Baffinland

TECHNICAL SUPPORTING DOCUMENT

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

TSD 10

Terrestrial Wildlife Baseline and Impact Assessment





WILDLIFE AND WILDLIFE HABITAT TECHNICAL SUPPORTING DOCUMENT SUMMARY

The Wildlife and Wildlife Habitat Technical Supporting Document provides an assessment of the Phase 2 Proposal's effects on wildlife and wildlife habitat 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.

The document provides a review of the issues and concerns raised in community meetings regarding effects on wildlife and wildlife habitat, and updates the impact assessment on wildlife and wildlife habitat based on activities proposed for the Phase 2 Proposal.

The Phase 2 Proposal is not expected to influence terrestrial wildlife and habitat at the population level due to planned mitigation and the small footprint affected relative to available habitat in the region. Given the existing wildlife management limits (i.e. total allowable harvest), increased hunter access is not expected to result in harvesting activities with the potential to cause population-level effects on caribou.

Caribou currently are in very low numbers and are seldom expected to be encountered along the rail route. Caribou vehicle strikes will be reduced by existing mitigation practices such as adjusting speed limits, seasonal traffic limits, and regular monitoring of caribou sightings in proximity to the Tote Road and North Railway. Baffinland intends to continue the implementation of its wildlife policy, which grants wildlife the right-of-way for travel. The Tote Road and North Railway do not intersect known traditional caribou movement corridors including caribou crossings and are therefore not expected to present substantial barriers to caribou movement. The Phase 2 Proposal may disturb wolf denning habitat, however, this does not represent a substantial loss of potential denning habitat relative to the amount of alternative wolf denning habitat available.

With consideration of planned mitigation and wildlife harvest management in the region, terrestrial wildlife are not expected to be affected at the population level. 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 wildlife and wildlife habitat.

RÉSUMÉ DE LA DOCUMENTATION TECHNIQUE COMPLÉMENTAIRE SUR L'HABITAT FAUNIQUE ET LA FAUNE

La documentation technique complémentaire sur l'habitat faunique et la faune comporte une évaluation des effets de la proposition de la phase 2 sur l'habitat faunique et la faune 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 liée à l'énoncé des incidences environnementales (EIE) et aux addendas précédents.

Le document présente un examen des problèmes et des préoccupations soulevés lors des réunions communautaires concernant les impacts sur la faune et les habitats fauniques et met à jour l'évaluation de l'impact sur la faune et l'habitat faunique en fonction des activités proposées pour la phase 2.

La proposition de la phase 2 ne devrait pas avoir d'impact sur la faune et l'habitat terrestres au niveau de la population en raison des mesures d'atténuation prévues et de la faible empreinte laissée par rapport à l'habitat disponible dans la région. Étant donné les limites actuelles de gestion de la faune (c.-à-d. la récolte totale autorisée), l'accès accru des chasseurs ne devrait pas entraîner d'activités de récolte susceptibles d'avoir des effets sur le caribou au niveau de la population.

À l'heure actuelle, le nombre de caribous est très faible et on s'attend rarement à ce qu'ils soient rencontrés le long de la voie ferrée. Le nombre de collisions de véhicules avec des caribous sera atténué par les pratiques d'atténuation existantes, comme l'ajustement des limites de vitesse, les limites de la circulation saisonnière et la surveillance régulière des observations de caribous à proximité du chemin Tote et du chemin de fer du Nord. Baffinland a l'intention de poursuivre la mise en œuvre de sa politique sur la faune, qui accorde à la faune le droit de passage. Le chemin Tote et le chemin de fer du Nord ne croisent pas les corridors traditionnels de déplacement du caribou connus, comme les passages pour caribous, et ne devraient donc pas constituer des obstacles importants au déplacement du caribou. La proposition de la phase 2 pourrait perturber l'habitat de mise bas des loups, mais cela ne représente pas une perte substantielle de l'habitat de mise bas potentiel par rapport à l'habitat de mise bas alternatif disponible.

Compte tenu de l'atténuation planifiée et de la gestion des prélèvements d'animaux sauvages dans la région, la faune terrestre ne devrait pas être affectée au niveau de la population. 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 l'habitat faunique et la faune.

ᓂᕐᔪᑏᑦ ᓇᔪᒐᕆᓲᖏᓪᓗ ᓄᓇᐃᑦ ᐱᔭᕆᑐᔪᑦ ᐃᑲᔪᐃᔾᔪᑎᑦ ᑎᑎᖅᑲᑦ ᐅᓂᒃᑳᓕᐊᑦ

ᓂᕐᔪᑏᑦ ᓇᔪᒐᕆᓲᖏᓪᓗ ᓄᓇᐃᑦ ᐱᔭᕆᑐᔪᑦ ᐃᑲᔪᐃᔾᔪᑎᑦ ᑎᑎᖅᑲᑦ ᐅᓂᒃᑳᓕᐊᑦ ᓴᖅᑭᑎᑦᑎᕗᑦ ᕿᒥᕐᕈᓂᕐᒥᒃ ᐱᓕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓᑕ ᐊᒃᑐᐃᓂᕐᑲᕐᓂᐅᓂᐊᖅᑐᓂᒃ ᓂᔾᔪᑎᓂᒃ ᓇᔪᕆᖏᑕᓗ ᓄᓇᖏᓐᓂᒃ ᐃᓚᕐᑲᖅᓱᓂᓗ ᓄᑖᓂᒃ ᑐᑭᓯᐅᒪᔾᔪᑎᒃᓴᓂᒃ ᑲᑎᖅᓯᒐᑦ ᑎᑎᕋᐅᓯᐅᔪᓪᓘᓐᓃᑦ ᑕᐃᑲᙵᓂᑦ ᑎᑎᕋᐅᖅᓯᒪᔪᑦ ᓯᕗᓪᓕᖅᐹᑦ ᑐᓐᓂᕆᔭᐅᓚᐅᖅᑎᓪᓗᒋᑦ ᐊᖏᖅᓯᒪᔭᒧᑦ ᐅᔾᕋᖅᓂᐊᕐᓂᕐᒧᑦ. ᐱᓕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓ ᐃᓚᒋᐊᓇᔭᕐᑲᖅᑐᖅ ᖄᖓᒍᑦ ᐊᖏᕗᕚᑦ ᑐᙵᕕᑦ ᖃᐅᔮᓴᕕᓃᑦ ᐊᕙᑖᓄᑦ ᑕᒪᓐᓇᓗ ᕿᒥᕐᕈᐃᓂᖅ ᑕᐃᑲᖓᑦ 2011–ᒥ ᑖᓯᒧᖓ ᐃᓗᐃᑦᑑᔪᒧᑦ ᐊᖏᖅᓯᒪᔭᒧᑦ ᐅᔾᕋᖅᓂᐊᕐᓂᕐᒧᑦ ᑕᐃᓖᒃᑯ ᐊᒃᑐᐊᓂᖅᑲᖅᐳᑦ ᑭᖑᓪᓚᖅᐹᑉ ᐊᕙᑎᒧᑦ ᐊᒃᑐᐃᓂᐅᓂᐊᖅᑐᓄᑦ ᐅᓂᒃᑳᖏᓄᑦ (FEIS) ᓯᕗᓂᐊᒍᓪᓗ ᐅᐃᒍᕆᐊᖅᑕᐅᓂᑰᔫᒃᑯᑦ.

ᐅᓇ ᑎᑎᖅᑲᖅ ᓴᖅᑮᓯᒪᔪᖅ ᕿᒥᕐᕈᔭᐅᓂᖏᓄᑦ ᐃᓱᒪᒋᑦᑯᔭᐅᔪᑦ ᐃᓱᓖᑦᑎᐅᔪᓪᓗ ᐅᕐᑲᐅᓯᐅᓂᑯᑦ ᓄᓇᓕᖕᓂ ᑲᑎᒪᑎᑦᑎᓂᒃᑯᑦ ᐱᔾᔪᑎᖃᖅᑐᑦ ᐊᒃᑐᖅᑕᐅᓂᖏᑕ ᓂᔾᔪᑏᑦ ᓇᔪᒐᕆᓲᖏᓪᓗ ᓄᓇᐃᑦ, ᓄᑖᖑᓇᐊᖅᓯᒪᔪᖅ ᐊᒃᑐᐃᓂᐊᑕ ᕿᒥᕐᕈᔭᐅᓂᖏᑦ ᓂᔾᔪᑎᓄᑦ ᓄᓇᓄᓪᓗ ᓇᔪᕆᖏᓄᑦ ᑐᙵᓪᓗᑎᒃ ᐱᓕᕆᐊᖑᔪᒪᔪᓄᑦ ᐊᑐᕈᒪᔭᖏᑦ ᐃᓗᐊᒍᑦ ᐱᓕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓᑕ.

ᐱᓕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᖅ ᐊᒃᑐᐃᓂᐊᕐᓂᖓᑕ ᓄᓇᐅᑉ ᓂᔾᔪᑎᖏᓐᓂᒃ ᓇᔪᕆᖏᑕ ᓄᓇᖏᓐᓂᒃ ᐱᓪᓗᒍ ᐸᕐᓇᒃᑕᐅᓯᒪᔪᑦ ᓱᕋᐃᑦᑕᐃᓕᒪᓂᕐᒧᑦ ᐊᑐᖅᑕᖓᓗ ᓄᓇ ᒥᑭᑦᑑᓂᖓᓄᑦ ᐊᒃᑐᖅᑕᖅ ᑕᑯᓪᓗᒍ ᓴᓂᖀᑕ ᓄᓇᒥᔭᖏᑦ ᓇᔪᒐᒃᓴᐃᑦ ᓇᑎᕐᓇᕐᔪᐊᖓᓂ. ᐱᓪᓗᒍ ᐊᑐᖅᑕᐅᔪᑦ ᓂᕐᔪᑎᓄᑦ ᐊᐅᓚᕐᑎᔾᔪᑎᑦ ᑭᓪᓕᕐᑲᖅᑐᑦ (ᓲᓪᓗ, ᐊᖑᓂᒃᑕᐅᔪᓐᓇᖅᑐᑦ ᐃᓱᖏᑦ), ᐅᓄᖅᓯᓇᔾᕐᓂᖏᑦ ᐊᖑᓇᓲᒃᑏᑦ ᐃᓱᖅᐸᓪᓕᐊᔪᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᑦ ᐊᖑᓇᓱᒃᑐᑦ ᐱᓕᕆᓂᖏᑦ ᐊᒃᑐᐃᓇᔾᕐᓂᖓᓂᒃ ᐊᒥᓲᓂᖏᓄᑦ ᑐᒃᑐᓂᒃ.

ᑐᒃᑐᑦ ᐅᓪᓗᒥ ᐅᓄᖏᑦᑐᒻᒪᓇᐅᖓᑕ ᕿᒪᕈᐃᓯᒪᓂᖏᓄᑦ ᓂᕆᐅᒋᔭᐅᓗᐊᖅᐸᒐᑎᒃ ᓄᓇᓯᐅᑎᑯᑖᑉ ᐊᖅᑯᑎᒃᓴᒍᑦ. ᑐᒃᑐᑦ ᐊᐳᖅᑕᑦ ᐅᓄᖏᓐᓂᖅᓴᐅᓚᐅᖅᑐᑦ ᐊᑐᖅᐸᓐᓂᖅᑐᑦ ᓄᖅᑲᖓᑎᑦᑎᔾᔪᑎᑦ ᐊᐅᓚᓃᑦ ᓲᓪᓗ ᓱᒃᑲᐃᑉᐸᓪᓕᓃᑦ, ᐊᕐᕌᒎᑉ ᑕᖅᑭᖏᑦ ᒪᓕᒡᓗᑎᒃ ᑭᓪᓕᓕᐊᓄᑦ, ᖃᐅᔨᓴᖑᐃᓐᓇᖃᑦᑕᕐᓂᖏᑎᒍᓪᓗ ᑐᒃᑐᖃᕐᓂᖓ ᐊᕙᑖᒍᑦ ᕿᙱᐊᓄᑦ ᐊᖅᑯᑖᑕ ᐅᐊᖕᓇᑕᐅ ᓄᓇᓯᐅᑎᑯᑖᖅᑲᖅᕕᐊᒍᑦ. ᐸᕙᖓᓐᖓᒍᑦ ᑲᔪᔾᓐᓇᕈᒪᔪᑦ ᐊᑐᓕᖅᑎᑦᑎᓂᕐᒥᒃ ᓂᕐᔪᑎᓄᑦ ᐊᑐᐊᒐᖅᑭᖓᓂᒃ, ᑖᓇ ᐅᕐᑲᐅᓯᕐᑲᒪᑦ ᓂᕐᔪᑎᑦᑖᓕᑦ ᓯᕗᓪᓕᐅᔪᒥᒃ ᐃᓂᕐᑲᓇᐊᑏᑦ ᓇᕈᓇᒃᑎᓪᓗᒋᑦ. ᕿᙱᐊᓄᑦ ᐊᖅᑯᑖ ᐅᐊᖕᓇᑕᐅ ᓄᓇᓯᐅᑎᑯᑖᖅᑲᖅᕕᐊᓐᖓᓗ ᐃᑳᓇᔾᕐᑲᖅᑎᑉ ᖃᐅᔨᒪᔭᐅᔪᓂᒃ ᑐᒃᑐᑦ ᑐᓪᓚᓈᖅᑎᓂᒃ ᐱᓱᒃᑕᕝᕕᕆᓲᖏᓂᓪᓗ ᐃᓚᕐᑲᖅᓱᑎᒃ ᑐᒃᑐᑦ ᐃᑳᕋᕝᕕᖏᑦ ᑰᓐᓄᑦ ᓂᕆᐅᒋᔭᐅᓇᑎᒃ ᓴᖅᑮᒐᔾᓐᓂᖏᑦ ᐊᖏᔪᒥᒃ ᐊᔭᖏᔾᔪᑎᒥᒃ ᑐᒃᑐᑦ ᓇᕈᓇᒃᑎᓪᓗᒋᑦ. ᓴᓇᐅᒪᓂᐊ 2 ᐅᒃᑑᑎᖓ ᐸᕝᕙᓴᐃᑐᐃᓐᓇᓇᓚᐊᓕᒃ ᐊᒪᖅᑯᑦ ᑎᓯᕐᑲᕝᕕᕆᓲᖏᓐᓂᒃ, ᑭᓯᐊᓂ, ᑕᒪᓐᓇ ᐊᖏᔪᐋᓗᒻᒥᒃ ᐊᓯᐅᔨᓂᐅᓇᓂ ᑎᓯᕐᑲᕝᕕᐅᓲᒥᒃ ᐊᓯᕐᑲᑎᐊᓐᓂᖓᓄᑦ ᐊᑐᕈᓐᓇᖅᑕᖓ ᑎᓯᕐᑲᕝᕕᐅᔭᓇᖅᑐᖅ.

ᐃᓱᒪᒋᓪᓗᒋᑦ ᐸᕐᓈᐅᑏᑦ ᓴᕋᐃᓗᐊᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᓂᔾᔪᑎᓪᓗ ᐊᖑᓂᒃᑕᐅᔫᑦ ᐊᐅᓚᑕᐅᓂᖓᒍᑦ ᕿᑭᖅᑖᓗᒃ ᐅᐊᖕᓇᖓ, ᓄᓇᐅᑉ ᓂᕐᔪᑎᖏᑦ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᑦ ᐊᒃᑐᖅᑕᐅᓇᔭᕐᓂᖏᑦ ᐊᒥᓲᓂᓴᖅᑦ. ᑐᓪᓗᒍᑦ ᐅᓪᓗᒥ ᕿᒥᕐᕈᐊᓂᐅᔪᒧᑦ ᐸᕐᓇᐅᑎᓄᓪᓗ ᓱᕋᐃᑦᑕᐃᓕᒪᓂᕐᒧᑦ, ᐅᔾᕋᖅᓂᐊᕐᓂᖅ ᐱᓕᕆᓂᖏᑦ ᐊᑐᖅᑕᐅᔪᒪᔪᑦ ᐃᓚᒋᔭᐅᔪᑦ ᑖᓯᒪ ᐱᓕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓᒍᑦ ᓂᕐᔪᑎᔭᐅᔪᑦ ᓴᖅᑮᒐᔾᔪᑎᖏᑦ ᐊᖏᔪᒥᒃ ᐱᐅᓯᑎᑕᐅᔪᒥᒃ ᓄᓇᐅᑉ ᓴᓇᐅᒪᓂᐊ, ᐃᔾᔪᖅ ᐃᑭᐊᖓᓗ ᕐᑯᐊᖑᐃᓇᓲᑉ ᐃᓗᓕᖏᓄᑦ.

Baffinland Iron Mines Corporation
Mary River Project
Phase 2 Proposal —
Technical Supporting Document No. 10:
Terrestrial Wildlife Baseline
and Impact Assessment

Prepared For
Baffinland Iron Mines Corporation
2275 Upper Middle Road East, Suite 300
Oakville, ON L6H 0C3

Prepared By
EDI Environmental Dynamics Inc.
2195 – 2nd Avenue
Whitehorse, YT Y1A 3T8

EDI Contact
Mike Setterington, CWB, R.P.Bio.
Senior Terrestrial Biologist

EDI Project
18Y0315
July 2018

Down to Earth Biology

ENVIRONMENTAL DYNAMICS INC.

EXECUTIVE SUMMARY

The Mary River Project is an operating iron ore mine located in the Qikiqtani Region of Nunavut. 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, the 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.

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 Northern 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.

To assess potential Project effects from the Phase 2 Proposal activities on wildlife, an understanding of baseline wildlife characteristics in the Project area is required. Initial baseline wildlife surveys were conducted from 2006-2011. Additional wildlife surveys were completed as part of wildlife monitoring programs from 2012-2016. Combined, these data are used to characterize wildlife for Phase 2 of the Project.

This technical supporting document provides a summary of wildlife characteristics in a Regional Study Area (RSA) surrounding the Mary River Project, highlights new information collected or new information published since submission of materials for the Final Environmental Impact Statement (FEIS) and Early Revenue Phase (ERP) assessments. It provides a review of the issues and concerns raised in community meetings regarding effects on wildlife and wildlife habitat and updates the impact assessment on wildlife and wildlife habitat based on activities proposed for the Phase 2 Proposal.

Baseline wildlife studies completed for the Mary River Project from 2006–2016, which includes the following surveys and analyses (refer to Table 1):

- Caribou Inventory (Aerial Surveys)
- Caribou Trail Surveys
- Caribou Collaring Program
- Large and Small Carnivore Inventory and Wolf Den Survey
- Rodents Inventory
- Caribou Height-of-Land Surveys
- Caribou Track Surveys
- Caribou Water Crossing Assessment
- Caribou Fecal Collection

In addition, the Government of Nunavut (GN) led two north Baffin Island caribou surveys and two Baffin Island-wide surveys to determine caribou abundance and distribution. A 2014 late-winter survey, estimated north Baffin Island caribou numbers at 159–622 (mean of 315) individuals (Campbell et al. 2015). Caribou were confirmed to be non-migratory, have small-scale annual and daily movements and to be mostly dispersed across the range even during calving (Campbell et al. 2015). Fall demographic studies completed in 2015 indicated a strong calf recruitment ratio at 71 calves to 100 cows and estimated 93 bulls per 100 cows (Pretzlaw 2016), much higher than the minimum requirement of 40 bulls per 100 cows to confirm all cows are bred (Tobey 2001). The GN replaced the harvesting ban in August 2015 with a total allowable harvest limit of 250 male caribou for the whole island. Further fall demographic surveys in 2016 saw a lower count at 46 males per 100 cows (Anderson 2016).

The information collected for baseline characterization and Project monitoring were sufficient to inform the environmental impact assessment on wildlife and wildlife habitat.

Scoping activities contributed to the identification of wildlife and wildlife habitat as a VEC for the Mary River Project and the baseline and post-FEIS wildlife studies provided information on wildlife and their habitat use patterns in the Project area. The Key Indicator species (KIs) are caribou based on community and harvester interest, and wolf in response to Nunavut Impact Review Board (NIRB) guidelines and requests from the Government of Nunavut. Focus on those KIs (especially caribou) guided the assessment of impacts on wildlife and habitat for the Phase 2 Proposal.

There are several mechanisms or pathways through which the Phase 2 Proposal could potentially affect caribou and wolves that use the Project area. All these potential effects could occur during any/all of the Phase 2 proposal stages. Although there are a variety of pathways through which Project interactions could occur, Project impacts were grouped into four measurable parameters: habitat, movement, mortality and health. Effects on those measurable parameters have the potential to affect caribou and wolves, potentially resulting in changes in behavior and/or in population abundance and distribution.

