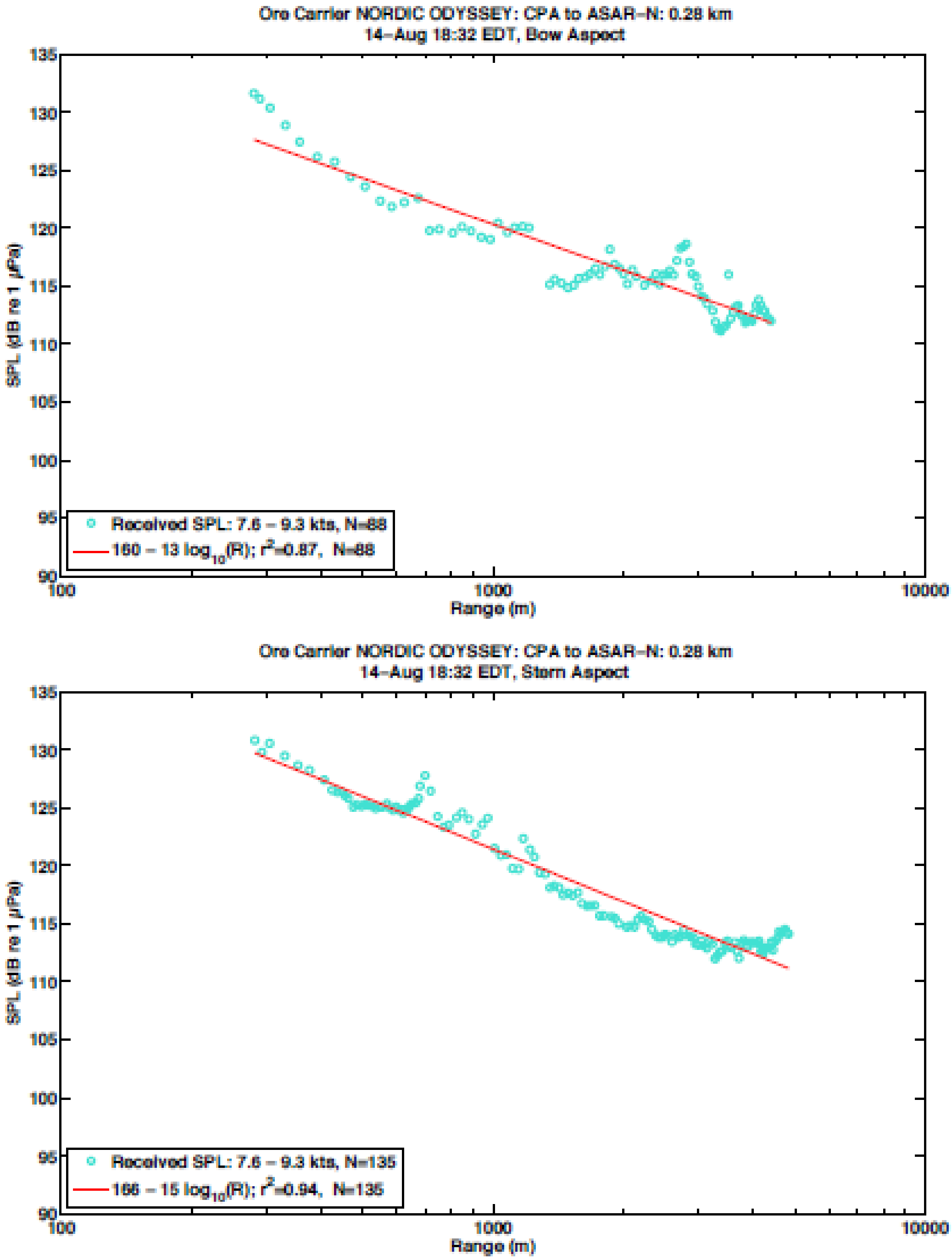
Source: Greeneridge (2015)

Figure 4.23 Received sound pressure levels (SPL) from Svitzer Njal (tug) as a function of distance (range).



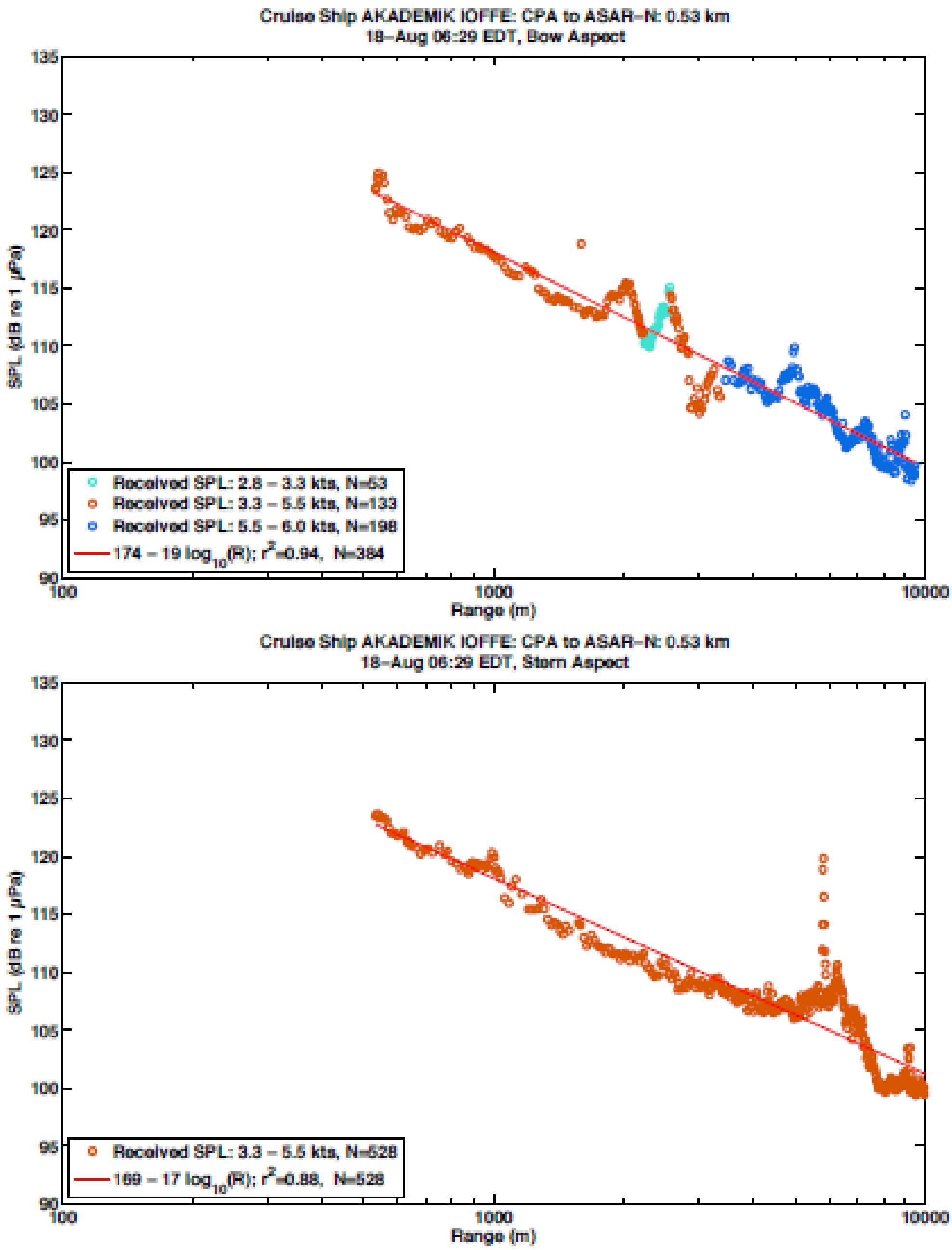
Source: Greeneridge (2015)