Assessment methods were both quantitative and qualitative, or mix of both, and included scientific literature and IQ for both methods and significance determination. Habitat was assessed quantitatively using seasonal resource selection function (RSPF) models for caribou in the calving, growing and winter seasons, where the Potential Development Area (PDA) and an estimated Zone of Influence (ZOI) were overlayed to predict habitat loss and reduced habitat effectiveness. Movement was assessed quantitatively by considering caribou behaviour discussed in IQ workshops, and a conservative approach (i.e., biased towards there being a negative effect when there may not be one) that considered physical barriers or filters to movement due to road and rail embankments and vehicle transits. Mortality was assessed qualitatively by considering the potential for increased mortality risk due to continuous human presence in the Project area, and the potential of improved access on the improved Tote Road. Health was addressed semi-quantitatively in the Evaluation of Exposure Potential from Ore Dusting Events in Selected VECs report (Intrinsik 2017), and summarized in this report.

Mitigation measures to limit any identified effects, and determination of the residual effects (effects that remain after all mitigation attempts have been made to try to reduce Project effects), and an assessment of level of confidence that of the assessment results summarize the potential impacts for each measurable parameter. To help provide a broader perspective on the combined effects there is an evaluation of Energy-protein modeling of North Baffin Island caribou in relation to the Mary River Project. That model considered the combined effects of the Project and a potential ZOI on the productivity of North Baffin Island caribou with several scenarios of potential caribou response to disturbance.

The residual effects of Project activities on wildlife include localized direct habitat loss and chronic disturbance; however, overall effects are not likely to have serious implications for the regional populations of any species. Species abundance and habitat use will almost certainly be altered within the PDA, and to some extent within a certain zone of influence, and some individuals may relocate to less-disturbed neighboring areas. Mitigation measures will need to be applied to reduce the effects of collisions with vehicles and infrastructure. The efficacy of proposed mitigation will be monitored by Baffinland.

The Project's existing Terrestrial Environment Mitigation and Monitoring Plan (TEMMP) is already continually updated to address Approved Project changes, improved monitoring methods, statistical analysis to determine power for detection of effects, and input form the Terrestrial Environment Working Group. There are no suggested changes to Project Terms and Conditions for the Phase 2 Proposal.

Table 1. Baseline wildlife studies and workshops completed for the Mary River Project, Baffin Island, 2006–2016.

Survey	Year	Purpose	Results
Caribou Inventory (Aerial Surveys)	2006–2008	To determine abundance and distribution of caribou in regional study area (RSA).	Aerial surveys conducted in late winter, calving season and in the fall found low numbers of caribou in the RSA. Most caribou were found south of the Project; however, some potential calving sites were identified north of the Project corresponding with areas identified through Inuit Qaujimajatuqangit (IQ).
Caribou Trail Surveys	2006–2008, 2010	To identify caribou movement patterns in the RSA.	Most trails were found south of the Mary River Camp, near Steensby Inlet and around Angajurjualuk Lake and northwest of Mary River Camp. Trails north of the Project were fewer and less used.
Caribou Collaring Program	2009–2011	To identify movement rates, seasonal distribution, habitat and calving areas using data from caribou.	Data from thirty-two collared caribou showed current caribou on north Baffin Island were sedentary and non-migratory. Most caribou calved in early June and those that calved in 2009 and 2010 generally calved in the same areas.
Large and Small Carnivore Inventories	2006–2010	To identify abundance and distribution of wolves and foxes in the RSA.	Aerial wolf and fox dens survey completed in 2006 and opportunistic observations of dens, Arctic and red fox, and wolves. There is a low abundance of wolves in the RSA. Arctic fox observations were infrequent, but they are still considered the most abundant terrestrial mammal in the Project area.
Rodents Inventory	2006–2008	To identify prey availability in the RSA.	Live-trapping suggested lemming populations were at the peak of their cycle in 2008. During other years, few were caught despite abundant signs of lemmings.
Inuit Qaujimajatuqangit Traditional Knowledge	2008	Knowledge about historical distribution and abundance, sensitive areas, knowledge about potential effects.	As part of broader IQ workshops about land use, resource use, and IQ, a workshop to discuss specifically wildlife resources and caribou was held in Igloolik in 2008. There were follow-up workshops at community Hunter and Trapper organizations to review and confirm information gathered at the workshop.
Caribou Height-of-Land Surveys	2013–2016	To inventory caribou in Project footprint	Eight caribou were observed during the 2013 HOL survey. Although additional survey stations and surveying during late-winter were added, no caribou were observed in subsequent years. Due to the small number of caribou seen in 2013, no conclusions on behaviour or decrease in caribou abundance in Project area could be determined. In addition, viewshed mapping was completed to determine how far and to what extent surveyors could see. It was determined that 4 km was the maximum distance to identify caribou by sex and age.
Caribou Track Surveys	2014–2016	To identify caribou movement and behaviour along Tote Road in April	No caribou tracks were observed along Tote Road. Most tracks observed belonged to Arctic fox and a few to Arctic hare.
Caribou Water Crossing Assessment	2014	To address QIA concerns about caribou water crossings	An aerial survey covered previously identified caribou trails and crossing sites along the railway alignment and Tote Road in July, including up-and-downstream of any water crossings. No barriers were found up-and-downstream of existing or proposed water crossings. Existing and proposed developments are not believed to inhibit caribou crossings or area usage.
Caribou Fecal Collection	2011–2014	Caribou diet analysis, QIA suggestion	Fecal pellets were collected when encountered during other survey work in the RSA. No analysis has been completed, and samples are kept frozen.
Wolf Den Surveys	2014	Ensure project avoids disturbance at den sites	Den surveys were conducted within 10 km of the Mine Site, Milne Port and Tote Road. No wolves or active wolf dens were identified but one suspected Arctic fox

Table 1. Baseline wildlife studies and workshops completed for the Mary River Project, Baffin Island, 2006–2016.

Survey	Year	Purpose	Results
			den was identified 9.2 km from any Project activities. No mitigation measures are needed.
Phase 2 Community Workshop	2016	To inform of data gaps in existing IQ study	Confirmed knowledge collected for FEIS and noted that caribou behaviour and migration was a function of herd size as few to one caribou tend to be more skittish and avoid disturbances such as the Project. Confirmed importance of lichen as a food source to caribou.

Notes: [1] Project Conditions and Project commitments as per: Project Certificate No. 005.

AUTHORSHIP

This report was prepared by EDI Environmental Dynamics Inc. Staff who contributed to this project include:

Alissa Nyheim-Rivet, BSc. EPt........Primary Author (Baseline)

Hannah Gray, B.Sc........GIS Mapping

Mike Setterington, M.Sc., R.P.Bio., CWB........Primary Author (Impact Assessment)

Andy Smith, M.Sc........Senior Review of Baseline Characteristics

Todd Mahon, M.Sc., R.P.Bio........Senior Review of Impact Assessment

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ATTACHMENT 1. CARIBOU ENERGETICS

ACRONYMS AND ABBREVIATIONS

Acronym	Definition
Baffinland	Baffinland Iron Mines Corporation
EDI	Environmental Dynamics Inc.
ERP	Early Revenue Program
FEIS	Final Environmental Impact Statement
HOL	Height-of-land
INAC	Indigenous (formerly Indian) and Northern Affairs Canada
IQ	Inuit Qaujimajatuqangit
KIs	Key Indicators
Mtpa	Million Tonnes Per Annum
NIRB	Nunavut Impact Review Board
NLCA	Nunavut Land Claims Agreement
PDA	Potential Development Area
QIA	Qikiqtani Inuit Association
RSA	Regional Study Area
SARA	Species at Risk Act
TSD	Technical Support Document
the Project	Mary River Project
TEMMP	Terrestrial Environment Mitigation and Monitoring Plan
WWF	World Wildlife Fund

1 INTRODUCTION

1.1 THE MARY RIVER PROJECT CURRENT OPERATIONS

The Mary River Project is an operating iron ore mine located in the Qikiqtani Region of Nunavut (Map 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, the 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.

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. Shipping at Milne Port will continue to occur during the open water season and may extend into the periods of ice formation and ice break-up as required (July 1-November 15) 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.

1.2 CHANGES FROM THE APPROVED PROJECT MATERIALS

The baseline information on wildlife and habitat characteristics in this report is updated to include additional baseline and relevant monitoring data collected since 2012. This includes summaries of site observations and government surveys that have been included in annual monitoring reports.

The impact assessment portion of the document addresses the effects of the increase in habitat loss, changes to emissions, and increased sensory disturbances to wildlife because of the increased road traffic until the North Railway is operational.

Material in this document is provided for reviewers both familiar with the Mary River Project and written materials provided since 2012, and for those that are new to the review of the Project. There should be sufficient information in this document to form a suitable understanding of the characteristics of wildlife and wildlife habitat within the immediate Project area, the Regional Study Area (RSA), and the broader north Baffin Island region. There should be sufficient information provided on the potential impacts of the Phase 2 Proposal so that reviewers can determine the characteristics of the residual impacts following proposed mitigation and inform decisions on impact significance without having to review the entire Approved Project.

1.3 REPORT OBJECTIVES

This Technical Supporting Document (TSD) provides a summary of wildlife and wildlife habitat characteristics in a Regional Study Area (RSA) surrounding the Mary River Project, highlights new information collected or new information published since submission of materials for the Final Environmental Impact Statement (FEIS) and Early Revenue Phase (ERP) assessments. It provides a review of the issues and concerns raised in community meetings regarding effects on wildlife and wildlife habitat and updates the impact assessment based on activities proposed for the Phase 2 Proposal.

BAFFIN BAY
Pond Inlet
Arctic Bay
ADMIRALTY INLET
Milne Inlet Camp and Port
Milne Inlet Tote Road
Proposed North Railway
Mary River Project Mine Site
Angajurjualuk Lake
Nina Bang Lake
Erichson Lake
Steensby Port
Neergaard Lake
STEENSBY INLET
MURRAY MAXWELL BAY
FURY AND HECLA STRAIT
GULF OF BOOTHIA
MELVILLE PENINSULA
FOXE BASIN
BAFFIN ISLAND
TAY SOUND
NORTH ARM
Map Area
Mary River Project
LEGEND
Community
Mary River Project
Approved - Current Development Area
Approved - Future Development Area
Phase 2 - Proposed Development Area
NOTES
PDA provided by KP, July 11, 2017.
Map Projection: Canada Albers Equal Area Conic.
Scale
Km
Baffinland
Mary River Project
Overview Map
EDI
Date: 6/15/2018
MAP 1

2 WILDLIFE AND WILDLIFE HABITAT CHARACTERISTICS

2.1 REGIONAL STUDY AREA

The Regional Study Area (RSA) was chosen to represent wildlife and habitat at an ecologically relevant scale and to reflect regional habitat use and seasonal movement patterns on north Baffin Island. The RSA also had to be a reasonable size so that surveys and information could be gathered in an economical fashion and provide information that is directly relevant to project management and mitigation.

The 21,053 km² regional study area (RSA) encompasses the Mine Site, the Tote Road to Milne Inlet, the South Railway to Steensby Inlet, the Milne Port and the Steensby Port (Map 2). It is surrounded by ecological boundaries (Ecological Stratification Working Group 1995) and substantial topographic and drainage features. The RSA was identified to confirm that the range of direct and indirect potential disturbances because of the Project's activities could be examined and potential effects could be spatially quantified. It includes variable topography form higher elevation rugged terrain to low elevation rolling tundra. The RSA represents wildlife and habitat at ecologically relevant scales, and reflects regional habitat use and seasonal movement patterns. Determining wildlife distribution and abundance in this area provides site-specific information on key or sensitive areas for wildlife, zones of continual wildlife use, and periods when animals might be more sensitive to disturbances in the region which is directly relevant to Project management and mitigation. The RSA evolved from 2006–2007 to include evolving development plans, recurring sightings of wildlife activities in certain areas and key areas of interest identified during Caribou Focus Working Group meetings (2008) in Hall Beach, Igloolik, Arctic Bay, Pond Inlet and Clyde River.


85°W
80°W
75°W
70°W
72°30'N
70°N
90°W
BYLOT ISLAND
BAFFIN BAY
BRODEUR PENINSULA
ADMIRALTY INLET
BORDEN PENINSULA
Arctic Bay
Eclipse Sound
Pond Inlet
Milne Inlet
Milne Inlet Tote Road
Milne Inlet Camp and Port
Mary River Project Mine Site
BAFFIN ISLAND
Angajurjualuk Lake
Nina Bang Lake
Steensby Port
Erichson Lake
Neergaard Lake
STEENSBY INLET
MURRAY MAXWELL BAY
FURY AND HECLA STRAIT
Igloolik
GULF OF BOOTHIA
FOXE BASIN
MELVILLE PENINSULA
Hall Beach
Map Area
Mary River Project
BAFFIN ISLAND
LEGEND
Community
Mary River Project
North Baffin Caribou Herd Range
Regional Study Area
Potential Development Area
NOTES
Major Herd Distributions:
Ferguson, M. 1989. Baffin caribou. Pp. 142 in Hall, E. (ed). People and caribou in the Northwest Territories. Department of Renewable Resources, Government of the Northwest Territories. Yellowknife, NT. 190 pp.
Updated PDA provided by Hatch (25 April 2013).
Map Projection: Canada Albers Equal Area Conic.
0 10 20 40 60 80 100
Scale
Km
Baffinland
Iron Mines Corporation
RSA for the Terrestrial Wildlife Baseline and Impact Assessment for the Mary River Project
EDI
Date: 6/18/2018
MAP 2

2.2 NORTH BAFFIN ISLAND ECOLOGY OVERVIEW

The Project is located on north Baffin Island in the Northern Arctic Ecozone. The climate is the coldest and driest landscape in Canada with snow cover from September to June and continuous permafrost. Oceanic waters are ice-fast in the northern half of the ecozone but open with offshore ice-pack in the southern half (Ecological Stratification Working Group 1995). Cold temperatures ranging between -30°C in winter and -1.5°C in summer, a short growing season, high winds, shallow predominately cryosolic soils, and limited annual precipitation averaging 10–20 cm result in sparse and dwarfed vegetation. Vegetation cover consists of grasses, herbs, shrubs, and lichens, but the diversity of vegetation species is relatively low.

The Project falls mainly within the Melville Peninsula Plateau Ecoregion, defined by a mid-Arctic climate, but is also located or bordered by the Baffin Island Uplands and Borden Peninsula Plateau Ecoregions. Drier sites in this ecoregion can support sparse covering of purple saxifrage (*Saxifraga oppositifolia*), mountain avens (*Dryas integrifolia*), and willow (*Salix* spp.). Wet sites support continuous cover of grasses, and predominantly include sedges (*Carex* spp.) and cottongrass (*Eriophorum* spp.).

The topography is mainly characterized by a broad, gently warped, old erosion surface composed of Precambrian granitoid bedrock but also varies considerably from plateaus to rocky hills. This includes non-mountainous terrain characterized by major land components such as dry, rugged uplands, rolling plains, and lowland features with some standing water as well as mountainous terrain with some occurrence of glaciers. Deposit No. 1 (Nulujaak), from which iron ore is being extracted, is part of a ridge trending approximately north–south that rises quickly above the flat and sandy outwash plain where the exploration camp is currently located. Nulujaak is a major landmark for Inuit travelling on the land.

Animal diversity and abundance in the area is generally lower than the mainland portions of Nunavut and possibly cyclic with long periods between years of abundance. Caribou (*Rangifer tarandus groenlandicus*) is considered a focal species for the Project as it is the only ungulate on Baffin Island and an important food source for local communities. As of 2016, the barren-ground caribou population was designated as threatened by the Committee of the Status of Endangered Wildlife in Canada (COSEWIC 2016). Other terrestrial mammals found in the Project area include wolf (*Canis lupus manningi*), Arctic fox (*Vulpes lagopus*), brown lemming (*Lemmus trimucronatus*), Peary Land (northern) collared lemming (*Dicrostonyx groenlandicus*), Arctic hare (*Lepus arcticus*) and ermine (*Mustela erminea*). Documented occurrences of wolverine (*Gulo gulo*) and red fox (*Vulpes vulpes*) are rare or uncommon.

2.3 PRE-DEVELOPMENT DATA

This section summarizes information that was presented in the baseline report submitted to the Nunavut Impact Review Board (NIRB) as part of the Mary River Project's Final Environmental Impact Statement (FEIS) submission in 2012. Summaries are included of information that existed at the time, including published Inuit Qaujimajatuqangit (IQ) studies, surveys and studies, and other information related to wildlife on north Baffin Island. This section includes some updates based on any publications or reports that have been produced that summarize wildlife information on north Baffin Island prior to the start of Mine operations in 2014. Details of knowledge and surveys discussed in Section 2 are available in the *Mary River Project Wildlife Baseline 2006–2011*, Appendix 6F (EDI Environmental Dynamics Inc. 2012) submitted to NIRB in 2012 and available on the NIRB public registry.

Most knowledge about Baffin Island wildlife is held by Inuit land users. IQ was shared with Baffinland during baseline environmental work in preparation of the FEIS and was incorporated throughout the baseline report and impact assessment. Some of the IQ had been documented in land use studies such as the Inuit Land Use and Occupancy Project (ILUOP, Brody 1976*a*), Northern Land Use Information Series Maps (Indigenous and Northern Affairs Canada 1981), and the Nunavut Atlas (Riewe 1992). Additional to that published information, Baffinland conducted land user and IQ collection workshops to confirm and update knowledge specific to the north Baffin Island region and the Mary River Project area, and that information is described below where relevant to wildlife baseline conditions.

In addition to the IQ, there were several surveys and studies documented in government reports (Government of Northwest Territories, Government of Nunavut, and Environment Canada). Many of those reports were generally summaries of wildlife resource surveys and harvest data. There were also unpublished (e.g., Pattimore 1984) and published (Priest and Usher 2004) harvest studies that provided further data on wildlife and caribou abundance to support the IQ about wildlife and caribou abundance trends on north Baffin Island and surrounding areas.

In addition to the incorporation of the published and unpublished information and IQ workshops noted above, Baffinland started conducting Mary River Project wildlife baseline work in 2006. That work included aerial and ground surveys for caribou, furbearers and small mammals, all of which are summarized below.

Finally, since the initiation of Baffinland's environmental baseline work, the Government of Nunavut has contributed several studies, surveys, and reports on information relevant to north Baffin Island caribou. These include a caribou collaring program supported by Baffinland (e.g., partly summarized in (Jenkins 2008, Jenkins and Goorts 2011), and Baffinland-supported Baffin Island-wide surveys of caribou and other wildlife (e.g., as summarized in Campbell et al. 2015).

2.3.1 HISTORICAL KNOWLEDGE

2.3.1.1 North Baffin Island Caribou

Caribou herds on Baffin Island include north, south and northeastern Baffin Island herds, which are tentatively based on distinct fall breeding areas and IQ (Kraft 1984, Ferguson 1989, Campbell et al. 2015). The north Baffin Island caribou population surrounding the Project are/were potentially composed of migratory (from south Baffin Island), resident and mainland caribou (Piksiksik Working Group 2006). Exchange and interactions between populations have been documented but are not well understood, and it is not certain if it is justified to describe these groups as distinct populations (Ferguson 2005, pers. comm.); however, for the purposes of baseline characterization, the caribou interacting with the Mary River Project will be referred to as the north Baffin Island caribou.

Historical Surveys

Several surveys were conducted for north Baffin Island caribou from 1970 through to the mid-1990s; however, none of them covered the entire north Baffin Island region (Table 2). Estimates of north Baffin Island caribou numbers ranged from 30,000 in 1985 (Williams and Heard 1986) to 50,000–150,000 in 1991 (Ferguson and Gauthier 1992), but all estimates were based on weak information.

Table 2. Summary of historical caribou surveys completed on north Baffin Island, 1949–1997.

Survey	Year	Purpose and Results	Reference
Aerial surveys	1949–1972	Four aerial surveys of north Baffin Island produced inconclusive population estimates.	(Hall 1980, Ferguson 1989)
Calving reconnaissance survey	May 30 – Jun. 21 1980	Aerial surveys of north Baffin Island including the Mary River area, which was identified as an important calving site by hunters. The survey confirmed community belief that caribou use range was expanding and caribou abundance possibly increasing.	(Allen et al. 1980, INAC 1981)
Reconnaissance survey	Late-Jul. – early Aug. 1982	One live caribou was observed near Tugaat River during an aerial survey of Bylot Island and adjacent areas on Baffin Island.	(Zoltai et al. 1983)
Aerial surveys supplemented with caribou collaring telemetry	1994–1997	Weekly helicopter sex and age classification surveys were completed on north Baffin Island in June 1994 and June 1997 and supplemented with data collected from three collared females. Overall, cows appeared to have calved on rugged ridges on south-facing slopes from mid-June to early July. They were consistently seen along the snowmelt margin. Cows and calves were seen near Tugaat Canyon, in the Project area, in a valley heading southeast of the Project, and the headwaters of Phillips Creek. Cows without calves were seen in the fjords south of Pond Inlet.	(GNDoE unpublished data, Ferguson 1999a)

Historic Harvest

Harvest data, although inconsistently collected and incomplete, were recorded in three sources: 1) from the 1930s to late 1950s by the Royal Canadian Mounted Police (RCMP); 2) in the 1980s summarized in a harvest study for the Baffin Region Inuit Organization (Pattimore 1984); and 3) from the late 1990s to 2001 in the Nunavut Wildlife Harvest Study (Priest and Usher 2004). These data provided an indication of the historical trends of caribou prior to the baseline assessment. There was an abundance of caribou harvested from the mid-to-late 1930s followed by a decrease in harvest numbers in early 1940s to early 1970s, even though human population was increasing at the time. Caribou range use and harvest abundance seemed to gradually recover from the 1960s to 1970s. Caribou harvest abundance was high in the 1980s and 1990s, but caribou in the region have since declined considerably (Priest and Usher 2004, Arctic Bay Caribou Focus Working Group 2008, Clyde River Caribou Focus Working Group 2008, Hall Beach Caribou Focus Working Group 2008, Igloolik Caribou Focus Working Group 2008, Pond Inlet Caribou Focus Working Group 2008). No harvest data have been collected since the Nunavut Wildlife Management Board's Wildlife Harvest Study with data last collected in 2001 (Priest and Usher 2004).

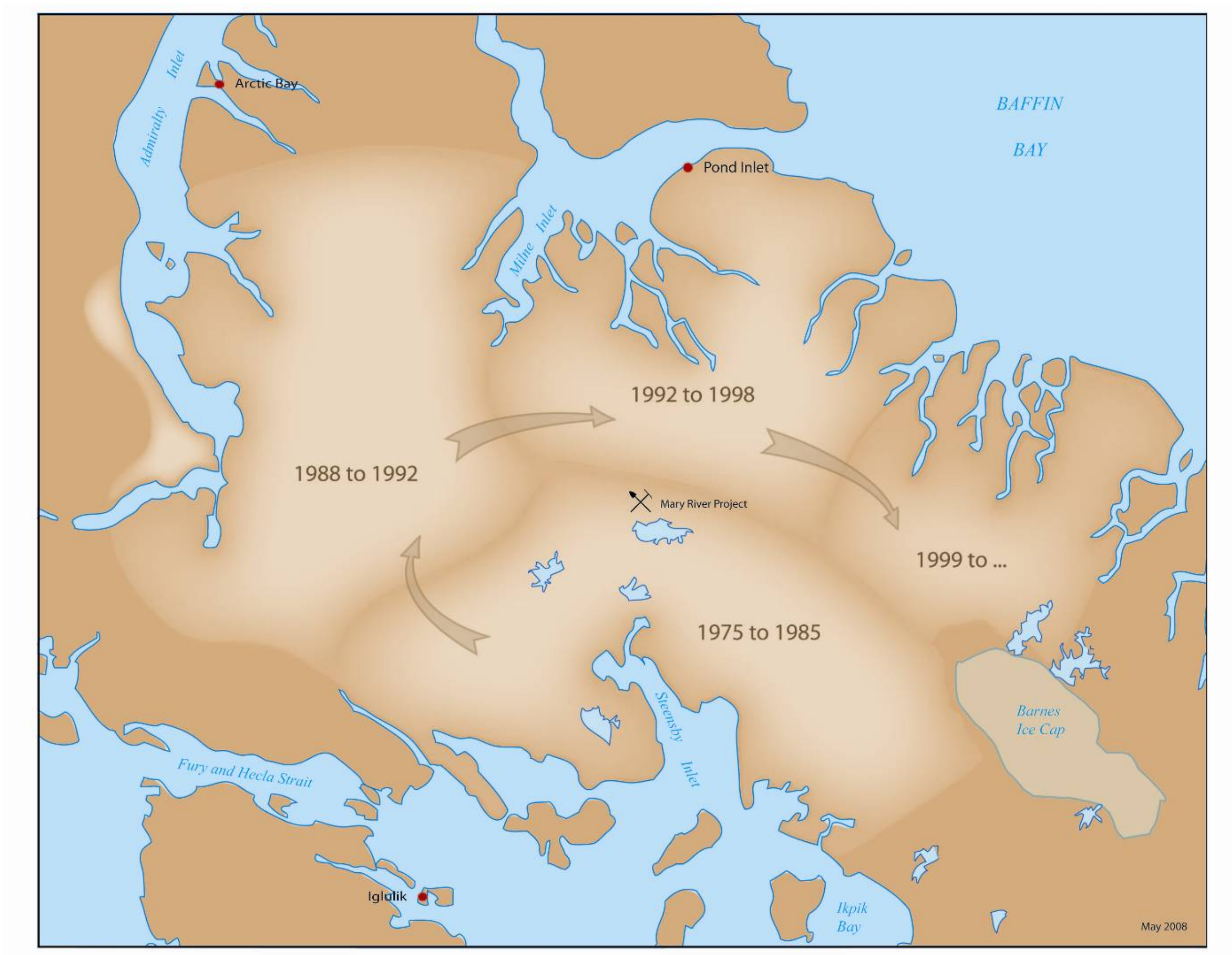
Cyclical Abundance

Syntheses of harvest data, observations, and IQ dating back to 1879 (Clark 1971) suggest that north Baffin Island caribou follow population cycles. The north Baffin Island caribou abundance peaked in the 1920s–1930s after a low in the 19th century (Macpherson 1963 cited in Clark 1971) and was followed by a noteworthy decline starting in the 1940s (Kelsall 1949, Macpherson 1963 cited in Hall 1980, Pond Inlet Caribou Focus Working Group 2008).

The caribou population started recovering in the 1950s, but remained low until the 1970s (Brody 1976a, b) which was also noted by an increase in harvest. Caribou range expanded from the 1970s (Allen et al. 1980, Pond Inlet Caribou Focus Working Group 2008) to areas they had previously left in response to lichen recovery, an important food source for caribou (Arctic Bay Caribou Focus Working Group 2008). In the mid-1970s, caribou numbers were recognized as "high" south of the Project area but only returned to the Pond Inlet area in the early 1990s (Map 3).

Although harvest numbers were higher in the 1980s than the 1990s (Pattimore 1984, Priest and Usher 2004) caribou abundance and range use were at a peak in the 1990s (Mittimatalik Hunters and Trappers Organization (MHTO) 2006 pers. comm.). Approximate spatial distribution varied according to the abundance of caribou and Pond Inlet hunters might have been travelling further to harvest caribou in the 1980s than the 1990s (Map 3). However, the north Baffin Island caribou population started decreasing in the late-1990s and people were finding dead caribou across the land (Mittimatalik Hunters and Trappers Organization (MHTO) 2006, Piksiksik Working Group 2006).

Caribou are currently in the low of their estimated 60–70 year cycle of abundance (Pond Inlet Caribou Focus Working Group 2008). The regularity and cause of these cycles are not well understood as it is unknown if their population fluctuates (e.g., increase and die off) or if the larger component of the herd move and disperse to different and more remote locations. IQ strongly suggests that caribou abundance cycles are related to food renewal (lichen), estimating the return of large numbers to the area in 40–50 years from present (Igloolik Caribou Focus Working Group 2008). Similar cycles were observed for the south Baffin Island herd (Ferguson et al. 1998) and several herds in Greenland (Post and Forchhammer 2004).



Map 3. Estimated distribution of caribou during the last high in the population cycle on north Baffin Island, Nunavut, based on IQ.

(Adapted from map drawn by Malachi Arreak and discussion at Pond Inlet Caribou focus working group meeting, February 13, 2008)

Movement and Seasonal Distribution

North Baffin Island caribou are found in most areas year-round and unlike many mainland herds have no large-scale seasonal migratory movements. Their seasonal movements are small-scale and elevation movements that are limited to calving and winter habitats. Difficult topography does not restrict their movement as they are often found in areas lacking vegetation such as glaciers (Ferguson 2005 pers.. comm. Arctic Bay Caribou Focus Working Group 2008, Clyde River Caribou Focus Working Group 2008, Pond Inlet Caribou Focus Working Group 2008).

Migration and Movement — IQ knowledge is key in understanding north Baffin Island caribou movement and distribution. Caribou range and migration corridors were mapped using documented IQ in the Inuit Land Use and Occupancy Project (Brody 1976b), and on Northern Land Use and Information Series maps (Indigenous and Northern Affairs Canada 1981). These documents suggest that during May, females and young males move from Tay Sound, Paquet Bay, and Milne Inlet southward through Mary River valley to reach calving areas. The bulls remain behind in summer and do not migrate inland (Ferguson 1989).

This knowledge was updated during Community Focus Working Group meetings in Arctic Bay, Pond Inlet, Clyde River, Hall Beach and Igloolik in 2008. During high abundance, caribou location and movement are not well defined. However, participants identified well-worn trails formed on the landscape from large numbers of caribou following each other during seasonal movement (Map 4). A substantial spring migration route was identified from central Baffin Island, running along the northern shore of Foxe Peninsula corridor, north along Steensby Inlet, and dispersing into the Project area (Map 4). Several smaller seasonal movement routes, most likely from smaller more distributed animals, showed general areas where caribou move into higher or lower elevations depending on the season (Map 4). Participants noted that north Baffin Island caribou constantly move to find food. IQ participants expect North Baffin Island caribou to return in large numbers when the habitat recovers from their last period of high abundance. This suggests that their population cycles could be due to overgrazing of north Baffin Island.

Calving Areas — North Baffin Island caribou calve in June. Caribou Focus Working Groups (2008, 2008, 2008, 2008, 2008) noted that caribou calve in higher elevation habitats in rugged mountainous terrain away from predators. This is consistent with aerial surveys conducted in June 1994 and 1997 that noted that cows calved on rugged ridges of south facing slopes and were found along the snowmelt margin (Ferguson 1999a). In fact, primary factors influencing calving locations are believed to be the distribution of snowmelt margin, timing of snowmelt, and proximity to post-calving areas (Ferguson 1999a). This coincides with caribou following the spring phenology of plants, feeding on purple saxifrage in upland areas where the snow melts first.

Participants identified the Mary River region as a calving area (Map 5). This is consistent with previous information (Ferguson 2005 pers. comm.) and with June 1997 observations of cows with calves in the valley southeast from Mary River (Ferguson 1999a). Many other calving areas coincided with previous information (Map 5) such as calving sites in rough terrain at the eastern edge of Angajurjualuk Lake (Indigenous and Northern Affairs Canada 1981, Ferguson 1989), Deposit No. 1 and Tugaat River and

Tugaat canyon (INAC 1981, Ferguson 1989, 1999). Ferguson (1989) using Inuit local knowledge broadly identified additional calving areas north of Steensby Inlet and east to south of Barnes Ice Cap. Participants mentioned that while large areas may be encompassed within a calving area, caribou do not necessarily calve there every year and usually only in portions of the identified areas. It was not confirmed whether calving grounds were dispersed or grouped, but caribou do not necessarily migrate and congregate in distinct calving grounds as many likely calve dispersed and near their wintering areas (Ferguson 1989, Arctic Bay Caribou Focus Working Group 2008, Igloolik Caribou Focus Working Group 2008, Pond Inlet Caribou Focus Working Group 2008). Some of the areas identified by participants were only known through IQ and current use of the area for calving is unknown.

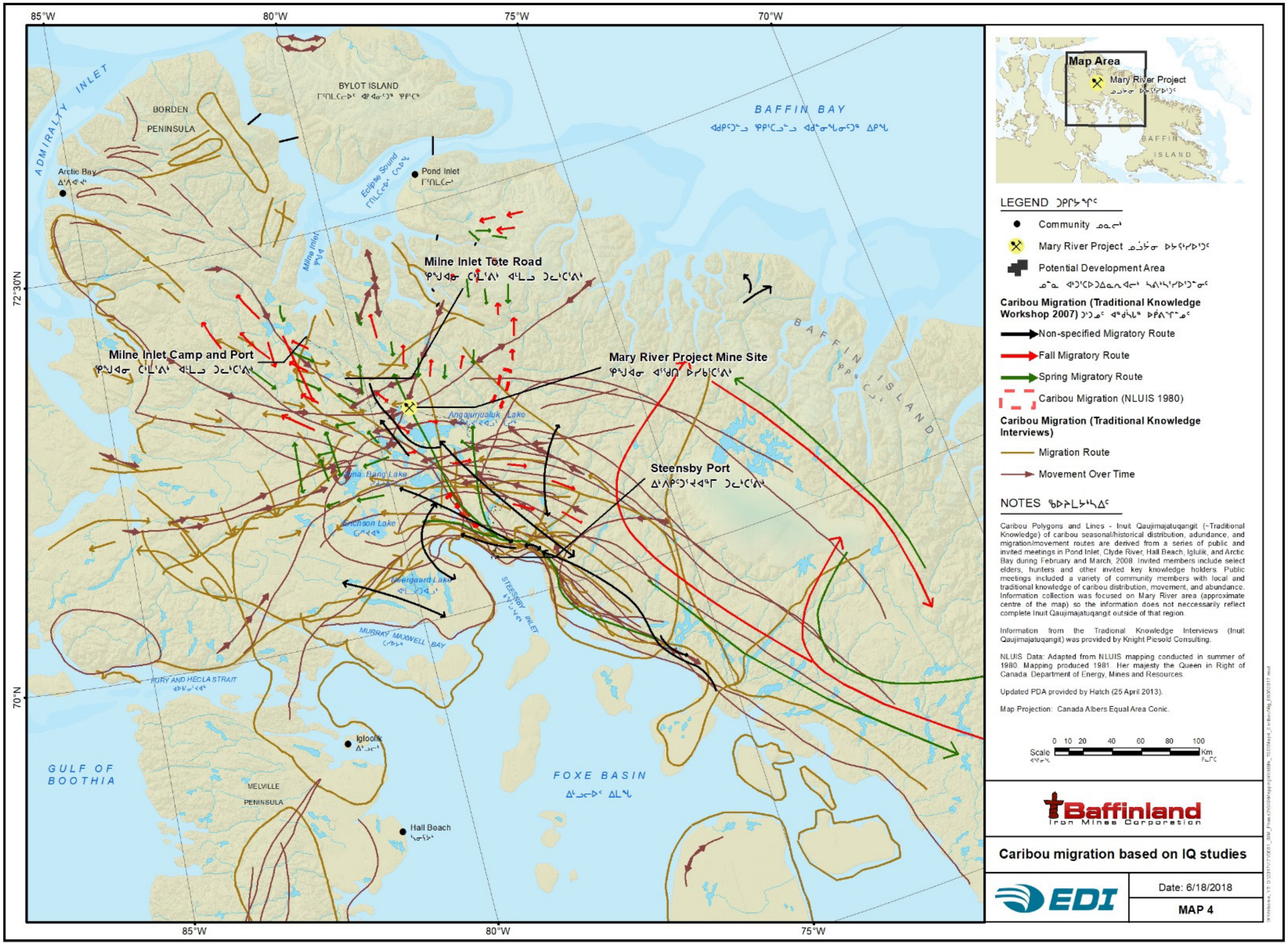
Summer — Caribou summer range depends on food availability (Ferguson 1989, Arctic Bay Caribou Focus Working Group 2008, Clyde River Caribou Focus Working Group 2008, Hall Beach Caribou Focus Working Group 2008, Igloolik Caribou Focus Working Group 2008, Pond Inlet Caribou Focus Working Group 2008). In early summer they are found upland in well-drained areas. In late summer they are located on coastal plains, including the vicinity of Steensby and Milne Inlets, or near inland lakes. They are also scattered south of Oliver Sound (Ferguson 1989). Bulls, and eventually cows and calves, move close to larger waterbodies so they can swim to avoid wolf predation (Pond Inlet Caribou Focus Working Group 2008). Caribou movement and habitat selection is also driven by avoidance of insect harassment (e.g., Hagemoen and Reimers 2002) and they have been found walking on glaciers to avoid insect harassment (Brody 1976b, Clyde River Caribou Focus Working Group 2008).

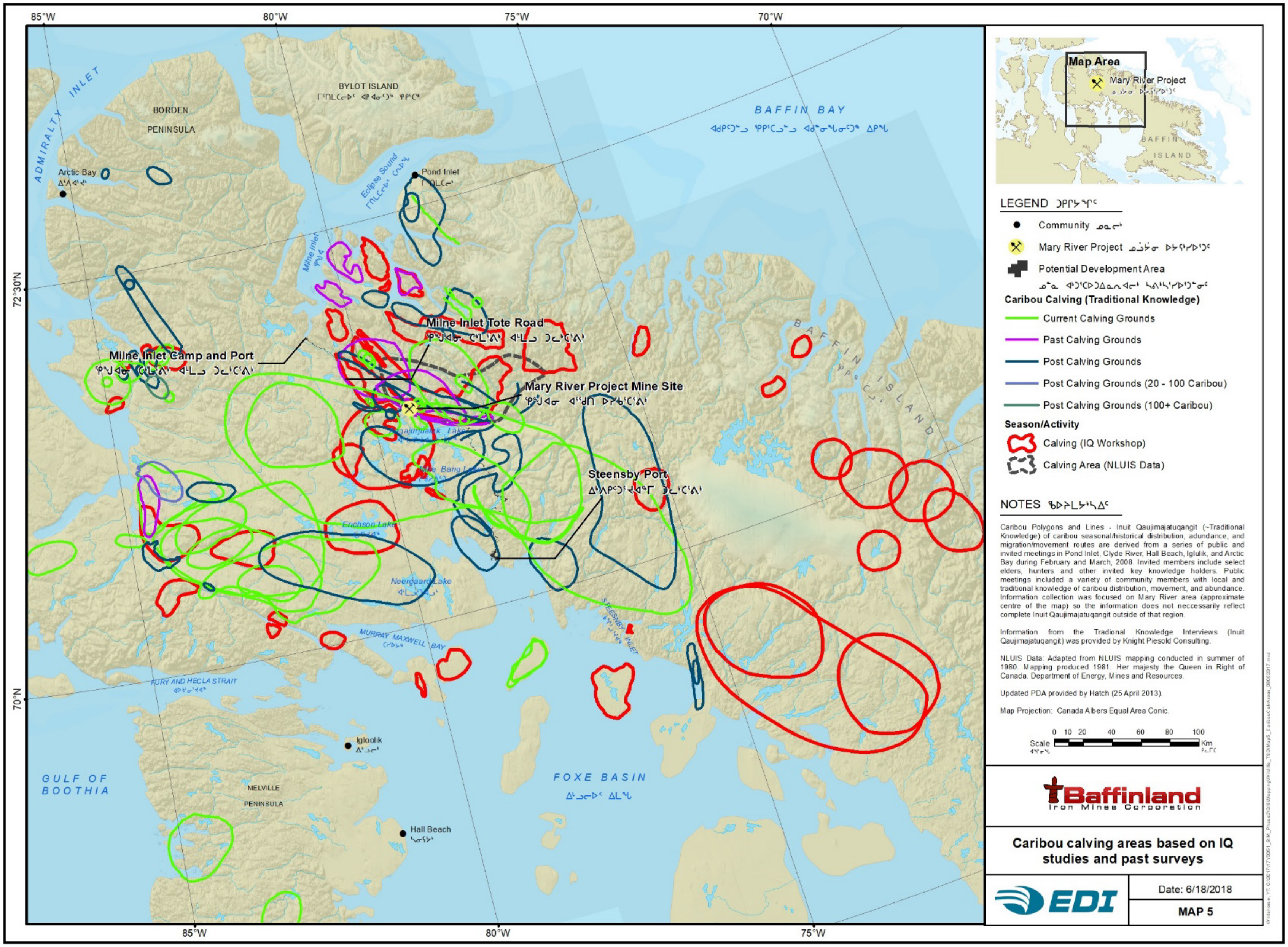
Fall/Breeding — Fall aggregations start to occur in September (Arctic Bay Caribou Focus Working Group 2008, Clyde River Caribou Focus Working Group 2008, Hall Beach Caribou Focus Working Group 2008, Igloolik Caribou Focus Working Group 2008, Pond Inlet Caribou Focus Working Group 2008). Areas known to have caribou during the fall breeding season were generally at low elevation along shoreline margins. Fall migration routes were noted on Map 4. It was suggested that east of Angalurjuak Lake is a mating area.

Winter and Spring — Caribou move little in winter (Ferguson 2005, pers. comm.). IQ mentions that they winter on mountain tops (Uttak 2008). Winter distribution is not consistent most likely in response to forage abundance (Ferguson 2005, pers. comm. Piksiksik Working Group 2006, pers. comm. Arctic Bay Caribou Focus Working Group 2008, Pond Inlet Caribou Focus Working Group 2008). Ferguson (1989) suggested that in winter caribou concentrate in the valley bottoms south of Tay Sound, Paquet Bay, and Milne Inlet. In winter, caribou feed on vegetation exposed by wind, or crater through the snow to feed (Ferguson 1999b). Interactions among snow, terrain, and wind determine accessibility of forage on winter range (Ferguson 1999b). Although there is no published information on winter forage selection of North Baffin caribou, one participant mentioned the importance of lichen in their diet (Uttak 2008).