Figure 4.24 Received SPL from ore carrier Golden Ice as a function of distance (range).



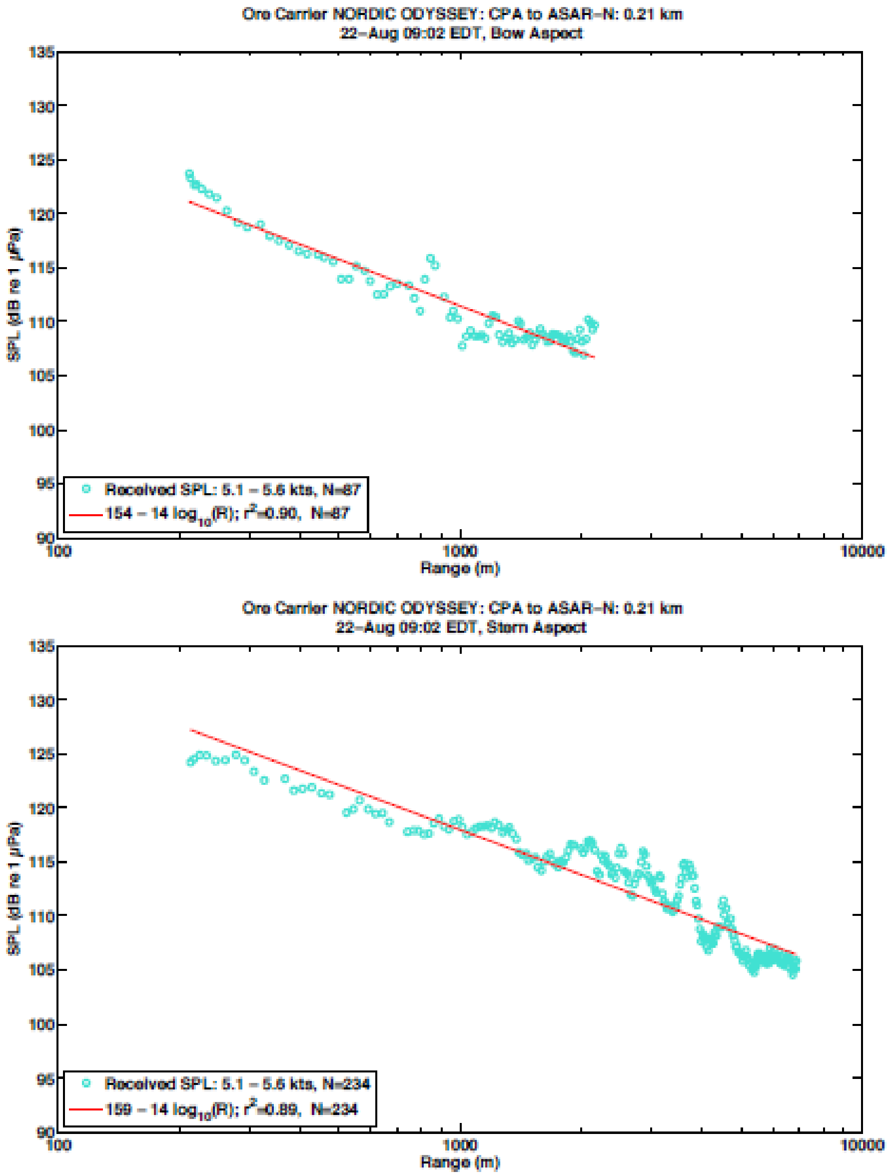
Source: Greeneridge (2015)

Figure 4.25 Received SPL from ore carrier Nordic Odyssey as a function of distance (range).