Current knowledge suggests that from late-winter until fall, bulls and non-pregnant females are found near southern Admiralty Inlet and on southern Borden Peninsula. Cows from southern Admiralty Inlet, Bell Bay and Jungersen River migrate east to the calving areas north of Steensby Inlet. Igloolik Inuit reported caribou found north of Agu Bay east and south to Baird Peninsula for much of the year. In the spring, the caribou migrate from the Gifford River to calving areas north and east of Steensby Inlet.

Some calve along the coast of Ikpik Bay and on Baird Peninsula. The migration route identified the south coast (east and north of Steensby Inlet) as being used when caribou are abundant, and it is the movement of the "large" herd rather than the few that persist during the population low of the cycle (Igloolik Caribou Focus Working Group 2008).


85°W
80°W
75°W
70°W
72°30'N
70°N
ADMIRALTY INLET
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
Arctic Bay
Pond Inlet
Eclipse Sound
Milne Inlet
Milne Inlet Tote Road
Milne Inlet Camp and Port
Mary River Project Mine Site
Angajurjualuk Lake
Nina Bang Lake
Erichson Lake
Neergaard Lake
Steensby Port
STEENSBY INLET
MURRAY MAXWELL BAY
BAFFIN ISLAND
FURY AND HECLA STRAIT
Igloolik
GULF OF BOOTHIA
MELVILLE PENINSULA
Hall Beach
FOXE BASIN
Map Area
Mary River Project
LEGEND
Community
Mary River Project
Potential Development Area
Caribou Migration (Traditional Knowledge Workshop 2007)
Non-specified Migratory Route
Fall Migratory Route
Spring Migratory Route
Caribou Migration (NLUIS 1980)
Caribou Migration (Traditional Knowledge Interviews)
Migration Route
Movement Over Time
NOTES
Caribou Polygons and Lines - Inuit Qaujimajatuqangit (~Traditional Knowledge) of caribou seasonal/historical distribution, adundance, and migration/movement routes are derived from a series of public and invited meetings in Pond Inlet, Clyde River, Hall Beach, Iglulik, and Arctic Bay during February and March, 2008. Invited members include select elders, hunters and other invited key knowledge holders. Public meetings included a variety of community members with local and traditional knowledge of caribou distribution, movement, and abundance. Information collection was focused on Mary River area (approximate centre of the map) so the information does not neccessarily reflect complete Inuit Qaujimajatuqangit outside of that region.
Information from the Tradional Knowledge Interviews (Inuit Qaujimajatuqangit) was provided by Knight Piesold Consulting.
NLUIS Data: Adapted from NLUIS mapping conducted in summer of 1980. Mapping produced 1981. Her majesty the Queen in Right of Canada. Department of Energy, Mines and Resources.
Updated PDA provided by Hatch (25 April 2013).
Map Projection: Canada Albers Equal Area Conic.
Scale
0 10 20 40 60 80 100
Km
Baffinland
Iron Mines Corporation
Caribou migration based on IQ studies
EDI
Date: 6/18/2018
MAP 4



85°W
80°W
75°W
70°W
72°30'N
70°N
ADMIRALTY INLET
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
Arctic Bay
Pond Inlet
Eclipse Sound
Milne Inlet
Milne Inlet Tote Road
Milne Inlet Camp and Port
Mary River Project Mine Site
Steensby Port
Erichson Lake
Neergaard Lake
MURRAY MAXWELL BAY
FURY AND HECLA STRAIT
STEENSBY INLET
BAFFIN ISLAND
Igloolik
Hall Beach
GULF OF BOOTHIA
MELVILLE PENINSULA
FOXE BASIN
Map Area
Mary River Project
LEGEND
Community
Mary River Project
Potential Development Area
Caribou Calving (Traditional Knowledge)
Current Calving Grounds
Past Calving Grounds
Post Calving Grounds
Post Calving Grounds (20 - 100 Caribou)
Post Calving Grounds (100+ Caribou)
Season/Activity
Calving (IQ Workshop)
Calving Area (NLUIS Data)
NOTES
Caribou Polygons and Lines - Inuit Qaujimajatuqangit (~Traditional Knowledge) of caribou seasonal/historical distribution, adundance, and migration/movement routes are derived from a series of public and invited meetings in Pond Inlet, Clyde River, Hall Beach, Iglulik, and Arctic Bay during February and March, 2008. Invited members include select elders, hunters and other invited key knowledge holders. Public meetings included a variety of community members with local and traditional knowledge of caribou distribution, movement, and abundance. Information collection was focused on Mary River area (approximate centre of the map) so the information does not neccessarily reflect complete Inuit Qaujimajatuqangit outside of that region.
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Updated PDA provided by Hatch (25 April 2013).
Map Projection: Canada Albers Equal Area Conic.
0 10 20 40 60 80 100
Scale
Km
Baffinland
Iron Mines Corporation
Caribou calving areas based on IQ studies and past surveys
EDI
Date: 6/18/2018
MAP 5

General Habitat Use

The range of north Baffin Island caribou is estimated at 134,308 km² extending from south of the Barnes Ice cap, north along the southern coast to the southern Brodeur Peninsula and inland to the east of Pond Inlet (Baffinland 2013). General caribou habitat use is summarized below:

- During summer, caribou restore their fat reserves for the coming winter and pregnancy (Ouellet *et al.* 1997); therefore, their movement is influenced by regional plant phenology and new vegetation (Post and Forchhammer 2008). Their movements also seem to be guided by thermoregulation, and predator and insect avoidance.
- Summer foraging areas are focused on fresh vascular plants such as habitats with sedges, Arctic willow, grasses and forbs, especially purple saxifrage (various sources summarized in COSEWIC 2004). Many studies highlighted the importance of willow (e.g., Parker 1978) and purple saxifrage (e.g., Miller 1991). Lichen is also an important food source (Thomas et al. 1999) and caribou have long been known for their relationship with lichen.
- Vegetation quality is highest during early summer, gradually decreasing as vegetation matures (Hebblewhite et al. 2008).

Habitat is more limited in late winter due to food availability from snow depth and hardness (e.g., Adamczewski et al. 1988). Key findings from the literature review suggest:

- Caribou are found on more exposed sites with less snow depth and hardness such as broken rock outcrops (COSEWIC 2004) or upland habitats (Larter and Nagy 2000) where vegetation is easier to access (e.g., Tucker et al. 1991).
- Winter foraging consists of willows, forbs, grasses, sedges (Miller 1998), legumes (Larter and Nagy 2004) and lichen. Studies highlight the importance of willow for better nutritive and reproductive conditions (Miller 1998) and legumes due to their high protein content and because they are found in upland habitats (Larter and Nagy 2004). Lichens, especially *Cladina* spp. and *Cladonia* spp, are also very important food sources when available (e.g., Ferguson et al. 2001). Although lichens are not abundant, they are always part of caribou diet as they are generally able to efficiently digest lichen.

2.3.1.2 Baffin Island Wolf and other Carnivores

The Baffin Island wolf (*Canis lupus manningi*) is the smallest of the Arctic wolves. It is found in all parts of Baffin Island (Anderson 1943) and is listed as a big game species under the Nunavut Land Claims Agreement (NLCA 1993). Wolves generally occur around the Project area (Arctic Bay Caribou Focus Working Group 2008, Clyde River Caribou Focus Working Group 2008, Hall Beach Caribou Focus Working Group 2008, Igloolik Caribou Focus Working Group 2008, Pond Inlet Caribou Focus Working Group 2008) but are believed to be rare on north Baffin Island by Inuit hunters (Piksiksik Working Group 2006 pers. comm.). Their abundance, density, distribution and movement patterns are tied to that of caribou, which can partly account for their current low abundance (Clark 1971, Arctic Bay Caribou Focus Working Group 2008, Clyde River Caribou Focus Working Group 2008, Hall Beach Caribou Focus Working Group 2008, Igloolik Caribou Focus Working Group 2008, Pond Inlet

Caribou Focus Working Group 2008). They are considered the greatest predators of caribou, after humans, but are also opportunistic foragers and will prey on other animals such as lemmings and Arctic hare. The size and number of wolf pups have been correlated with hare abundance on Ellesmere Island (Mech 2007). Wolf dens in central Baffin Island are located in suitable soils (glacio-fluvial materials) that are snow-free, well-drained, near a water source and caribou spring migration routes (Clark 1971).

Foxes are a top predator historically trapped by local people and are distributed across Baffin Island. Arctic foxes (*Vulpes lagopus*) are considered the only abundant terrestrial mammal on north Baffin Island (Zoltai et al. 1983) but their numbers and reproduction fluctuate widely following lemming populations (Macpherson 1969, Garrott and Eberhardt 1987, Bêty et al. 2002). Arctic foxes also feed on birds and bird eggs during summer and the low-phase of the lemming cycle (Macpherson 1969, Bêty et al. 2002). Arctic foxes are commonly found in lowland and coastal areas (Miller 1955). Fox dens are commonly found on accumulations of suitable glacial materials such as eskers (Macpherson 1969). Arctic foxes select sites on ridges or slopes with early snow melt and close to a food source avoiding north-facing slopes (Szor et al. 2004). The red fox (*Vulpes vulpes*) colonized south Baffin Island in 1918 before reaching the north 30 years later (Anand-Wheeler 2002). Arctic and red foxes are direct competitors, and the larger red foxes have been seen displacing Arctic foxes (Rudzinski et al. 1982, Bailey 1992).

Wolverines (*Gulo gulo*) are solitary carnivores that may have crossed onto Baffin Island via Fury and Hecla Strait in the early 1900s and bred in large numbers extending their range to the northern tip of Baffin Island by the 1920s (Manning 1943). Wolverines are scavengers, but are also opportunistic predators, most likely relying on a diversity of foods to offset the uncertainty of availability in the harsh northern environment. The presence of large prey such as ungulates, at least at some time during the year, appears to be important for the persistence of wolverine populations (Banci 1994). Thus, the distribution and abundance of wolverine are related to the presence of caribou. Wolverines may rely on alternate food sources such as seal pups and scavenging on dead marine mammals. All IQ interviews participants had heard of wolverines occurring in the Project area but did not recall ever actually seeing one. The western population of wolverines have been listed as a species of Special Concern by COSEWIC since 2003 (COSEWIC 2014) but are listed as secure in Nunavut by the Canadian Endangered Species Conservation Council (2011). Currently, wolverines are suspected to be rare in the Project area (Piksiksik Working Group 2006, pers. comm.).

The ermine (*Mustela erminea*) is a top-level predator, primarily consuming small mammals. Its presence is considered an indication of the size of prey populations, and ultimately an indication of the state of the Arctic ecosystem. Little is known about ermine populations in the Arctic. Zoltai *et al.* (1983) describe the ermine as a common lowland species on north Baffin Island, usually denning in rocky areas or scree slopes. Given that several ermine populations occurring on islands (Prince of Wales, Queen Charlotte Islands, Kodiak Island, and Suemez Island) have been designated as sub-species it is possible that the Baffin Island ermine is also distinct. This hypothesis has not been investigated further.

2.3.1.3 Small Mammals

The brown lemming (*Lemmus trimucronatus*) and Peary Land (northern) collared lemming (*Dicrostonyx groenlandicus*) are the only known rodents on north Baffin Island (Anand-Wheeler 2002). Their abundance affects the behaviour, habitat use and population dynamics of carnivores such as Arctic fox, red fox, wolf, Snowy Owls (*Bubo scandiacus*) and falcons (*Falconidae*) (Baffinland 2012d). Their populations seem to cycle every three to four years, although recent studies suggest collared lemming populations might not cycle as do brown lemmings (Predavec et al. 2001, Laval University 2006). Collared lemmings prefer higher and drier sites while brown lemmings prefer lower and wetter habitats. Lemmings are primary consumers and good indicators of overall environmental health.

Arctic hare (*Lepus arcticus*) are abundant on north Baffin Island (Zoltai et al. 1983) and their major predators include foxes and wolves. The current population status is considered secure (CESCC 2011) although their overall population seems to be in decline as groups of thousands previously seen on Ellesmere Island have not been observed recently (Canadian Museum of Nature 2004). Their populations have been found to fluctuate widely over several years but it is unknown if they do so in distinct cycles such as the snowshoe hare (Canadian Museum of Nature 2004). They are primary consumers and at high densities can compete for willows with caribou (NatureServe Explorer (NatureServe) 2006). Arctic hare are found on tundra, rocky slopes, hills, and lower mountain slopes (NatureServe Explorer (NatureServe) 2006).

2.3.1.4 Wildlife Health and Contaminants

Limited information was available for contaminants and wildlife health on north Baffin Island. Rangerfine brucellosis, which can cause miscarriages and lameness in some infected caribou, was found on Baffin Island in the 1980s (Ferguson 1997). Samples collected from caribou harvested in the Mary River region from 1983–1986 presented some of the highest reported seroprevalence of brucellosis (33–43%) for any wild population of *R. tarandus* in the world (Ferguson 1997). Inuit hunters and elders noted swollen joints on caribou in the 1980s, but caribou seemed healthier than in the past at the time of the interviews (Qikiqtaaluk Wildlife Board and World Wildlife Fund Canada 2000). Additionally, the Northern Contaminants Program sampled kidneys and livers from 15 herds across Canada (INAC 2003). No potential health concerns were found for the south Baffin Island herd, the closest to Project area.

2.3.2 BAFFINLAND BASELINE SURVEYS OVERVIEW

To augment the historical information, Baffinland conducted Project-specific wildlife studies from 2006 through 2011. Surveys are summarized below and in Table 3.

Table 3. Summary of surveys completed for the wildlife baseline assessment, Mary River Project, Baffin Island, 2006–2011.

Survey	Year	Purpose	Results
Caribou inventory	2006–2008	To determine abundance and distribution of caribou in the RSA	Aerial surveys conducted in late winter, calving season and in the fall found low numbers of caribou in the RSA. Most caribou were found south of the Project; however, some potential calving sites were identified north of the Project corresponding with areas identified through IQ.
Caribou trail surveys	2006–2008, 2010	To identify caribou movement patterns in the RSA	Most trails were found south of the Mary River Camp, near Steensby Inlet and around Angajurjualuk Lake and northwest of Mary River Camp. Trails north of the Project were fewer and less used.
Caribou collaring program	2009–2011	To identify movement rates, seasonal distribution, habitat and calving areas	Data from thirty-two collared caribou showed current caribou on north Baffin Island were sedentary and non-migratory. Most caribou calved in early June and those that calved in 2009 and 2010 generally calved in the same areas.
Large and small carnivores inventory	2006–2010	To identify abundance of wolves and foxes in the RSA.	Aerial wolf and fox dens survey completed in 2006 and opportunistic observations of dens, Arctic and Red fox, and wolves. Low abundance of wolves and foxes in the RSA.
Rodents inventory	2006–2008	To determine prey availability in the RSA.	Live-trapping suggested lemming populations at peak of their cycle in 2008. Few lemmings caught during other years but abundant signs of lemmings.

2.3.2.1 Regional Wildlife (Caribou) Surveys

Caribou Inventories

Baffinland conducted aerial surveys from 2006–2008 to determine caribou abundance and distribution in the RSA during late winter, calving and fall seasons. Caribou observations included, when possible, an estimate of group size and composition, direction of movement, activity and habitat. Surveys in 2006 and 2007 were completed by "back-tracking" which followed trails crossing the survey lines; the survey method was standardized in 2008 and followed 10 km spaced transects. Infrequent observations of caribou during aerial surveys suggested very low abundance of caribou in the RSA (Table 4). During surveys, many tracks did not lead to caribou observations but did confirm their presence in the area. Most caribou were observed south and east of the Mary River camp. In late-winter, caribou were found feeding on high-centered tundra polygon habitat. One summer survey conducted in 2006 observed caribou in high elevation on patches of snow. Aerial surveys were abandoned in 2008 due to low densities of caribou and requests by GN in their permits to fly at greater altitudes that would not allow for caribou classification to age and gender.

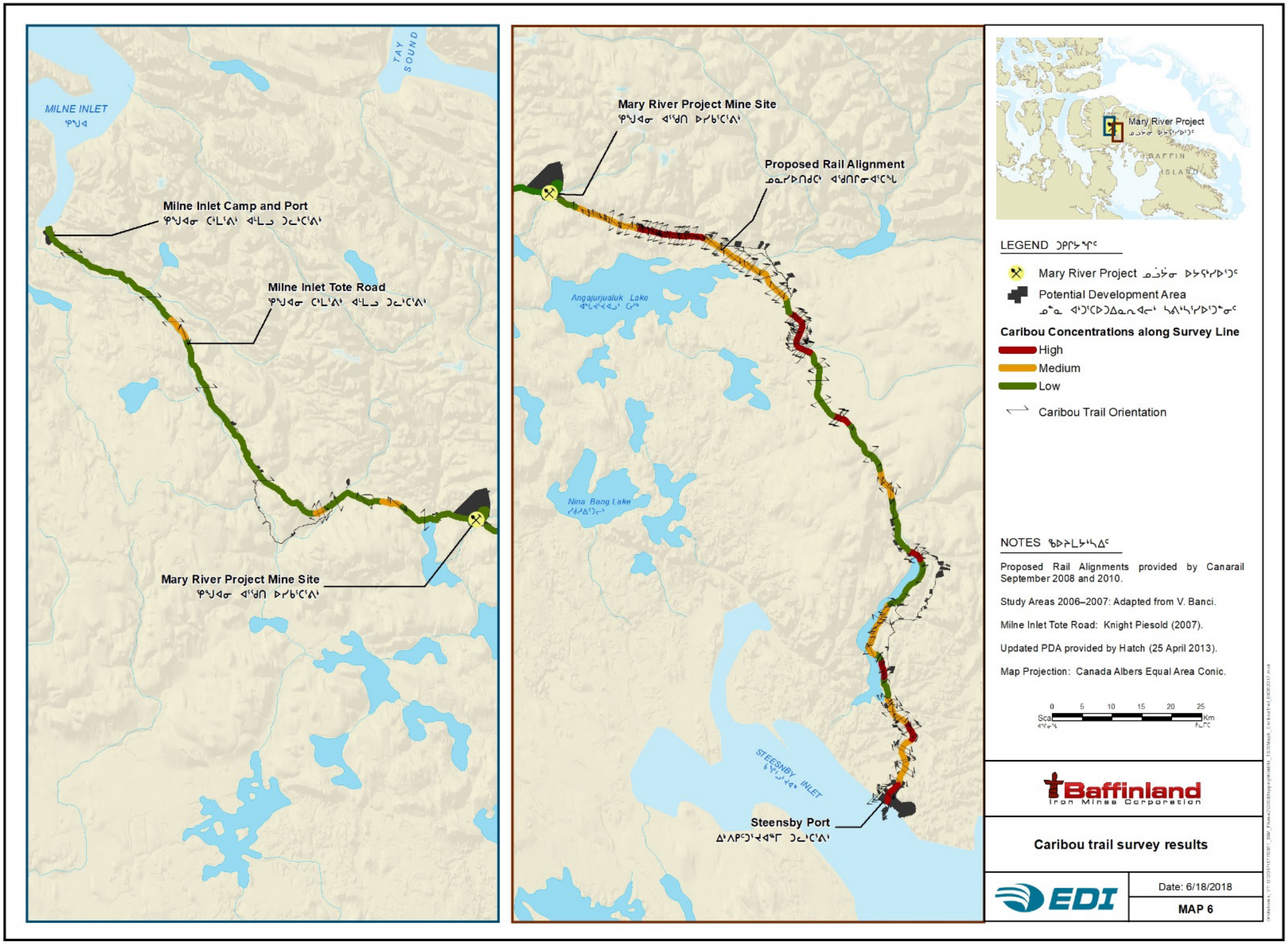
Table 4. Summary of caribou observed during caribou inventory and distribution surveys, Mary River Project, Baffin Island, 2006–2008.