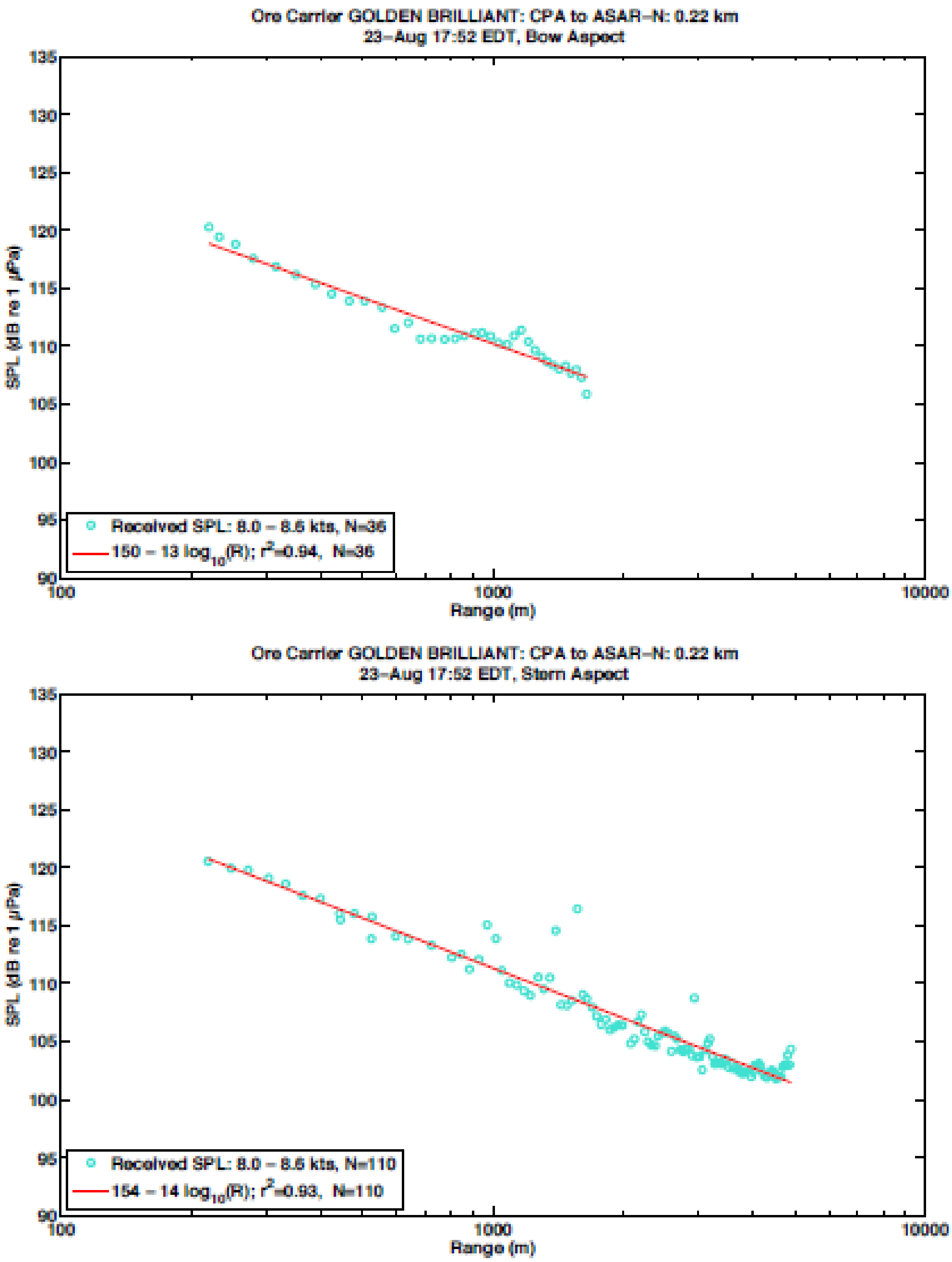
Source: Greeneridge (2015)

Figure 4.26 Received SPL from cruise ship Akademik Ioffe as a function of distance (range).



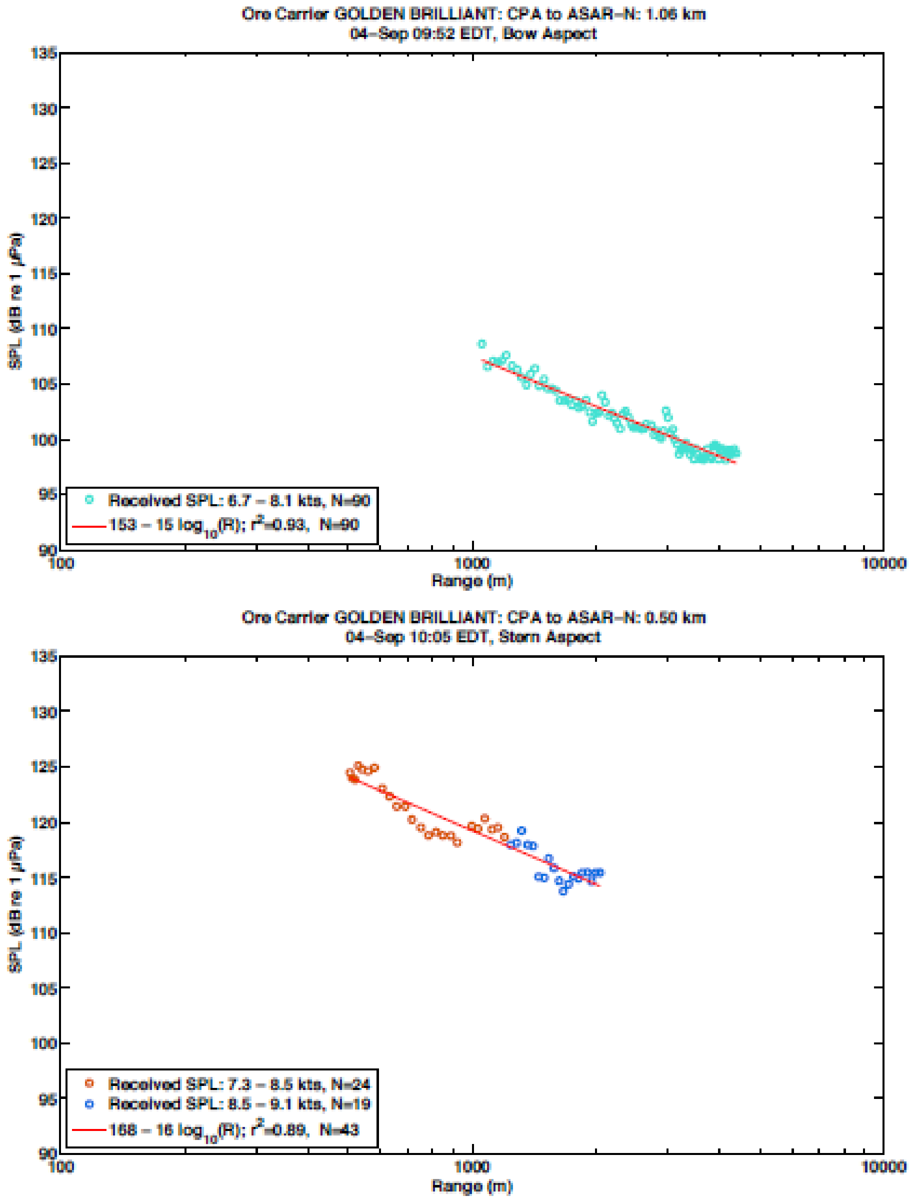
Source: Greeneridge (2015)

Figure 4.27 Received SPL from ore carrier Nordic Odyssey (carrying 73,710 mt of iron ore) as a function of distance (range).



Source: Greeneridge (2015)

Figure 4.28 Received SPL from ore carrier Golden Brilliant as a function of distance (range).



Source: Greeneridge (2015)

Figure 4.29 Received SPL from ore carrier Golden Brilliant (carrying 73,053 mt of iron ore) as a function of distance (range).

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

Based on data collected to date, it has not yet been possible to determine if habituation has taken place to ship passages. 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 Baffinland 2017a 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.*

In 2017, Golder, on behalf of Baffinland, designed and implemented a narwhal study based on a remote tagging approach for investigating the behavioral and vocal response of individual narwhal to ship noise and close ship approaches. Specialized instrumentation packages made up of GPS location tags, accelerometers, high-resolution dive sensors, and passive acoustic recorder tags were deployed on 20 live-captured narwhal to track their individual movements and behavior throughout their summer calving season, while concurrently monitoring overlapping ship movements using the Automatic Identification System (AIS) ship tracking tool. Innovative programming features were incorporated into the tag design to address Baffinland's specific study objectives and to overcome previous challenges associated with detecting potential Project-related effects on elusive free-ranging mammals. Preliminary results have allowed for an in-depth analysis of the 3-dimensional movement and vocal behavior of narwhal during both ship-exposure and non-exposure events, while simultaneously recording the animal's acoustic environment using hydrophones built into the tags. Analyzing changes in physical and vocal behaviour in relation to known ship position and existing ship noise levels will help resolve the following research questions:

- Do narwhal move away from approaching ships? What is the distance at which behavioural responses are observed?
- What is the received sound level from ships, measured at the position of the animal, when behavioural responses are observed?
- If narwhal display avoidance or displacement behaviour from ships, and given the large range occupied by individual narwhal on the summering grounds, does this result in larger scale movements than would naturally occur in the absence of ships? What are the physiological consequences? Does this mean that narwhal in the presence of ships use more energy than what is used by narwhal when ships are absent?
- Do individual narwhal habituate to ships, and if so, how long does it take for habituation to occur?

This study is part of a multi-year collaboration between Golder's marine mammal scientists and DFO's Arctic Science Group. Results of the 2017 Narwhal Tagging Study will be released in Q4 2018. Year 2 of the Narwhal Tagging Study is scheduled for summer of 2018.

4.1.6 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. The 2017 Narwhal Tagging Study was developed to address this present data gap, with study details presented above.

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

4.1.7.1 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).

4.1.7.2 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. 2012).

4.2 Change in Narwhal Behaviour

Results presented in this section pertain to the following research question:

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

This question was divided into the following sub-component questions:

4.2.1 What is narwhal behaviour in Milne Inlet before Project shipping? [

Behavioural observations were conducted from Bruce Head by tracking "focal groups" of narwhals and recording their behaviour. Observations from 2013 (LGL 2014) 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.

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

See Section 4.1.2.1.

4.2.3 Is narwhal group composition affected?

Seven large vessel transits went through the study area during the 2013 field season (LGL 2014). 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 group 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 4.9 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 data on group composition or group size 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 4.10). 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 4.1.7.1. The difference in group spread was not statistically significant.

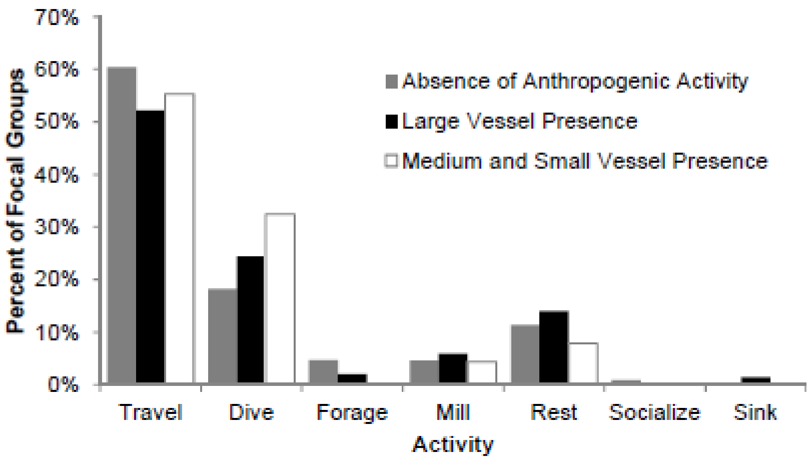
Table 4.10 Narwhal group composition and group spread observed from Bruce Head in 2015 relative to vessel presence.

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

Source: LGL (2016a)

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

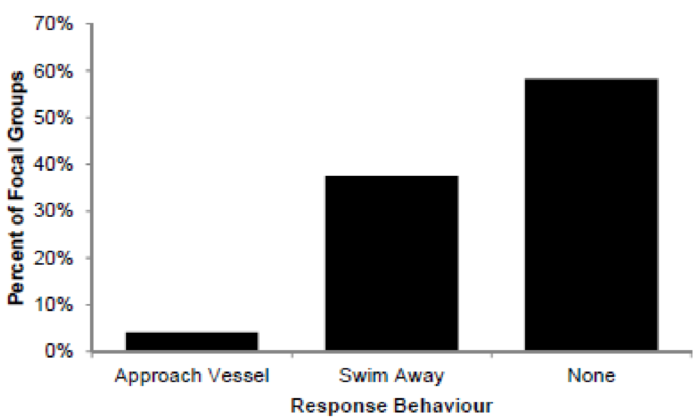
In 2013, no significant differences were detected for any of the “general” behaviour categories across the three types of anthropogenic activity (LGL 2014). Visual inspection of the data (Figure 4.30) does not suggest a clear pattern of changes in group behaviour when vessels were present. However, there was some indication that diving was observed more frequently during periods when vessels were present versus absent.



Source: LGL (2014)

Figure 4.30 Narwhal behaviour during focal group observations at Bruce Head in 2013 relative to vessel presence.

More than half of the observed narwhal exhibited no detectable response to the presence of large vessels (~58% of focal groups) (Figure 4.19). 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.



Source: LGL (2014)

Figure 4.31 Narwhal behaviour observed at Bruce Head in 2013 relative to large vessel presence.

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 4.11).

Table 4.11 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 (2014) 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 (2014) 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 4.12. 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 4.12). Due to small sample size, no statistical analysis was conducted.

Table 4.12 Narwhal swimming behaviour observed from Bruce Head in 2014 relative to vessel presence.

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

Note: data were not collected during large vessel transits

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 4.14). Swimming speed and linearity were determined, but were not statistically tested due to small sample size (Table 4.14).

Table 4.13 Narwhal swimming speed observed at Bruce Head (2015) relative to vessel presence.

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

Note: Groups observed during shooting events or group sizes of 1 were excluded. Source: LGL (2016a)

Table 4.14 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

4.2.5 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 2014). 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 (Baffinland 2017a Appendix B). Many of these small vessels spent time anchored at the shoreline immediately below the observation site.