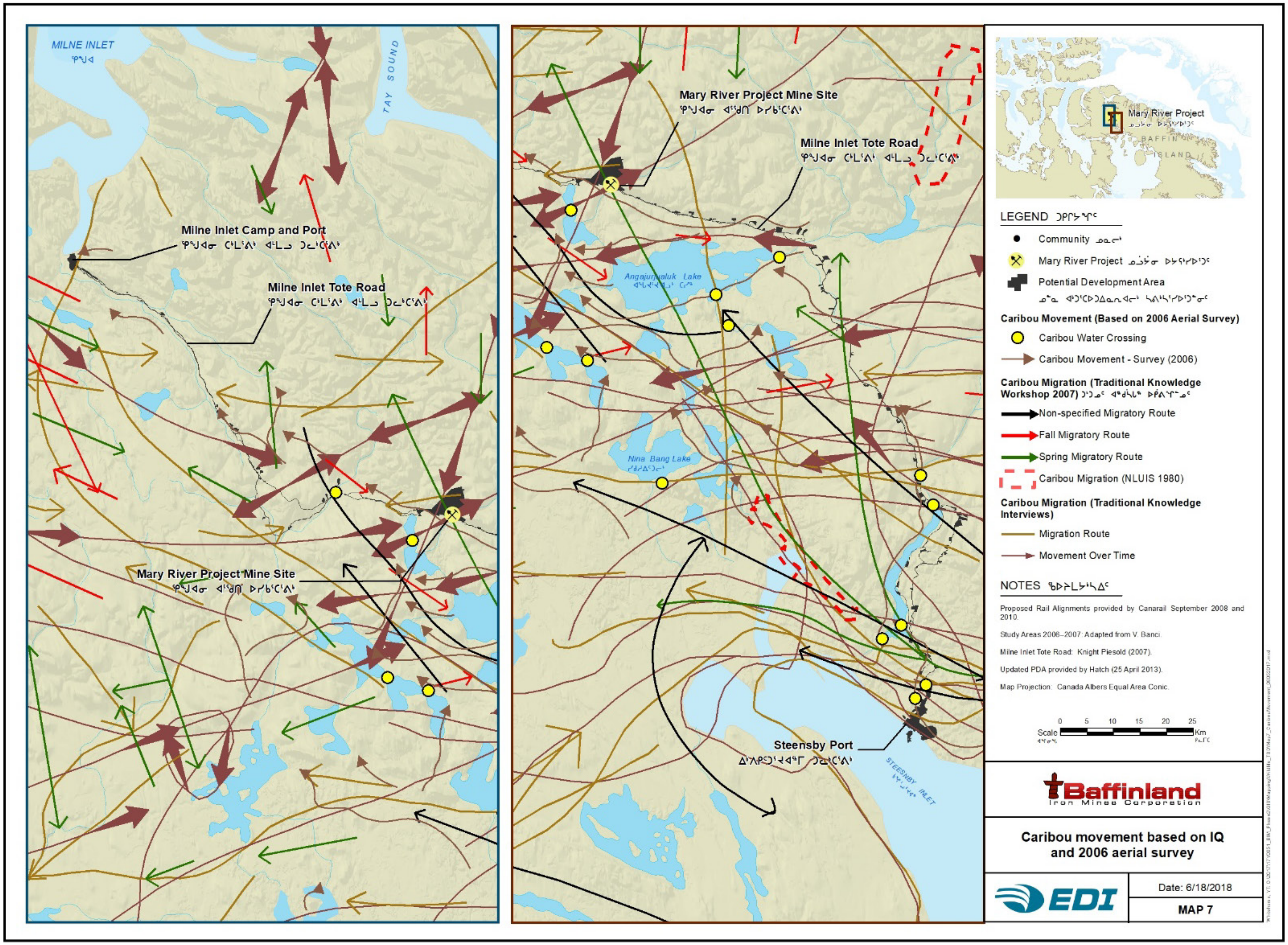
Year	Date	Purpose	Observations					
			Unspec. Ad.[a]	Ad. ♀	Ad. ♂	Calves	Yearlings	Total
2006	Jun. 19–20	Calving distribution		5	5	2	19	31
2006	Jul. 27–30	Summer distribution						12
2006	Sept. 4, 5, 7, 8	Fall distribution	2	36	15	4	-	57
2007	Jun. 13, 17	Calving distribution						0
2007	Various	Unspecified surveys[b]		5[c]		2		7
2007	Sept. 1, 3–5, 12	Fall distribution			6		1	7
2007	Oct. 3, 5	Late fall distribution		11	6	4		21
2007	Mar. 29–31	Late-winter distribution						37[d]
2008	Jun. 8–15	Calving distribution	15			5	1	21
2008	Sept. 18–19	Fall distribution						29[d]
2008	Mar. 29–31	Late-winter distribution						20[d,e]

Notes: [a] Unspecified adults
[b] Opportunistic sightings during other surveys not specific to caribou
[c] Three cows appeared pregnant
[d] Caribou not specified to age or sex.
[e] Includes observation of one wolf-killed caribou

Trail Surveys

Well-worn trails are responsible for some of the predictability in caribou movement patterns and traditions. Trail surveys completed in summer 2006–2008 and 2010 were quantified by reconnaissance trail surveys, 100 km² survey blocks, aerial and ground surveys of the proposed rails route and existing Tote Road, and IQ. Trails along the proposed southern railway and Tote Road were classified as light, moderate or heavy use and their orientation to the survey line identified. Caribou trails were most visible in wetlands and sandy substrates. Their movement corridors were identified in areas that were snow-free in the spring such as valley bottoms and bordering high elevation areas and large lakes. They did not appear to use large lakes for security from predators but were found on small to mid-size lakes or in the middle of large wetlands. Trails were visible across the RSA, but most were concentrated and heavily used in coastal habitats adjacent to Steensby Port, near Angajurjualuk Lake and northwest of Mary River camp (Map 6). There were fewer and less used trails in the upper two-thirds of Tote Road. IQ interviews also identified 14 water crossings near Steensby Inlet, Cockburn River and Angarjurjualuk Lake (Map 7). Most caribou signs observed on ground surveyed areas were old (>2 yrs). Recent signs were seen on four of the 56 ground-surveyed trails that were extrapolated to the total 168 trails suggesting 12 trails could have recently been used by caribou. Density of trails and caribou signs (e.g., antlers, scat) were somewhat related to the local conditions. For example, caribou signs such as antlers decomposed faster in wetter environments.


MILNE INLET
TAY SOUND
Milne Inlet Camp and Port
Milne Inlet Tote Road
Mary River Project Mine Site
Mary River Project Mine Site
Proposed Rail Alignment
Angajurjualuk Lake
Nina Bang Lake
STEENSBY INLET
Steensby Port
Mary River Project
BAFFIN ISLAND
LEGEND
Mary River Project
Potential Development Area
Caribou Concentrations along Survey Line
High
Medium
Low
Caribou Trail Orientation
NOTES
Proposed Rail Alignments provided by Canarail September 2008 and 2010.
Study Areas 2006–2007: Adapted from V. Banci.
Milne Inlet Tote Road: Knight Piesold (2007).
Updated PDA provided by Hatch (25 April 2013).
Map Projection: Canada Albers Equal Area Conic.
0 5 10 15 20 25
Scale
Km
Baffinland
Iron Mines Corporation
Caribou trail survey results
EDI
Date: 6/18/2018
MAP 6


MILNE INLET
TAY SOUND
Milne Inlet Camp and Port
Milne Inlet Tote Road
Mary River Project Mine Site
Angajurjualuk Lake
Nina Bang Lake
Steensby Port
STEENSBY INLET
Mary River Project
BAFFIN ISLAND
LEGEND
Community
Mary River Project
Potential Development Area
Caribou Movement (Based on 2006 Aerial Survey)
Caribou Water Crossing
Caribou Movement - Survey (2006)
Caribou Migration (Traditional Knowledge Workshop 2007)
Non-specified Migratory Route
Fall Migratory Route
Spring Migratory Route
Caribou Migration (NLUIS 1980)
Caribou Migration (Traditional Knowledge Interviews)
Migration Route
Movement Over Time
NOTES
Proposed Rail Alignments provided by Canarail September 2008 and 2010.
Study Areas 2006–2007: Adapted from V. Banci.
Milne Inlet Tote Road: Knight Piesold (2007).
Updated PDA provided by Hatch (25 April 2013).
Map Projection: Canada Albers Equal Area Conic.
0 5 10 15 20 25
Scale
Km
Baffinland
Iron Mines Corporation
Caribou movement based on IQ and 2006 aerial survey
EDI
Date: 6/18/2018
MAP 7

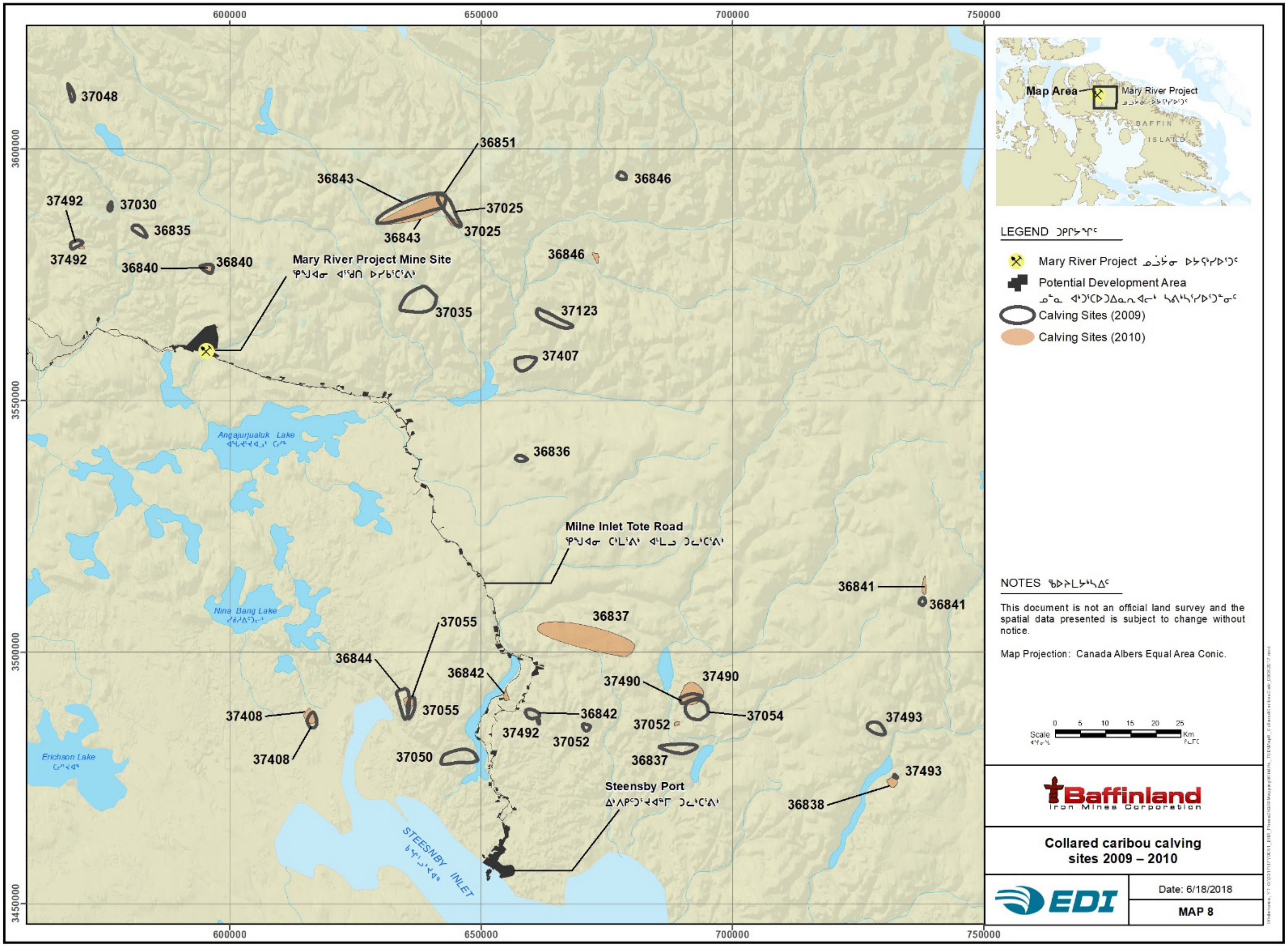
Caribou Collaring Program — Baffinland supported a caribou satellite collar program conducted by the GN that began in 2009 and ended in 2011. Through a Memorandum of Understanding with the GN, Baffinland used data collected from that study to further characterize caribou habitat use on north Baffin Island. Although there was a relatively low sample size and short time period, locations of thirty-two collared female caribou were used to calculate recent movement patterns and rates, seasonal distribution, habitat and calving areas.

Caribou on north Baffin Island were found to be non-migratory and mostly sedentary as described by current IQ knowledge. Most caribou that calved in consecutive years returned to the same calving sites (67%) and the ones that did not return were still relatively close to their 2009 calving site (4.0– 38.5 km apart — Map 8). More information on collared caribou data analysis is available in the Wildlife Baseline Report, Appendix 6F, FEIS (Baffinland 2012d).

2.3.2.2 Caribou Habitat Classification

A Resource Selection Probability Function (RSPF) model was developed using the 2009–2011 collar data to better define caribou habitat use on north Baffin Island. The RSPF method was based on statistical analysis of habitat features frequently selected by collared caribou from 2009 through 2011. RSPF analysis was completed to the extent of the collared caribou (2009 to 2011 data) using a minimum convex polygon with a 10 km buffer zone around collared locations. At the request of the Government of Nunavut, this analysis was extrapolated to model the probability of habitat use across their entire historic range.

Overall, caribou habitat selection during calving season was best predicted by the combination of south or east facing slopes of approximately 10–20 degrees and proximity to rivers (Map 9). During growing season, caribou habitat selection was best predicted by the combination of slopes of approximately 5–25 degrees, proximity to rivers and higher greenness scores (Map 10). In winter, caribou habitat selection was best predicted by the combination of higher greenness scores, slopes of approximately 10–25 degrees and proximity to rivers (Map 11). Based on individual inspection of covariates caribou selected for elevations between 300 and 600 m during calving and growing seasons, preferred south or east facing slopes during the growing season and lower elevations with south facing slopes during winter. Overall, caribou habitat selection during calving, growing, and winter seasons are similar suggesting current caribou are not migratory and have small-scale seasonal movements.



600000
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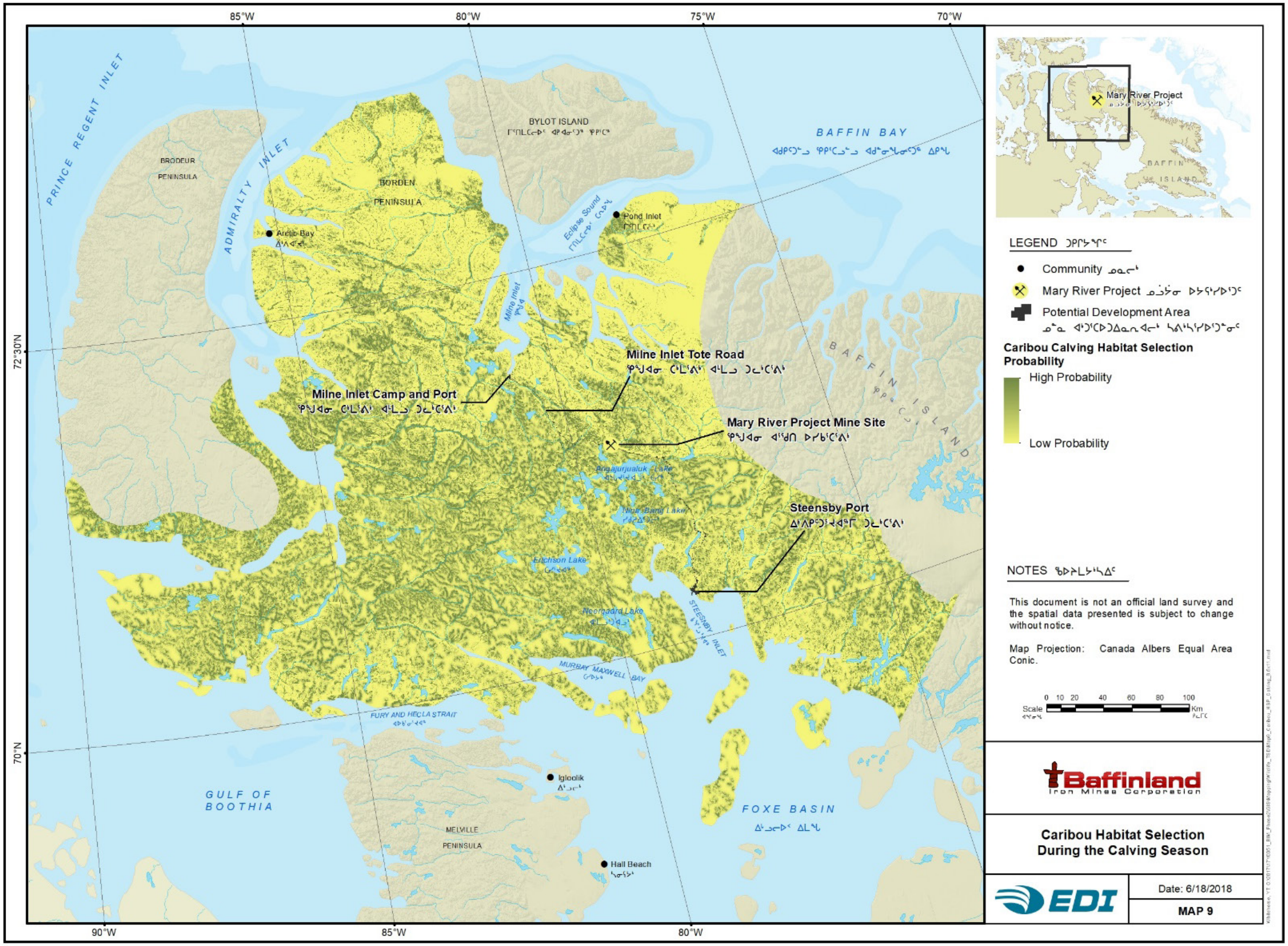
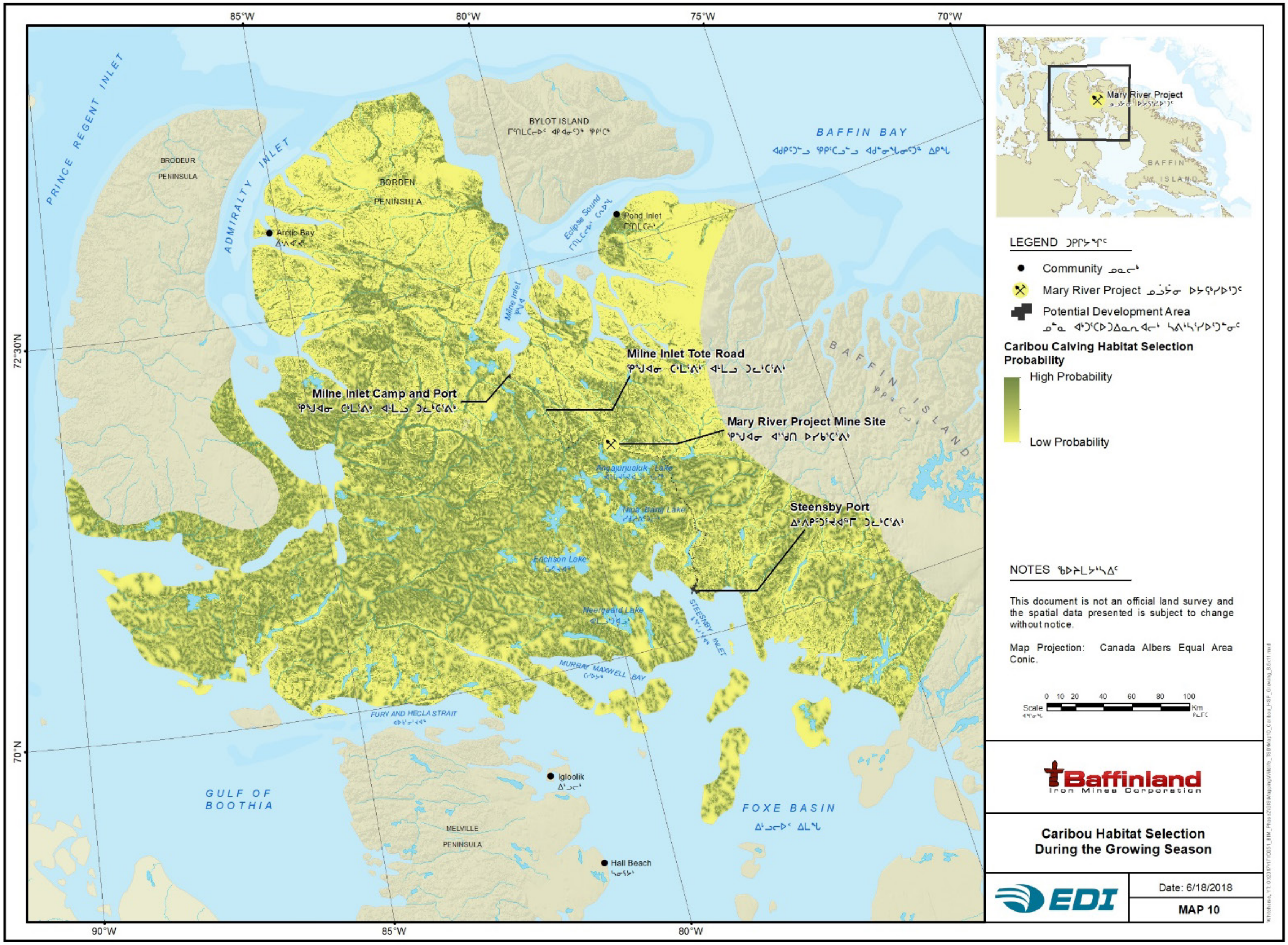
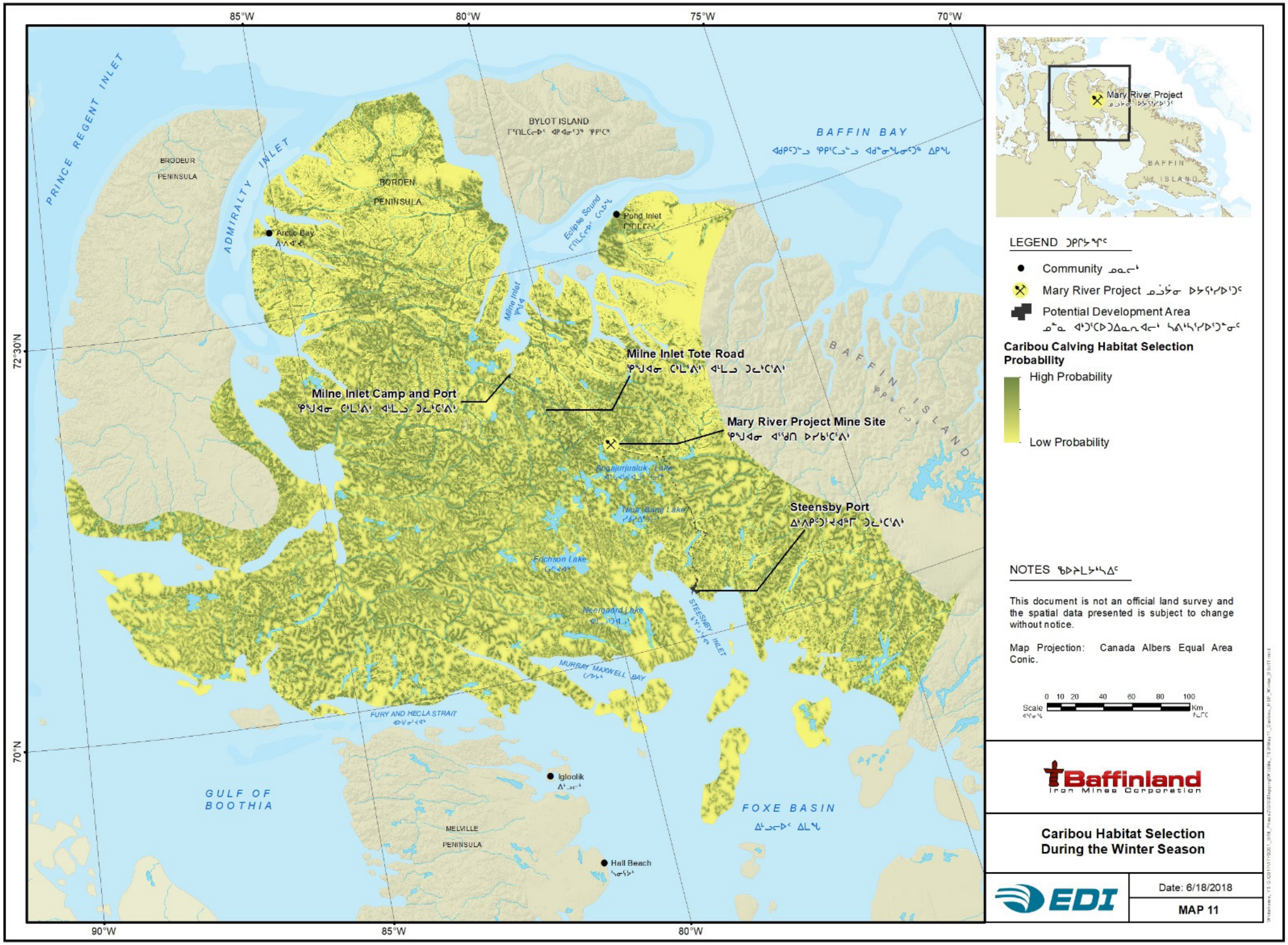
700000
750000
3600000
3550000
3500000
3450000
37048
36851
36843
36846
37492
37030
37025
36835
36843
37025
37492
36840
36840
Mary River Project Mine Site
36846
37035
37123
37407
Angajurjualuk Lake
36836
Milne Inlet Tote Road
36841
36841
Nina Bang Lake
37055
36837
36844
36842
37490
37490
37408
37055
36842
37054
37492
37052
37052
37493
37408
37050
36837
37493
Erichson Lake
Steensby Port
36838
STEENSBY INLET
Map Area
Mary River Project
BAFFIN ISLAND
LEGEND
Mary River Project
Potential Development Area
Calving Sites (2009)
Calving Sites (2010)
NOTES
This document is not an official land survey and the spatial data presented is subject to change without notice.
Map Projection: Canada Albers Equal Area Conic.
Scale
0 5 10 15 20 25
Km
Baffinland
Iron Mines Corporation
Collared caribou calving sites 2009 – 2010
EDI
Date: 6/18/2018
MAP 8


85°W
80°W
75°W
70°W
90°W
72°30'N
70°N
PRINCE REGENT INLET
BRODEUR PENINSULA
ADMIRALTY INLET
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
Arctic Bay
Pond Inlet
Eclipse Sound
Milne Inlet
Milne Inlet Tote Road
Milne Inlet Camp and Port
Mary River Project Mine Site
BAFFIN ISLAND
Steensby Port
STEENSBY INLET
MURRAY MAXWELL BAY
FURY AND HECLA STRAIT
GULF OF BOOTHIA
MELVILLE PENINSULA
Igloolik
Hall Beach
FOXE BASIN
Mary River Project
LEGEND
Community
Mary River Project
Potential Development Area
Caribou Calving Habitat Selection Probability
High Probability
Low Probability
NOTES
This document is not an official land survey and the spatial data presented is subject to change without notice.
Map Projection: Canada Albers Equal Area Conic.
Scale
0 10 20 40 60 80 100
Km
Baffinland
Iron Mines Corporation
Caribou Habitat Selection During the Calving Season
EDI
Date: 6/18/2018
MAP 9


85°W
80°W
75°W
70°W
90°W
72°30'N
70°N
PRINCE REGENT INLET
ADMIRALTY INLET
BRODEUR PENINSULA
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
Eclipse Sound
Pond Inlet
Arctic Bay
Milne Inlet
Milne Inlet Tote Road
Milne Inlet Camp and Port
Mary River Project Mine Site
BAFFIN ISLAND
Steensby Port
STEENSBY INLET
Nina Bang Lake
Erichson Lake
Neergaard Lake
MURRAY MAXWELL BAY
FURY AND HECLA STRAIT
GULF OF BOOTHIA
MELVILLE PENINSULA
Igloolik
Hall Beach
FOXE BASIN
Mary River Project
LEGEND
Community
Mary River Project
Potential Development Area
Caribou Calving Habitat Selection Probability
High Probability
Low Probability
NOTES
This document is not an official land survey and the spatial data presented is subject to change without notice.
Map Projection: Canada Albers Equal Area Conic.
Scale 0 10 20 40 60 80 100 Km
Baffinland Iron Mines Corporation
Caribou Habitat Selection During the Growing Season
EDI
Date: 6/18/2018
MAP 10


85°W
80°W
75°W
70°W
90°W
72°30'N
70°N
PRINCE REGENT INLET
BRODEUR PENINSULA
ADMIRALTY INLET
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
Arctic Bay
Pond Inlet
Eclipse Sound
Milne Inlet
Milne Inlet Tote Road
Milne Inlet Camp and Port
Mary River Project Mine Site
BAFFIN ISLAND
Steensby Port
Erichson Lake
Neeqaajuk Lake
STEENSBY INLET
MURRAY MAXWELL BAY
FURY AND HECLA STRAIT
GULF OF BOOTHIA
Igloolik
MELVILLE PENINSULA
Hall Beach
FOXE BASIN
Mary River Project
LEGEND
Community
Mary River Project
Potential Development Area
Caribou Calving Habitat Selection Probability
High Probability
Low Probability
NOTES
This document is not an official land survey and the spatial data presented is subject to change without notice.
Map Projection: Canada Albers Equal Area Conic.
Scale
0 10 20 40 60 80 100
Km
Baffinland
Iron Mines Corporation
Caribou Habitat Selection During the Winter Season
EDI
Date: 6/18/2018
MAP 11

2.3.2.3 Large and Small Carnivores Inventory

Wolf and fox dens were identified by one carnivore-specific aerial survey in 2006 and opportunistically during the following years. Dens were identified by visual cues such as suitable habitats (glaciofluvial, lacustrine, and marine deposits) and the characteristic green of enhanced vegetation surrounding the sites. Fifteen dens were observed during the 2006 aerial survey and opportunistically in 2007–2008. Three of these dens were specific to wolves and were active in 2007. Only one of these wolf dens was observed within the RSA; it was located approximately 10 km south of the mine site. In all, fewer than 100 wolves and foxes were observed from 2006–2010 and an estimated 2 or 3 breeding pairs were sighted in 2006. The majority of 278 small to medium mammals opportunistically sighted by Baffinland employees for 2007–2010 were Arctic foxes and Arctic hares. Observations suggested low density of wolves and foxes in the RSA consistent with IQ knowledge (see Section 2.3.1.2). It is assumed that availability of food, notably caribou, determine survival and reproduction of wolves (Frame et al. 2008) and that their populations could increase with the return of caribou in large numbers.

Based on a request from the Government of Nunavut during the review of the Environmental Impact Statement (GN IR No. 19, April 2012), Baffinland evaluated potential wolf denning habitat within the RSA. As per guidance from the GN, wolf denning habitat potential was identified as glacio-fluvial materials and esker habitats within the RSA. Based on those parameters, suitable wolf denning habitat in glacio-fluvial terrain is found in ~1,104 km² (~5%) of the RSA. These habitats are not considered ecologically sensitive.

2.3.2.4 Rodents Inventory

On Bylot Island, Nunavut, the lemming population peaks every 3–4 years (Gruyer et al. 2008) and it is believed that lemming populations on north Baffin Island also vary in these short cycles. Lemming-live trapping completed from 2006–2008 suggested that brown and collared lemming populations were at the peak of their cycle in 2008. Although few were caught in preceding years, most likely due to traps being placed near fox dens or new trap effectiveness, signs of lemmings (e.g., sightings, nest) were abundant.

2.4 POST DEVELOPMENT DATA

This section summarizes wildlife monitoring work conducted from 2012–2016 in the Project area and north Baffin Island. This monitoring work includes Baffinland's annual wildlife monitoring, Government of Nunavut surveys on caribou and contemporary local knowledge gained during a series of workshops. Wildlife monitoring programs were initiated to address approved Project Conditions and additional concerns from communities on caribou abundance, movement and habitat. Wildlife information provided in this section can be used to evaluate conditions for the Phase 2 Proposal.

2.4.1 KEY REFERENCE DOCUMENTS

Baffinland's NIRB Project Certificate no. 005 includes conditions for annual monitoring of the terrestrial environment. The following reports provide further baseline information on wildlife resources in the Project's RSA based on annual monitoring conducted from 2012–2016:

- 2012 Annual Terrestrial Monitoring Report (EDI Environmental Dynamics Inc. 2013)
- 2013 Terrestrial Environment Annual Monitoring Report (EDI Environmental Dynamics Inc. 2014)
- 2014 Terrestrial Environment Annual Monitoring Report (EDI Environmental Dynamics Inc. 2015)
- 2015 Terrestrial Environment Annual Monitoring Report (EDI Environmental Dynamics Inc. 2016)
- 2016 Terrestrial Environment Annual Monitoring Report (EDI Environmental Dynamics Inc. 2017)
- Results of community workshops conducted for Baffinland Iron Mines (Jason Prno Consulting Services 2017)

Relevant information from the terrestrial monitoring reports is summarized below to supplement the existing baseline information described above in Section 2.

2.4.2 INUIT QAUJIMAJATUQANGIT — CONTEMPORARY KNOWLEDGE

In preparation of the Phase 2 Proposal, Baffinland conducted a series of workshops in 2015 and 2016 to collect contemporary information for the Mary River Project area and interaction with Phase 2 Proposal activities. One of those workshops was focused on caribou, contemporary land uses and caribou knowledge (Jason Prno Consulting Services 2017). The existing information on north Baffin Island caribou ecology (EDI Environmental Dynamics Inc. 2012) was reviewed with participants so they could confirm its accuracy and provide additional details. Participants discussed caribou population dynamics, migration patterns, behaviour and food sources.

Population Distribution and Dynamics

Participants confirmed the existence of two main herds on Baffin Island which are the north Baffin Island and south Baffin Island herds. They added that a distinct sub-population of north Baffin Island caribou known to them as "mountain caribou" is found on the northern Borden Peninsula. They are differentiated from the main herd by their eyelashes and bigger body size.

> *"We also have caribou that are different; they are a separate caribou population. We consider them mountain caribou and they are found on the northern Borden Peninsula. They are slightly different than the main North Baffin herd. The main herd is smaller in body size and have no eyelashes. We notice this because we harvest and butcher caribou. That's how we differentiate between caribou."*

Participants also confirmed that north Baffin Island caribou generally follow a 60–80-year population cycle partly driven by food availability and that caribou around Pond Inlet are in the low of that cycle. When food sources become unavailable, caribou are believed to move to new locations and their numbers decline. Caribou will return when food sources grow back followed by a population increase. Participants also confirmed that the last high in caribou population started in the 1980s and peaked in the mid-1990s which is consistent with previous knowledge and studies. Caribou then started moving towards Clyde River (south) and their population declined. Participants agreed that caribou would eventually return to the Pond Inlet area.

> *"When hunters go hunting, we are always very observant of the caribou. In past years we had abundant caribou around Pond Inlet, in 1994 and 1995. The caribou then headed towards Clyde River for a 10 year period. They started moving south and into the fjords towards Clyde River. When the elders saw that they said 'uh oh', because they knew the caribou would not return for a while. They knew they would not return until the vegetation grew back. It can take a very long time for the vegetation to grow back… It seems like it will be a few years before the main herd arrives. It seems like there are more caribou starting to migrate north again."*

Migration Patterns and Behaviour

Participants explained that in the spring (April and May) cows move northwards towards their calving grounds for calving which occurs in mid-May to early June. Calving sites are found north in higher elevations where cows and calves are protected from predators and insect harassment. Cow-calf pairs remain in these areas until fall when they move southwards to rejoin the main herd and mate. This movement occurs from the end of August to October and coincides with the rutting season. Caribou are found in flatter, valley-like areas in the winter where their predators are easier to spot. Unlike large herds, these small herds do not travel far — although when populations increase, the spring and fall migration patterns of caribou groups will become discernable. Seasonal caribou locations were combined on Map 12.

> *"In the spring the females are travelling up in the land to give birth. In the fall they are going down south looking for the other herd. They will travel to the south to meet up with the other herd. They will gather and repopulate. The mothers and calves are up on the mountains where there are less mosquitos and to protect their young ones. In the fall they go back down to the beach and will look for their mate."* (Jason Prno Consulting Services 2017)

Migrating caribou (i.e., large herds) move more aggressively through the land and do not usually deviate from their routes (Map 12). They follow cows and calves and it is assumed that they sometimes follow their leaders' (i.e., cows with calves) migration patterns through scent if they are not with them. Participants also noted that large herd migration is usually responsible for leaving larger trails on the land, whereas narrower trails are caused by smaller groups. Additionally, caribou found on the Borden Peninsula migrate north from the mainland or from Barnes Ice Cap area in the fall and back south in the spring.

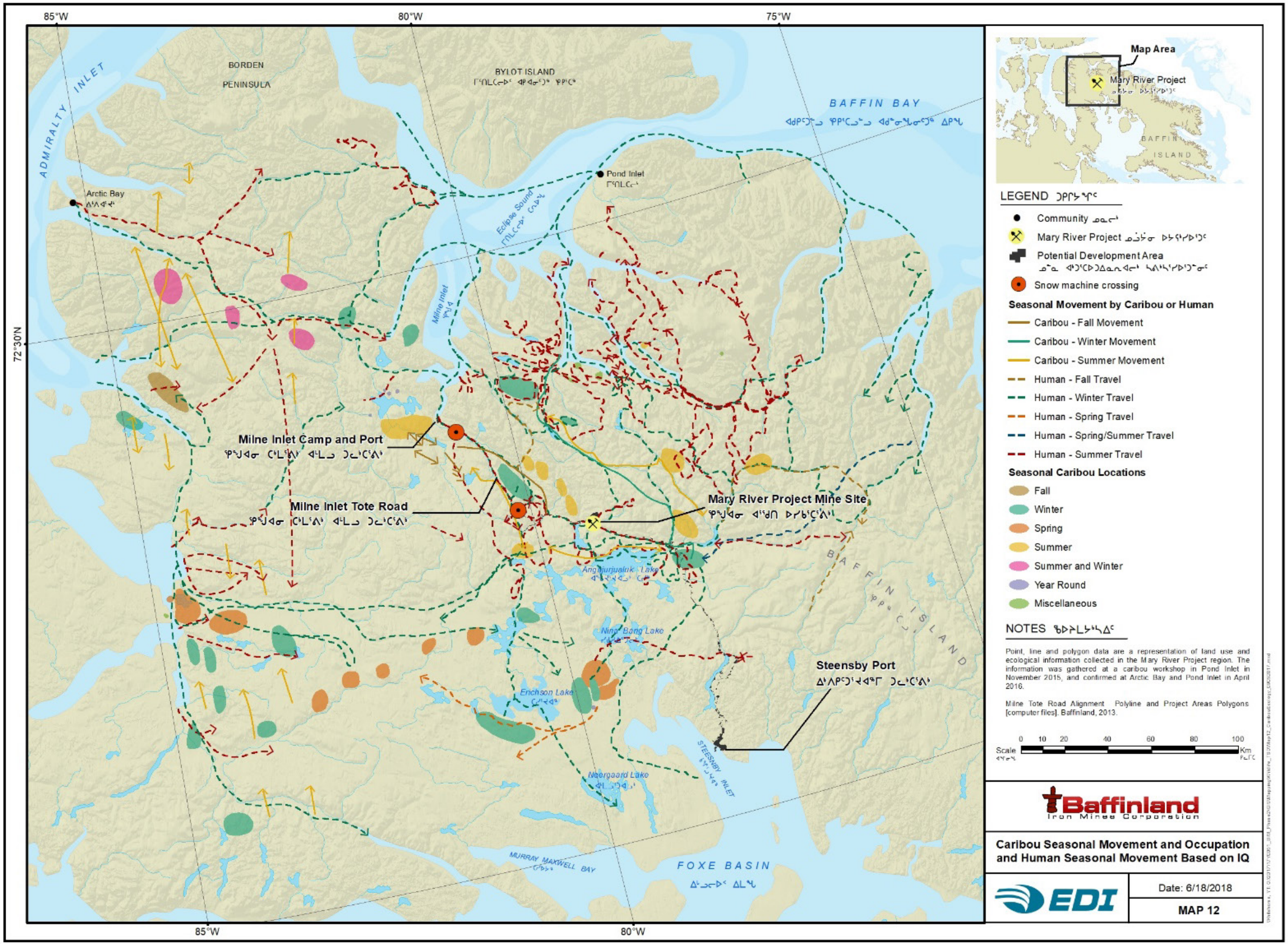
Participants noted that caribou behaviour reflected their herd size. Large herds tend to be less fearful and more aggressive when they move toward a destination. They are more curious and do not tend to detour from their route even when there are disturbances. Small herds, caribou in lower elevations, and cows with calves are more skittish and timid. They avoid routes with disturbances such as human development activities.

Historically, caribou gathered around Angajurjualuk Lake and possibly up to Milne Inlet. Currently they are not found concentrated around Milne Inlet, Steensby Inlet nor Angajurjualuk Lake but were found southeast of the Project and around Barnes Ice Cap. It was speculated that the noise from development activities could be driving caribou away while they are found in small numbers.

Food Sources

North Baffin Island caribou mainly feed on lichens although other types of vegetation are consumed depending on the season. Caribou do not move when there is sufficient food available but will move to other locations when that source is depleted. One participant noted that caribou have a diurnal feeding cycle; foraging at higher elevations during the day and lower elevations at night. During summer, caribou put on weight by foraging on black lichen found in higher elevations and rocky terrain and on twigs and willows in lower elevations. The type of vegetation impacts the colors of the stomach; higher elevation foods such as black lichen causes the rumen contents to become darker whereas greener, leafier and newly grown vegetation such as found in valleys give the rumen contents a greener color. The stomach color also changes with seasons and caribou abundance as caribou that are not competing for food have greener stomachs. Caribou stomachs become darker with decline of food availability and increased forage of rock lichens. Ultimately, caribou will migrate away together. Participants believe this occurred in Cape Dorset and Pond Inlet in the 1990s.