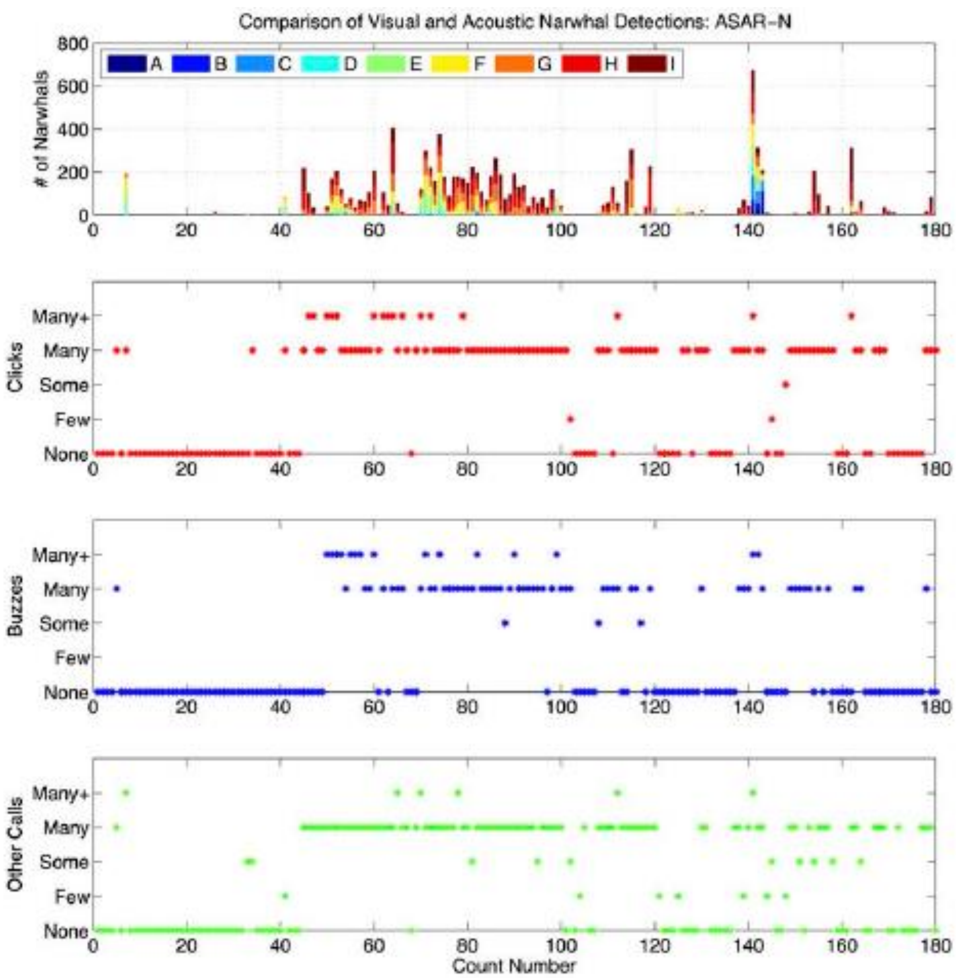
Much more hunting activity was observed at Bruce Head in 2015 than in either 2013 or 2014. The hunting camp was observed to be occupied on 16 days over the course of the 2015 study period (LGL 2016a). Hunting activity was observed on 12 days from 8 to 30 August, and comprised 72+ shooting events. The 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.

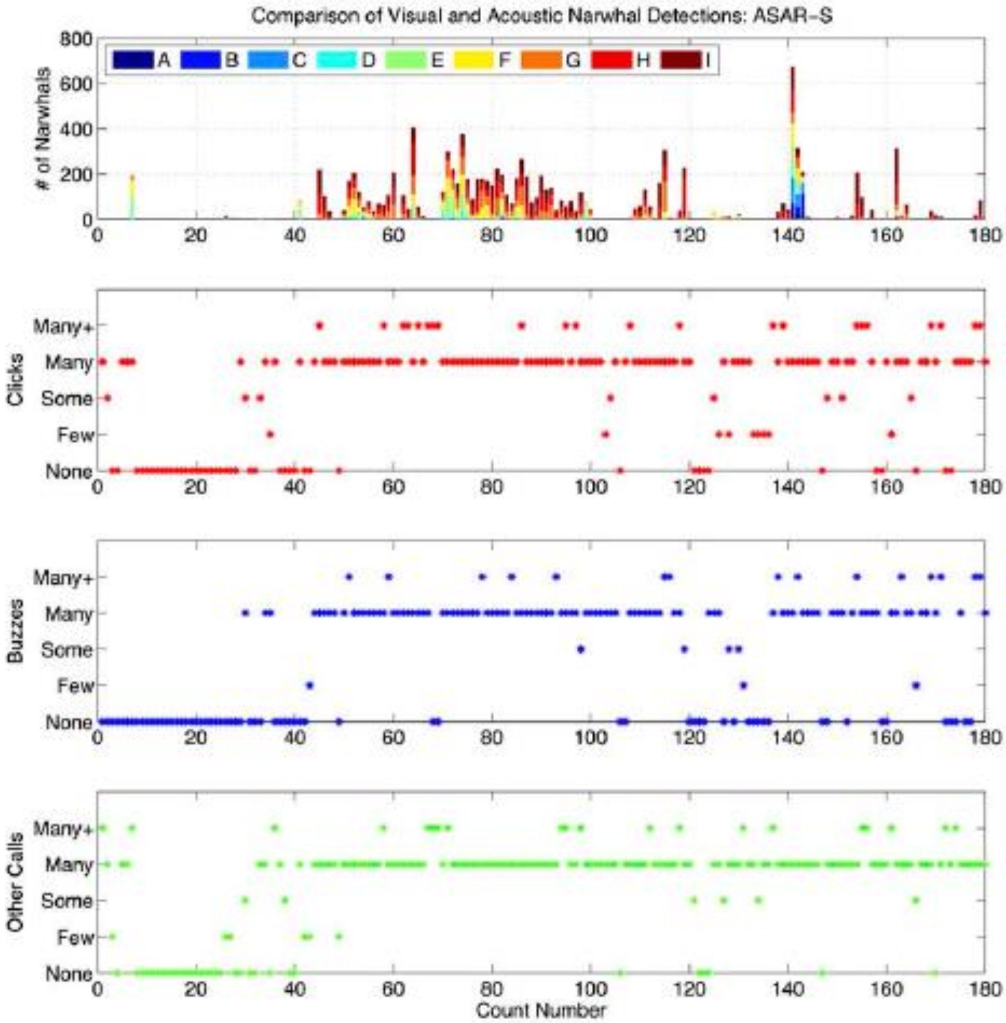
4.2.6 Do the number and characteristics of narwhal calls change in the presence of shipping?