Additionally, participants identified that caribou are more visible during spring (e.g., March – June) as their fur is darker and while there is snow-cover. Caribou are also more visible in October when they are gathered in herds. They are less visible during summer and fall when they are not with their herds and when their coats change colour. Darker and colder winter months also make it harder to spot caribou.


85°W
80°W
75°W
72°30'N
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
ADMIRALTY INLET
Arctic Bay
Pond Inlet
Eclipse Sound
Milne Inlet
Milne Inlet Camp and Port
Milne Inlet Tote Road
Mary River Project Mine Site
Angajurjualuk Lake
Nina Bang Lake
Erichson Lake
Steensby Port
STEENSBY INLET
Neergaard Lake
BAFFIN ISLAND
MURRAY MAXWELL BAY
FOXE BASIN
Map Area
Mary River Project
LEGEND
Community
Mary River Project
Potential Development Area
Snow machine crossing
Seasonal Movement by Caribou or Human
Caribou - Fall Movement
Caribou - Winter Movement
Caribou - Summer Movement
Human - Fall Travel
Human - Winter Travel
Human - Spring Travel
Human - Spring/Summer Travel
Human - Summer Travel
Seasonal Caribou Locations
Fall
Winter
Spring
Summer
Summer and Winter
Year Round
Miscellaneous
NOTES
Point, line and polygon data are a representation of land use and ecological information collected in the Mary River Project region. The information was gathered at a caribou workshop in Pond Inlet in November 2015, and confirmed at Arctic Bay and Pond Inlet in April 2016.
Milne Tote Road Alignment Polyline and Project Areas Polygons [computer files]. Baffinland, 2013.
Scale
0 10 20 40 60 80 100 Km
Baffinland Iron Mines Corporation
Caribou Seasonal Movement and Occupation and Human Seasonal Movement Based on IQ
EDI
Date: 6/18/2018
MAP 12

2.4.3 BAFFINLAND MONITORING SURVEYS

To address Project Conditions for the NIRB Project Certificate No. 005, Baffinland conducts annual monitoring to study potential changes to wildlife, especially caribou, in the Project area. These data collected as part of the wildlife monitoring program provide additional baseline information on the state of wildlife for the Project area. Caribou remain a focal species regardless of the low in their population cycle. Monitoring efforts were focussed on gathering ground-based data in proximity to Project components. Additionally, potential changes to vegetation used as caribou forage in the Project area are monitored as part of annual terrestrial environment monitoring described in Section 2.4.1.

2.4.3.1 Height-of-Land Caribou Surveys

HOL surveys observe caribou behaviour and monitor predicted Project effects on their movement and habitat use from a high point of land to increase the amount of observable area. HOL surveys primarily evaluated how caribou, especially cow-calf pairs, responded to activities and infrastructures related to the Project. HOL surveys in 2013 focussed on the calving season but expanded to include the late winter as of 2014. A post-calving (July) HOL survey was also completed in 2014.

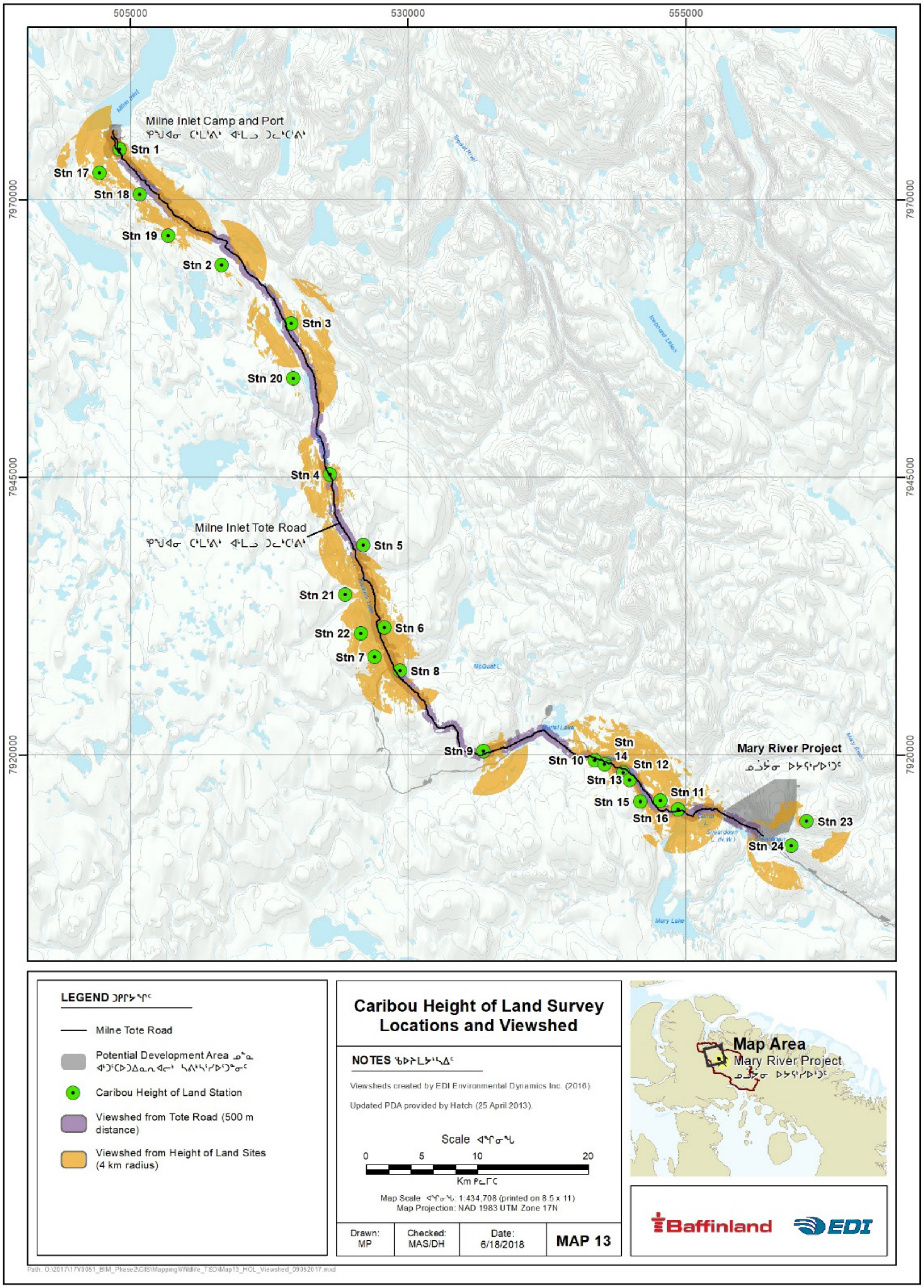
Methods — Potential HOL stations were identified on a 1:250,000 contour map based on their location along the road, gain in height (e.g., improved view) and accessibility in spring conditions. A 360-degree view was rarely achievable, but Project components were always visible from each station. Sixteen sites were established in 2013 and another eight in June 2014 in more remote areas that had less coverage (possible by helicopter) (Map 13). Stations were accessed via a bombardier side-by-side in April surveys and via helicopter or truck and hiking during June and July surveys. Observations were made by at least one spotting scope (two in 2015), one set of binoculars (two in 2014), and from normally scanning the area. Two to four observers were present and scanning the viewable landscapes took 15 – 31 minutes depending on sites and conditions. Observation periods were longer when caribou were spotted. When observed, caribou behaviour was monitored by scan sampling or focal sampling depending on the group size (Martin and Bateson 1993). Scan sampling assigned activity categories (i.e., walking, foraging, running, lying, etc.) which were tallied every two minutes. For the focal sample, activity observations were taken every two minutes although unique responses to different events were also recorded (e.g., truck passing by). When observed, caribou distance from the observers and from Project infrastructure and their directional movement were noted.

Viewshed mapping completed in 2016 identified how far and to what extent surveyors could see during HOL surveys (Map 13). Each HOL station was visited in June. One surveyor stayed on the ground at the HOL station and the other flew to the anticipated maximum distance for viewing cryptic caribou. The second surveyor would exit the helicopter to confirm they were visually detectable by binoculars or a spotting scope (confirmed by radio). Through repetition, the maximum viewable distance was refined. This was validated by the helicopter flying out that distance and the ground-based surveyor confirming it was the same size as previous assessments and that an object the size of a caribou near the helicopter was visible. Observers could detect animals 5 km from the station but could not determine sex or age, so the maximum detectable distance was scaled back to 4 km.

Results — During the 2013 HOL survey, two groups of caribou were observed most frequently foraging and walking, and less frequently running and standing. A group of five caribou was observed through a spotting scope at station no. 13 and were located approximately 2–3 km from the station, and about 1.5 km east of the road. Sex and age were not determined, but two individuals had relatively large antlers, one had small antler stubs, and two did not have antlers. Individuals were not facing the road. A scan sample was completed for 60 minutes.

Three young (yearling) bulls were incidentally observed approximately 20 m east of the Tote road while travelling along it near km 95. This observation provided an opportunity to assess caribou behaviour around Project components. Activities observed during a 60-minute focal sample were walking, running, foraging, standing, and lying down. The group seemed startled by a truck by immediately running away from the road. They slowly moved back to the road once the truck stopped and two individuals crossed the road and walked along it for a short time. Caribou were not startled by two vehicles that approached from the south during observation. The group stood and looked at the first vehicle (20 min. into observation) and continued walking slowly towards the road when the second vehicle drove by (28 min. into observation). They were located further from the road on both occasions (300 m and 250 m east).

No caribou were observed during HOL surveys from 2014–2016. Decrease in caribou numbers cannot be confirmed due to small size (8) observed in 2013. However, lack of observations during HOL surveys coincide with no caribou sightings between the Mine Site and Milne Port.


505000
530000
555000
7970000
7945000
7920000
Milne Inlet Camp and Port
Stn 1
Stn 17
Stn 18
Stn 19
Stn 2
Stn 3
Stn 20
Stn 4
Milne Inlet Tote Road
Stn 5
Stn 21
Stn 22
Stn 6
Stn 7
Stn 8
Stn 9
Stn 10
Stn 14
Stn 12
Stn 13
Stn 15
Stn 11
Stn 16
Mary River Project
Stn 23
Stn 24
LEGEND
Milne Tote Road
Potential Development Area
Caribou Height of Land Station
Viewshed from Tote Road (500 m distance)
Viewshed from Height of Land Sites (4 km radius)
Caribou Height of Land Survey Locations and Viewshed
NOTES
Viewsheds created by EDI Environmental Dynamics Inc. (2016).
Updated PDA provided by Hatch (25 April 2013).
Scale
0
5
10
20
Km
Map Scale 1:434,708 (printed on 8.5 x 11)
Map Projection: NAD 1983 UTM Zone 17N
Drawn: MP
Checked: MAS/DH
Date: 6/18/2018
MAP 13
Map Area
Mary River Project
Baffinland
EDI

2.4.3.2 Caribou Track Survey

The goal of snow track surveys was to look for caribou or other wildlife tracks along Tote Road. Snow track observations allowed surveyors to study the movement of caribou and other wildlife in relation to the road and their behaviour near the Mine Site.

Methods — Snow track surveys were completed along Tote Road, from the Mine Site to Milne Inlet, in mid-April 2014–2016. Observers travelled slowly in a vehicle or utility task vehicle along the road searching for wildlife tracks. In 2014, part of the survey was completed off the main road on transects (approx. 50 km of transects completed) at various distances from the road using a Bombardier side-by-side. The goal was to survey transects on both sides of the road outside of the disturbance area of the plow (>15 m from road). Due to equipment failure, the remaining portions were driven with a light pickup truck at speeds of approximately 35 km/h which provided relatively good track detectability. Snow track surveys were completed by pick-up at speeds of approximately 30–35 km/h in 2015 and 2016. Upon discovery of wildlife tracks, surveyors identified the number of tracks (i.e., group size) and their species, and recorded coordinates at road crossings or deflection points. Surveyors followed the tracks for a few hundred meters towards and away from the PDA to observe habitat use and describe them in relation to the road (e.g., divergence from road, parallel to road).

Results — In 2014 and 2015, snow track surveys were completed in ideal conditions although there was no fresh snow cover in 2014. Snow cover was variable in 2014 and consistent in 2015 except from kilometer 12 to 0 (Milne Inlet) where there was variable snow cover with windswept patches making it difficult to detect tracks. In 2016, the snow track survey was completed a few days after a heavy snow and wind storm and wind drifts temporarily caused the closure of Tote Road. No snow accumulated on the two days prior to surveying; however, there was wind causing light dusting of fresh/ windswept snow (covering recent tracks). The survey was completed during relatively good conditions. Visibility for surveys was estimated at over 1 km.

In 2014, two distinct Arctic fox trails and one Arctic hare trail were observed from the side-by-side. Tracks belonging to a hare were also noticed 300 m from the truck while travelling along Tote Road. Caribou trails with no recent signs of use were noticed in gravel that had become exposed by the wind. In 2015, surveyors observed 13 distinct Arctic fox crossings with track groupings of 1-8 tracks per crossing. It was believed that one or more individuals went back and forth on the same trail in areas with multiple track crossings. Tracks were often found going along the road before crossing it. One Artic hare crossing was also observed in 2015. In 2016, 80 distinct Arctic fox crossings containing 1–5 sets of tracks each were observed. As in 2015, it was believed that one or more individuals travelled back and forth on the same path. Due to fresh snow being dusted by light wind it was difficult to determine the freshness of the tracks. At least 10 of the tracks were considered "fresh" (made since the most recent snowfall). One set of Arctic hare tracks were observed. Additionally, one Arctic hare was sighted. No caribou or wolf tracks were detected during surveys.

2.4.3.3 Caribou Water Crossing Assessment

A caribou water crossings assessment on sites identified during baseline (Map 6) and at bridges along Tote Road was done in 2014 to address concerns from the Qikiqtani Inuit Association (QIA). Animal trail networks are very important for caribou movement patterns and although caribou abundance is very low, water crossings will be important to accommodate safe crossing for caribou when their numbers increase.

Methods — An aerial survey with four observers covered previously identified caribou trails and water crossing sites along the railway alignment from the Mine Site to Steensby Inlet and Tote Road in July 2014. It also evaluated conflicts between caribou trails and bridges along the Tote Road. Ground-based verification was done on more recently used trails. Survey methods were similar to those in Williams and Gunn (1982), the only Government publication found of water crossings in the Arctic. If sites were identified as key crossing areas and indicated signs of recent use, remote trail cameras would have been deployed at the site. This would monitor use of the sites during the ice-free period to assess current uses. Potential crossing areas between the Mine Site and Steensby Inlet were flown up to source waters, specifically 20 km upstream of the Ravn River crossing, and 5 km downstream at each crossing. Waterways with existing bridges along Tote Road were surveyed 4–5 km up-and-downstream.

Results — As noted during other surveys (EDI Environmental Dynamics Inc. 2012), the majority of trails observed were located between Steensby Inlet and Angajurjualuk Lake. Older and fewer caribou trails were also observed at water crossings north of the Mine Site. No barriers were found up-or-downstream of any proposed or established waterway crossings (e.g., bridge) although old caribou trails were present at some of the proposed railway crossings where up-and-downstream were suitable crossing sites. No caribou were observed during the water crossing assessment.

2.4.3.4 Caribou Fecal Collection

Fecal pellet analysis can provide information on caribou diet composition and quality, pregnancy rates, herd composition, stress levels, and proportions of inorganic content (e.g., ash) in diet. Caribou pellets were collected incidentally during other field work from 2011–2014. Generally, only relatively fresh pellets (i.e., from the past winter with no vegetation growth on them, dark brown/ black, somewhat shiny and softer) were collected although some older ones were taken. Their locations were marked by GPS and they were stored in properly identified paper bags. To prevent spoiling, samples were hung to dry for at least 24 hours and stored in a freezer once sufficiently dried.

Fecal pellets have not been analyzed because a robust program to determine ash content in caribou pellets as a correlate to a project-related effect is not possible due very low abundance of caribou in the RSA and a small sample size (< 10 "fresh" samples). A suitable number of samples of near (likely "affected" caribou diets) and far (likely "control, unaffected" caribou diets) are needed to inform Project effects and mitigation actions which will likely not be available until caribou return in larger numbers. Fecal pellets will continue to be collected opportunistically until an adequate sample size is available for analysis.

2.4.3.5 Wolf Den Surveys

A wolf den survey was completed in 2014. Identifying den sites provides information on wolf abundance and their habitats in the PDA, and Project effects on wolf and Arctic fox displacement allowing for buffers limiting disturbance to be established.

Methods — An active wolf den aerial survey by helicopter with three surveyors was completed over 3 days within a 10 km radius of the Mine Site, Tote Road and Milne Port. Surveys were not done east or south of the Mine Site due to blasting and poor weather conditions. A flight plan was mapped prior to surveying to include previously identified den sites (EDI Environmental Dynamics Inc. 2012) within the 10 km buffer. During the survey, observers searched mounded ground or soft ground that would allow for digging. Emphasis was placed on areas with higher denning potential. Photographs and coordinates were taken at observed dens and occupants identified to species. Disturbance was reduced at active dens. Incidental searches were conducted during aerial surveys not specific to locating dens, and exploration geologists working in the area reported any wildlife sightings and signs.

Results — Snow cover made it difficult to identify suitable denning habitat. One active den was detected at the same location of a previously active wolf den. The species using the den could not be conclusively identified but was suspected to be an Arctic fox. On June 11, 2014, fresh tracks surrounding the den were initially observed from the helicopter and confirmed by three biologists located 530 m west of the site using a spotting scope and binoculars. A Baffinland employee and helicopter pilot noted fresh tracks directly in the den area while conducting an aerial site inspection on June 16, 2014. Fresh tracks coming from and going to the den site were again noted during a subsequent Arctic Raptors survey which included an EDI biologist. No mitigation was recommended as the den was 9.3 km from the closest existing disturbance.

2.4.4 GOVERNMENT-LED SURVEYS

Since Baffinland initiated baseline work and submitted the FEIS, the GN initiated a collaring study (noted above), and several Baffin Island-wide caribou surveys supported by Baffinland. As of January 2017, two surveys have been conducted specific to north Baffin Island. The information for those surveys is included in the following reports:

- Working together for Baffin Island caribou. Workshop report (August 2013). (Government of Nunavut, Department of Environment 2013)
- Aerial abundance estimates, seasonal range use, and spatial affiliations of the barren-ground caribou (*Rangifer tarandus groenlandicus*) on Baffin Island – March 2014. (Campbell et al. 2015)
- 2015 Government of Nunavut north Baffin caribou fall composition/demographic survey (Pretzlaw 2016)
- North Baffin caribou fall demographic composition survey, September 2016 (Anderson 2016)

The GN surveys were conducted in response to Baffin Island community comments about the low numbers of caribou on Baffin Island that resulted from a workshop held in July 2013 to discuss caribou management (Government of Nunavut, Department of Environment 2013). A community-based approach to support Inuit self-management was identified as the preferred method of managing the caribou populations. Local Hunters and Trappers Organizations (HTOs) were to work with the communities and management partners to develop community restrictions and management actions. There were also suggestions for future work on caribou surveys including:

- Consultations with local Elders and experts to focus survey efforts
- More closely spaced transects during aerials surveys (2012 surveys used 10 km spacing)
- Both spring and fall surveys to capture calving and the rut
- Ground surveys to confirm and add to aerial surveys conducted by the local populations

The results of February and March 2014 aerial surveys for the Baffin Island and northern Melville Peninsula caribou population were released in Campbell *et al.* (2015). The survey design was based on results of previous aerial and telemetry surveys and guided by local knowledge and IQ. The estimate of surveyed area on north Baffin Island was approximately 144,627.8 km² with transects spaced at 7, 8 or 10 km depending on expected caribou density. The survey excluded areas where Inuit knowledge expected no caribou to be found, although areas around communities with unknown caribou presence were ground-surveyed. Sixty-three individuals were directly observed during aerial surveys; one on the Borden Peninsula transect, 49 on the Mine Site transect and another 13 on the North East Baffin transect. An additional two individuals were observed in one group on Crown Prince Frederik Island during the ground survey led by six Arctic Bay HTO surveyors; however, one of these two individuals were reported as harvested and therefore they were considered removed from the population and not included in the survey. Additionally, caribou sign was observed at seven separate locations, most of which were near or east of the Mary River camp. This survey resulted in an estimate of 159–622 (mean of 315) combined individuals (adults, calves and yearlings) for the North Baffin grouping survey. This was within the range of variability of the 2009 survey reanalyzed by Campbell *et al.* (2015) which was estimated 285–1,591 (mean of 673) individuals. Although relative densities dropped between 2009 and 2014, available demographic data on north Baffin Island is insufficient to determine a statistically substantial trend (Campbell et al. 2015).