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 4.32 and Figure 4.33). 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.



Source: Greeneridge (2015)

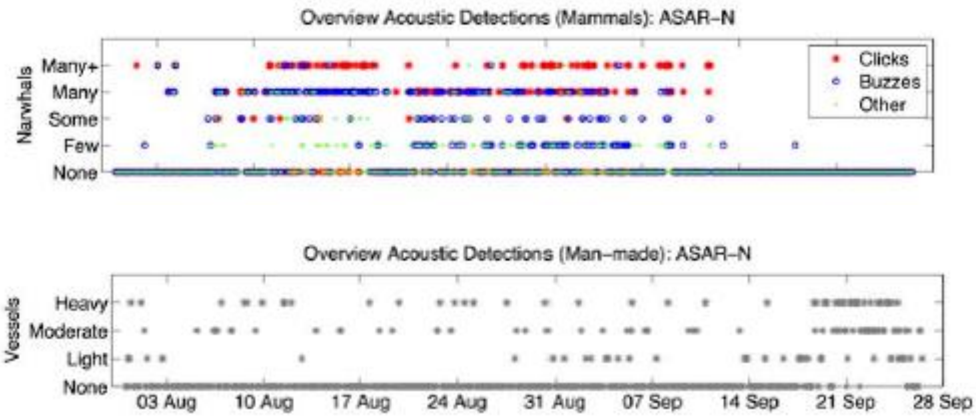
Figure 4.32 Comparison of visual sightings and acoustic detections of narwhal at Bruce Head (ASAR-N; 3 Aug to 5 Sept 2014).



Source: Greeneridge (2015)

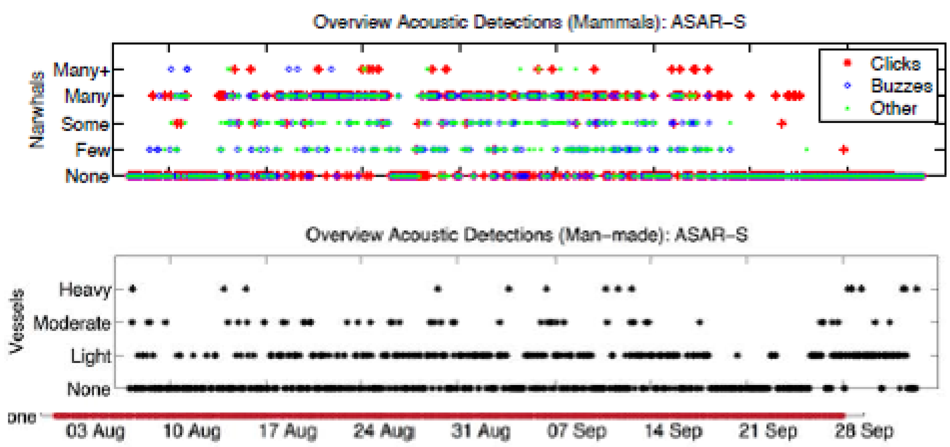
Figure 4.33 Comparison of visual sightings and acoustic detections of narwhal at Bruce Head (ASAR-S).

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 4.34 and Figure 4.35) 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.



Source: Greeneridge 2015

Figure 4.34 Comparison of narwhal vs. vessel acoustic detections near Bruce Head (ASAR-N; 2014).

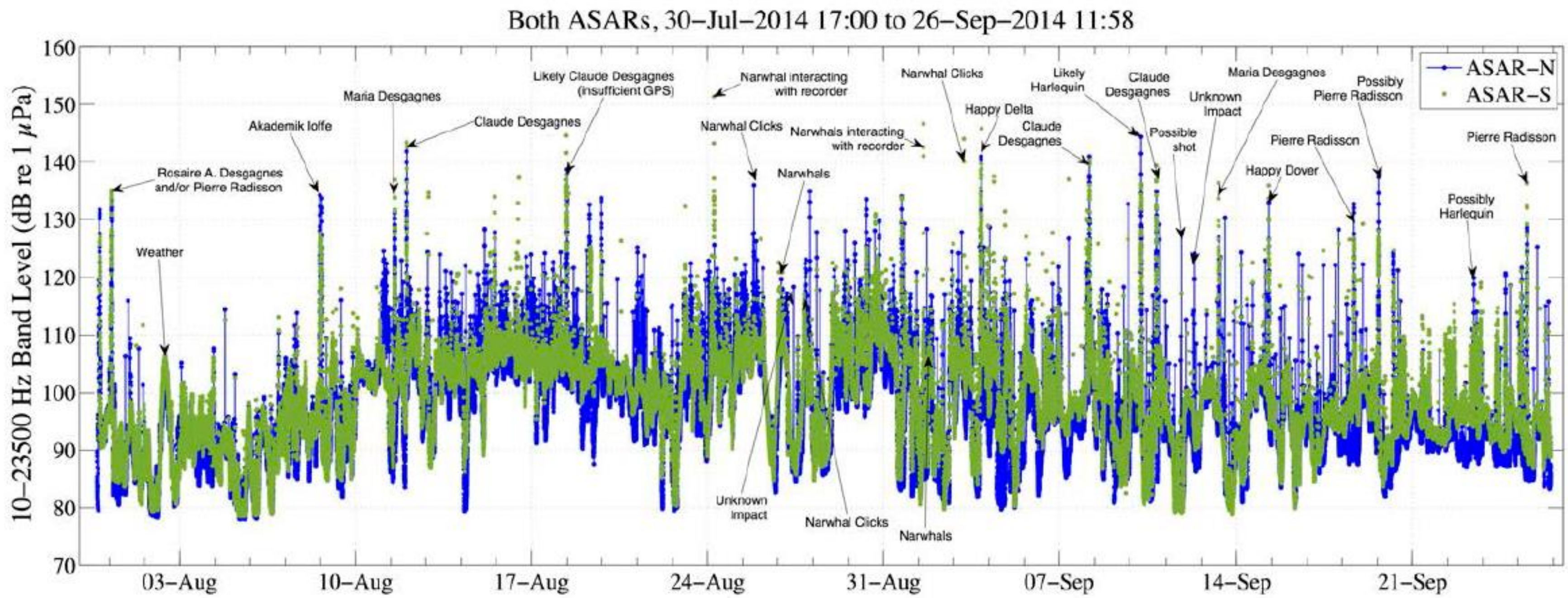


Source: Greeneridge 2015

Figure 4.35 Comparison of narwhal vs. vessel acoustic detections near Bruce Head (ASAR-S; 2014).

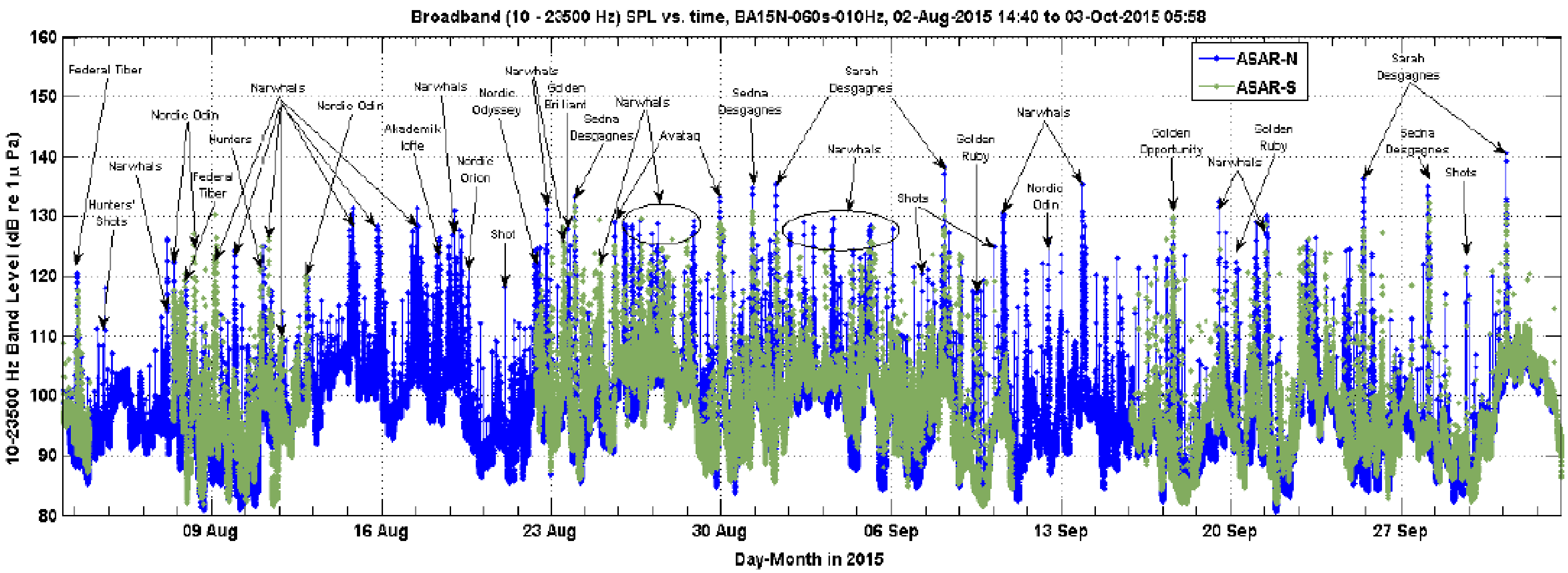
Broadband (10–23,500 Hz) received sound levels were similar for the two recorders in 2014 (Greeneridge 2015). Minimum broadband levels were 78.0 and 78.5 dB re 1 µPa for ASAR-N and ASAR-S, respectively. Maximum broadband received levels reached 144.4 and 151.4 dB re 1 µPa for ASAR-N and ASAR-S, respectively. 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 4.36).

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 4.37).



Source: Greeneridge (2015)

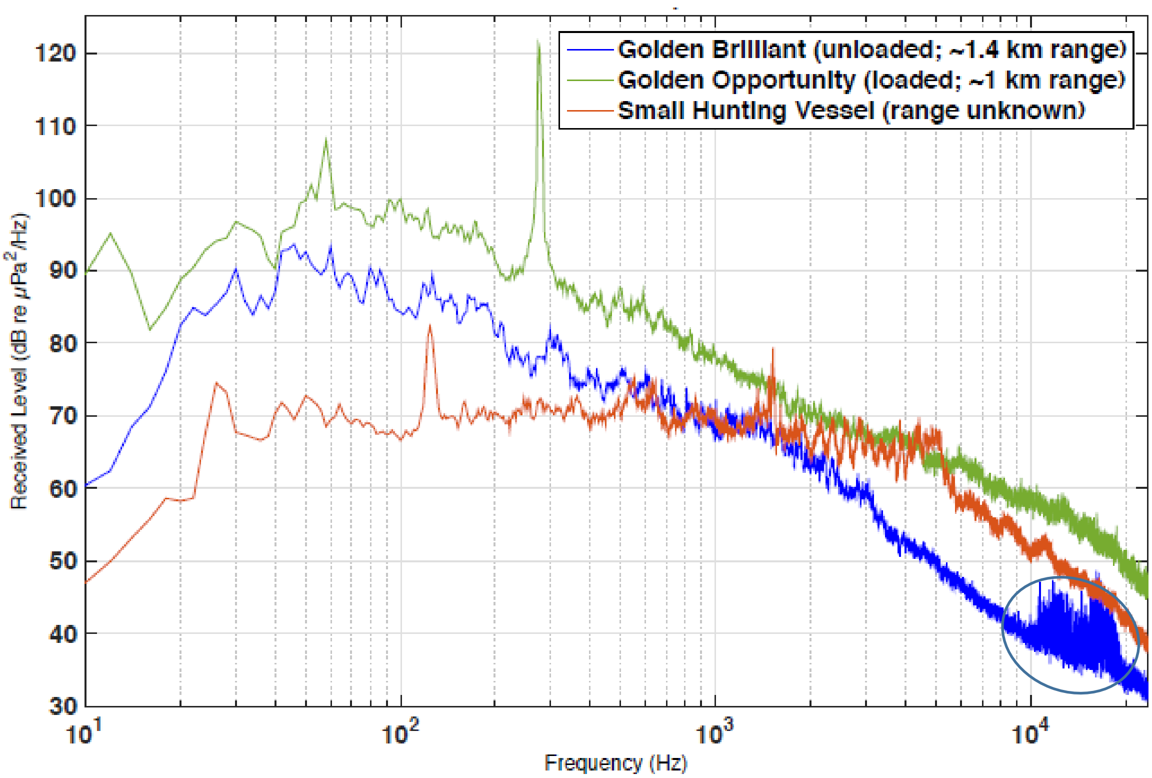
Figure 4.36 Transient sound sources detected in Milne Inlet by PAM stations in 2014.



Source: Greeneridge (2016)

Figure 4.37 Transient sound sources detected in Milne Inlet by PAM stations in 2015.

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 4.38, 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.



Note: 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)

Figure 4.38 Comparison of acoustic signatures of two ore carriers and a small hunting vessel recorded in 2016.

4.3 Short-term, Long-term, and Cumulative Effects of Shipping

Results presented in this section pertain to the following research question:

- **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. Ongoing monitoring programs have been modified, and new monitoring programs have been developed, to address this data gap.

5.0 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.

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APPENDIX A

Summary of Marine Mammal IQ From Community Workshops

1.0 INTRODUCTION

Baffinland identified the need for additional information to be collected in regards to contemporary Inuit land uses in areas potentially affected by the Phase 2 Proposal. This information is referred to as 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). In addition to collection of IQ information, there was a need for community concerns specific to the Phase 2 Proposal to be discussed and for potential mitigation measures to be reviewed and assessed. In order to do this, Baffinland organized a series of ‘invited persons’ workshops and public open houses in Pond Inlet and Arctic Bay, Nunavut between March 2015 and May 2016. These workshops were focused on five main themes: contemporary Inuit land use in the Eclipse Sound and Navy Board Inlet areas, shipping through ice, open water shipping, caribou, and Phase 2 and Arctic Bay. A number of discussions were held during these workshops and opportunities were provided for local residents to learn more about the Phase 2 Proposal, share comments and concerns, and provide suggestions on how the Phase 2 Proposal could be improved.

The first workshop, Contemporary Inuit Land Use in the Eclipse Sound and Navy Board Inlet Areas, reviewed seasonal conditions and land use activities for the Inuit seasons of Ukiaksaaq (October to mid-November), Ukiuq (mid-November to February), Upirngaksaaq (March to May), Upirngaaq (late May to July), and Aujaq (end of July to September) in the Eclipse Sound and Navy Board Inlet areas. This workshop documented a number of Inuit land use activities, some of which the Phase 2 Proposal may interact with. In addition to documenting land use information textually and on seasonal maps, graphical calendars were created to provide a more detailed timeline of selected land use activities throughout the year. Discussion and mapping of key narwhal migration and lifecycle activities in the Eclipse Sound and Navy Board Inlet areas also occurred during the workshop.

The second workshop, Shipping Through Ice, focused on obtaining community feedback pertaining to the shipping through ice component of the Phase 2 Proposal. Concerns about the effects of Phase 2 Proposal on the marine environment (including marine mammals) were raised, as were concerns on Inuit travel routes and land use activities being impeded by ice breaking activity and the creation of a ship track. However, various mitigation, monitoring and research, and compensation and benefits recommendations were made by workshop participants. Interest was expressed in the use of ship track crossing methods (e.g. removable bridges) and workshop participants discussed a number of ship track safety, crossing, and marking considerations. Workshop participants also commented on preferred timing, routing, and notification methods for shipping through ice activities, in addition to other related topics. Finally, workshop participants described ice conditions along the proposed Phase 2 shipping route and other locations in the Eclipse Sound and Navy Board Inlet areas.

The third workshop, Open Water Shipping, focused on obtaining community feedback pertaining to the open water shipping component of Phase 2. Some concerns about the effects of Phase 2 on the marine environment (including marine mammals) were again raised, as were some concerns on Inuit land use activities being impeded by open water shipping activities. However, open water shipping was generally noted to raise much fewer concerns than shipping through ice. Various mitigation, monitoring and research, and compensation and benefits recommendations were also made by workshop participants, in addition to discussing other related topics. Finally, workshop participants commented on the acceptability of Baffinland’s proposed trans-shipping sites, and described shipping route conditions along the proposed Phase 2 shipping route and other locations in the Eclipse Sound and Navy Board Inlet areas.

The fourth workshop, Caribou, focused on obtaining community feedback pertaining to the Phase 2 Proposal and caribou. Various North Baffin caribou ecology topics were discussed, including population dynamics, migration patterns, behaviour, and food sources. Contemporary caribou harvesting activities in the North Baffin region were also reviewed and community concerns pertaining to the Phase 2 Proposal were documented. For example, concerns pertaining to existing Project-related impacts, harvesting and land use, the tote road, dust, and monitoring programs were all reviewed. Likewise, various mitigation, monitoring and research, and compensation and benefits recommendations were made by workshop participants, in addition to discussing other related topics.

The fifth and final workshop, Phase 2 and Arctic Bay, focused on obtaining feedback from the community of Arctic Bay on the Phase 2 Proposal. Summaries of feedback obtained from the previous community workshops held in Pond Inlet were reviewed and discussions on a number of related topics ensued. These discussions were generally structured around the previous community workshop themes of contemporary Inuit land use in the Eclipse Sound and Navy Board Inlet areas, shipping through ice, open water shipping, and caribou, although other topics were discussed as necessary. While many comments raised in this workshop were similar to those documented in the previous community workshops, some valuable new information and experiences (e.g. from the Nanisivik Mine) were also shared.

Completion of these five community workshops has provided Baffinland with valuable community feedback on the Phase 2 Poposal. It has also helped identify a number of potential mitigation, monitoring and research, and compensation and benefits measures that could be employed moving forward. Additional outcomes from these workshops have included continued relationship building and information sharing with the residents of Pond Inlet and Arctic Bay in regards to the Mary River Project, and satisfaction of some Phase 2 public consultation requirements related to the environmental assessment that will be conducted. The success of these workshops was due in large part to the meaningful participation of community members from Pond Inlet and Arctic Bay, their willingness to discuss a diverse array of issues in an open and transparent manner, and the cooperative atmosphere that was established between all parties in attendance.

A summary of IQ for marine mammals in the Project area and community concerns pertaining to the Phase 2 Proposal is presented below, based on information excerpted from Jason Prno Consulting Services (2016), with information presented separately for each season.

2.0 SEASONAL ACTIVITIES

2.1 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.

2.2 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.

2.3 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.

2.4 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.

2.5 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.

3.0 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).

4.0 SHIPPING

4.1 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.*

4.2 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.*

4.3 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.

5.0 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.

5.1 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.

5.2 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.*

6.0 REFERENCES

Jason Prno Consulting Services Ltd. 2016. Results of Community Workshops Conducted for Baffinland Iron Mines Corporation’s Phase 2 Proposal. Report prepared for Baffinland Iron Mines Corporation. September 2016.

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APPENDIX B

Underwater Acoustic Modelling Report

APPENDIX C

2016 Marine Mammal Aerial Photography Survey – Milne Inlet and Eclipse Sound

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