Additionally, telemetry data collected by Ferguson from 1987 to 1994 and by Jenkins and Goorts (2011) from 2008 and 2011 were re-analyzed. Two satellite collars were deployed within the north Baffin grouping during a period of high abundance (early 1990s) and 31 GPS collars between 2008 and 2011. Results strongly suggested the existence of a north Baffin herd, separate from the south-central and southeast Baffin herds (confirmed with additional telemetry data for south Baffin Island). These potential subpopulations are referred to using the term "grouping" due to limited information. Data suggested very little mixing between groupings even during the low and high abundances of the north Baffin grouping. The north Baffin caribou grouping also had lower daily and annual movements compared to south Baffin groupings. Daily movement rates during spring (1.9 km/day) and calving (1.7 km/day) for the north Baffin grouping were very low emphasizing their reduced migratory behaviour. Calving was dispersed across their annual range mostly concentrated within nine general areas including the area of Tariujaq Arm of Steensby Inlet, west of Cockburn Lake, the Separation Lake, northern portion of Freshney River, south of Tay Sound, and extended area northwest of Nulujaak mountain and the Mary River drainage, the Ravn River drainage and east of the north Arm of Paquet Bay. Caribou were most active post-calving (2.8 km/day) as they were spread across their annual range with little tendency to aggregate and during fall (2.4 km/day). They became less active from the rut and early winter (2.2 km/day) to the winter period (1.3 km/day). The north Baffin grouping aggregations during rut and winter were like those of calving and post-calving spread across the range with a general eastern shift.

During the fall of 2015 and 2016 demographic composition surveys of the North Baffin caribou were conducted by helicopter based out of Mary River camp (Pretzlaw 2016, Anderson 2016). The aircraft flew a serpentine route to those areas where caribou were known to occur. These surveys were not intended to estimate overall population but rather to determine fall calf recruitment as an indicator of overall population trends. During the fall of 2015, 204 caribou were observed; 77 cows, 55 calves, 23 immature bulls and 49 mature bulls. There were 71 calves per 100 cows (considered to be high), this indicated strong calf recruitment and is a potential indicator for an increasing population. There were also 93 bulls per 100 cows. Forty bulls per 100 cows is cited as the minimum number to confirm all cows are bred assuming they are spread evenly across the range (Tobey 2001).

In the fall of 2016 the composition survey located 202 individuals. There were 56 calves per 100 cows, lower than the 2015 survey but still indicative of a stable to growing population. There were also 46 bulls per 100 cows, much lower than the 93 bulls per 100 cows counted in 2015 and possibly reflective of the bull-only harvest instituted in August 2015 (Anderson 2016).

2.4.5 CONTEMPORARY CARIBOU HARVEST

The GN implemented an interim moratorium on caribou harvest on January 1, 2015 (Government of Nunavut, Department of Environment 2014) in response to their 2014 Baffin Island-wide surveys which recorded a 90% decline in caribou population since the 1990s (Campbell et al. 2015). On August 29, 2015, the ban was replaced with a total allowable harvest limit of 250 male caribou for Baffin Island (Government of Nunavut, Department of Environment 2015). Considering the extremely low north Baffin Island population, the GN suggested that the Qikiqtaaluk Wildlife Board allocate most of the harvest quotas so that most harvesting occurs in central and south Baffin Island.

Contemporary caribou harvest on north Baffin Island was discussed during community workshops completed for Phase 2 of the Project (Jason Prno Consulting Services 2017). Participants confirmed the importance of caribou harvesting which is a valued component of the north Baffin Inuit diet. Important harvesting periods for Pond Inlet are at the end of August to early September due to the high meat quality, and in November and December for the Christmas season; however, November tends to be avoided because the meat is not so good during the rut. Hunting also occurs in January and early February. Similarly, Arctic Bay harvesting occurs in August, November and December; however, they also hunt in March and April unlike Pond Inlet hunters.

Important hunting routes/areas were located on a map of north Baffin Island (Map 12). The Mary River area was specifically mentioned as an important harvesting area, although mountains north of the Mine Site and the Milne Inlet area have been most recently used for harvesting. The Tote Road remains an important route for harvesting primarily in the summer but is less used since the development of the Project. Harvesting usually occurs near communities to reduce the need of travelling further (Jason Prno Consulting Services 2017).

2.5 WILDLIFE AND WILDLIFE HABITAT CHARACTERISTICS SUMMARY

Wildlife associated with the Project area on north Baffin Island can be summarized as follows:

Caribou Abundance

- North Baffin Island caribou have a 60–70-year population cycle of abundance believed to be related to availability of forage.
- Caribou abundance has declined by 90% since their last peak ended in the mid-1990s. Caribou are currently at a "low" in the population cycle. Their numbers are expected to gradually increase in the Mary River region but might not recover to historical high abundance until the 2050s.
- Very low numbers of caribou and signs have been observed in the RSA during Baffinland surveys. In 2013, 29 caribou were observed during HOL surveys and incidentally, followed by 19 caribou in 2014 to 2016 with 17 of those recorded for 2015.
- There are insufficient data to statistically determine a trend in caribou abundance, although caribou sightings have been reduced in recent years.
- As of 2016, barren-ground caribou (including the north Baffin Island herd) are listed as threatened by COSEWIC (COSEWIC 2016) but not yet included on the SARA list.
- There is currently an island-wide harvest limit of 250 bull caribou.

Caribou Distribution and Movement

- Caribou occur and have historically been found throughout the RSA. They used to concentrate around Angajurjualuk Lake and probably up to Milne Inlet and around Steensby Inlet. This is consistent with high-density trails concentrated around Steensby Inlet and east and south of Angajurjualuk Lake.
- Current residents indicate caribou are now found in mountains north of the Project and around Barnes Ice Cap.
- Caribou also calve throughout the RSA mostly located more northwards and in elevated areas for protection against predators and mosquitoes. There are no identifiable calving grounds where caribou are known to congregate.
- Caribou in the RSA are currently non-migratory with no large-scale seasonal movements and daily movements averaging below 4 km/day throughout the year.
- More recently gathered IQ knowledge suggests that caribou may become migratory when their numbers increase and that their migration routes will be more predictable. These routes and water crossings were identified.

Behaviour

- Caribou behaviour is related to their herd size: smaller herds to individual caribou such as cows with calves are more fearful of disturbances, such as the Project.

Carnivores

- Dominant carnivores in the Project area the Baffin Island wolf and the Arctic fox (also red fox).
- Few wolf and fox dens and a small number of wolves have been observed in the Project area.
- Wolf abundance and density is currently low as it is tied to caribou abundance.
- There have been abundant observations of Arctic fox in the area and they are currently considered the only abundant terrestrial mammal on north Baffin Island.

Small Mammals

- The Arctic hare is considered ubiquitous in the Project area.
- Brown and Peary Land collared lemming occur in the Project area.
- Based on existing studies, brown lemming are known to have 3–4 year population cycles whereas studies of Peary Land collared lemming indicate population cycles are varying.

Wildlife Health

- Limited information exists on wildlife health and no information was found on contaminants for north Baffin Island wildlife.
- Rangerfine brucellosis was prevalent in the Project area during the 1980s. The current prevalence in unknown although caribou harvested in 1990s and more recently are healthy.
- Kidneys sampled from herds on south Baffin Island found no health concerns due to contaminants.

3 IMPACTS ON WILDLIFE AND WILDLIFE HABITAT

3.1 INUIT COMMUNITY AND STAKEHOLDER COMMENTS

Baffinland conducted a number of public consultation meetings and personal interviews to receive information on baseline data and to scope potential issues of perceived project effects for the Final Environmental Impact Statement (FEIS, Baffinland 2012) and more recently to introduce the Phase 2 Proposal (TSD 03 – Phase 2 Workshop Report). The key issues that are addressed for the Phase 2 Proposal's impacts on terrestrial wildlife were identified through several consultation processes that included the following elements:

- Community scoping meetings;
- Terrestrial wildlife focused working groups;
- An environmental assessment workshop with the Qikiqtani Inuit Association (QIA) and their community representatives;
- Issues raised during meetings of the Terrestrial Environment Working Group held since 2013;
- Professional experience from other northern mining projects;
- Guidance provided by the Nunavut Impact Review Board's (NIRB) project EIS guidelines (Nunavut Impact Review Board 2015); and
- Information Requests and Technical Comments submitted by parties during review of the DEIS and FEIS materials for the Approved Project.

The community comments, personal interviews and Inuit Qaujimajatuqangit (IQ) were used in combination with the information gained from the above sources to develop the baseline report and formed the basis of this assessment. The interpretation of knowledge about specific issues and project interactions with terrestrial wildlife as it relates to the process used to predict impacts and determine their significance are described below.

Terrestrial wildlife valued ecosystem components (VECs) were identified based on ecological and social importance and relevance to the potential interactions with the Phase 2 Proposal. Caribou were consistently identified as an important species to the communities. They are abundant during population cycle "highs" and do interact with the existing operation and activities proposed for the Phase 2 Proposal. When present, caribou are harvested by hunters from communities surrounding the Project. There are harvest records back to the 1920s, and caribou certainly remain a key component of Inuit diet and culture. Caribou also appear to be a keystone species in the north Baffin Island ecosystem as the abundance of many other animals, particularly the island's carnivores, seem to be related to their abundance and distribution. Additionally, many studies have been conducted on caribou responses to industrial activities throughout the species range. For these reasons, caribou were identified as a VEC and are in part representative of a north Baffin Island terrestrial wildlife response to the Project.

Baffinland conducted several workshops, interviews, radio call-in shows and written requests to collect baseline information and determine public perceptions and concerns with the Project's interaction with terrestrial wildlife. Concerns were varied, but generally focused on the Project's potential to affect caribou behaviour, movement patterns, and the potential for increased mortality.

While preparing the EIS guidelines for the Mary River project, the Nunavut Impact Review Board (NIRB) also conducted several additional community meetings to scope key issues to be considered in the assessment of the Phase 2 Proposal. The NIRB guidelines generally seem to reflect many of the concerns identified during Baffinland's consultations where there are concerns about disturbance to caribou behaviour and movement, and a desire to predict the overall effects on animal health and distribution. The NIRB guidelines (Nunavut Impact Review Board 2015) related to terrestrial wildlife effects, Section 8.1.10.2, include direction to Baffinland to assess potential impacts on migratory routes, caribou calving and post-calving routes, impacts from ground and air traffic, attractants, and contaminants.

3.2 POTENTIAL INTERACTIONS WITH WILDLIFE AND WILDLIFE HABITAT

Construction, operation and closure activities of the Phase 2 Proposal have the potential to impact distribution and abundance of wildlife VECs in the RSA. Caribou and wolf were examined as the key indicators of the Proposal's potential impacts on terrestrial wildlife. Four measurable parameters were assessed for caribou: habitat, movement, mortality, and health, and one for wolf: habitat. A review of the potential interaction of the Phase 2 Proposal with the four measurable parameters is described below.

3.2.1 HABITAT

Habitat can be impacted through direct loss within the footprint of the Phase 2 Proposal that is either temporary or permanent, or through indirect loss from project activities that create sensory disturbances that reduces the effectiveness (usefulness) of adjacent habitats.

Loss of caribou foraging habitat will occur from the ground disturbance within the PDA. In addition, the presence of infrastructure is considered a negative impact on caribou as caribou have been reported to generally avoid infrastructure. The responses have been sex-specific during spring and summer, and females showed a greater response to human infrastructure (Whitten and Cameron 1983, Dau and Cameron 1986). Alternatively, caribou have also been reported using industrial infrastructure in northern Alaska as features that allow them to get relief from insect harassment (e.g., well pads, roads; Vistnes and Nellemann 2008). Direct loss of habitat is readily assessed by determining the spatial extent of the PDA, and the methods used to define habitat and the PDA are described below.

Indirect or functional loss of habitat includes reduction of habitat effectiveness due to project activities. Sensory disturbances can result in behavioural responses such as avoidance (e.g., running) responses or avoidance of particularly disturbing areas. These behavioural responses can ultimately affect the potential energetic benefits of using some habitats. Sensory disturbances associated with the project can be categorized by the senses they stimulate: sight (vision), hearing (audition), smell (olfaction), touch (tactition) and taste (gustation). Human caused visual stimuli that cause behavioural responses can include people (walking, etc.), off-road vehicles, automobiles, trains, aircraft and ships travelling across a landscape/seascape. Aural stimuli include noises associated with motors, generators, automobiles, aircraft, blasting, etc. Olfactory stimuli include scents associated with human presence (cooking), motors (exhaust) or dust. Tactile disturbances may be related to an animal's response to vibration. A taste response may be elicited by dust deposition on forage that affects palatability. Several Phase 2 Proposal activities can be associated with several sensory disturbances; for example, caribou could see, smell, hear and feel blasting around the mine and a resulting behaviour could be to avoid some areas of otherwise useable habitat.

The effectiveness of habitat can be reduced in proximity to developments even if the habitat is unaltered, and the extent of that effect can sometimes be at the scale of kilometres (Wolfe et al. 2000, Mayor et al. 2009), but it is difficult to predict how individual caribou, or animals of different herds than those already studied will respond to disturbance. The variability of the ecosystems caribou have adapted to means that precise and accurate predictions of how caribou may respond to specific human developments within their range are difficult to estimate because behavioural responses can be regionally specific. Recent advances in the analysis of caribou collar data have provided further insight into an understanding of how caribou select habitat, which has led to speculation about how caribou perceive their environment. Woodland caribou have been reported responding to human caused changes in habitat at distances up to 15 km (Mayor et al. 2009).

Sensory disturbances are the ultimate cause that explains why caribou may avoid areas closer to disturbing stimuli (Stankowich 2008). For caribou, visual stimuli, as opposed to aural stimuli, cause a greater change in activity, possibly because caribou tend to live in windy and, therefore, noisy environments. Olfactory and taste stimuli have not been studied, but anecdotal information suggests that smell can elicit a flight response in the absence of visual or aural stimuli. A review of literature examining caribou response to human activities by Reimers and Colman (2006) identified the following patterns:

- Cows and calves are more sensitive to disturbances than bulls.
- Humans moving on foot elicit a greater response than moving vehicles. The assumption is that the response has a genetic basis as caribou evolved with humans, and human sized animals as a predator. Habituation is possible.
- Off-road vehicles (ORVs) can cause increased flight responses if caribou are hunted from the machines. If the ORVs are seen frequently and consistently by caribou along fixed and predictable trails, caribou can habituate to the activity.

- Traffic activity along the transportation corridor causes the disturbance, not the infrastructure itself.
- Some degree of habituation to traffic is possible if it is not associated with direct mortality or other disturbances (e.g., harassment by humans or dogs).
- Responses to aircraft disturbance are variable. Caribou show no change in behaviour when aircraft travel at high altitudes (>900 m agl); however, studies of caribou responses to aircraft and helicopters at low altitudes have reported variable results. Multiple studies of fighter jets flying 30 m to 610 m above ground in caribou range resulted in small short-term changes in caribou behaviour. Caribou during calving and immediately post-calving seem to be the most sensitive to aerial disturbances.
- Wind turbines have the potential to impact caribou directly through turbulent noise, and indirectly through additional infrastructure such as access roads, transmission lines and human activity during construction and operation of the turbines.

Numerous studies have reported effects of industrial activity on migratory caribou range use. Most studies describe the presence/absence and abundance of caribou with distance from industrial infrastructure (e.g., pipelines, power lines, roadways, mine sites, drilling sites). Other studies rely on observations of caribou behaviour during disturbances. There have been only a few studies about wind turbine impacts on caribou, and those studies have been on reindeer in Scandinavia (discussed below where relevant). The conclusions from the studies are varied, and the differences are likely due to factors which are herd or even location specific. Consequently, while using general study results to predict effects of new disturbances on other caribou herds is possible, the ecosystem the caribou herds have adapted within are unique among herds so the utility of using detailed results from studies in one location to predict responses in another location may be limited (Klein 2000).

Caribou distribution in relation to oil and gas development within calving grounds in northern Alaska is the most well studied industrial interaction between caribou and humans. Caribou habitat use around oil field developments during calving and post-calving suggests that there is a reduction in habitat use (measured as number of animals observed) within 1 km of industrial developments (Cameron et al. 1992) and the reduction might continue up to a distance of 4 km (Cameron et al. 2005). Decreases in habitat use near industrial developments are correlated with increases in habitat use beyond 4 km (Cameron et al. 2005, Joly et al. 2006, Vistnes et al. 2008).

Although the overall caribou responses to human activity along roads in previous studies are negative, caribou may seasonally choose to be near roads. First, caribou may select gravel roads as an important feature during times of high insect abundance because a road tends to be elevated and exposed to greater wind speed, thus reducing insect harassment (Hanson 1981). Second, a 'dust shadow' effect was observed along roads in oilfield development areas of Alaska (Cronin et al. 1994). Increased dust levels from vehicle traffic may result in earlier snowmelt and growth of vegetation in spring, facilitating access to higher quality vegetation prior to parturition; conversely, intense dust deposition can change the vegetation cover and reduce overall availability to forage (Klein 2000), or a change in palatability (taste).

Dust from mining activities could be the primary mechanism that reduces the abundance of caribou within an area around a mine site. At the Ekati mine in the Northwest Territories, monitoring of caribou abundance showed that in some years caribou were four times more likely to be found >14 km away from mine activities than adjacent to activities, but in other years that was not observed (Boulanger et al. 2012). For the same area, mine and herd, Golder and Associates (Golder Associates Ltd. 2017) through alternative analyses and additional aerial survey data, showed that a ZOI could not be detected, and that distance from the mine(s) did not explain variation in caribou densities. Regardless of the debate, the mechanism of a ZOI at Ekati is unclear, and if there is one, is likely a combination of dust deposition and other sensory disturbances. Dust will be produced from blasting, crushing and traffic at the Project. The dust is not expected to be toxic to animals but will settle on vegetation and could make the vegetation less palatable. This would change habitat use by reducing habitat effectiveness within an area surrounding the mine and transportation facilities. Dust dispersion and its effects on forage palatability may also be a factor in determining a mine's ZOI.

Considering the potential disturbance of wind turbines, one study looked at the extent to which wind turbines could act as a behavioural barrier for semi-domestic reindeer movement in Finnmark, northern Norway (barren ground habitat like the Mary River Project area). That study showed that it was unlikely that the turbines and associated roads and power lines had a major negative effect on movements of the semi-domestic reindeer within the summer grazing areas (Colman et al. 2012).

During the construction phase of wind farms (~18 turbines in one location), there is the potential of reduced use of movement corridors by semi-domesticated free-ranging forest reindeer within 2 km of the development (Skarin et al. 2015). Skarin et al. (2015) conclude that any wind farm development in fragmented (e.g., by roads, power lines, forest harvest blocks) landscapes may influence forest reindeer habitat and range use which may cause an increase in the use of surrounding areas. It was unclear if the wind turbines per se, or other disturbances in the landscape or habitat differences were the cause of reduced habitat use.

Skarin and Alam (2017) studied forest reindeer habitat use during preconstruction, construction and operation in relation to two small wind farms (i.e., 8 to 10 turbines) in northern Sweden. The results were mixed, with caribou possibly selecting habitat near one of the locations at a local scale during operations, with possible, but inconclusive evidence of reduced use at a regional scale.

Flydal et al. (2004) tested whether a wind turbine and its rotor movement had any effect on area use or behaviour for captive semi-domestic reindeer. The experimental area was located within a wind turbine park consisting of five wind turbines in Norway. While results varied, they concluded that there were no negative behavioural responses with little to no aversion to wind turbines.

Currently there is no clear evidence of shadow flicker impact on caribou grazing patterns based on the results of wind farm projects in reindeer habitats in Scandinavia. In general, potential effects from wind farms on caribou are an increase in mortality risks due to the potential for collision with vehicles during construction. There are no conceivable effects of single, isolated operating wind turbines on caribou.

For wolves, denning habitat was identified as important by the Government of Nunavut, Department of Environment in an information request (GN IR request 19 for the FEIS, April 2012). Potential wolf denning habitat is likely anywhere with glaciofluvial surficial ground cover, which provides suitable soil for denning. The Phase 2 Proposal PDA will disturb this ground cover and thus there are potential impacts on potential wolf denning habitat.

3.2.2 MOVEMENT

Traditional movement patterns can be altered by Phase 2 Proposal related infrastructure or activities that act as a barrier or filter to (i.e., limiting some but not all) movement.

Infrastructure could change, restrict or stop the movement of caribou. Barriers that limit or change caribou movement may cause changes in the distribution and abundance of caribou through limiting access to important parts of their traditional range. Changes to the traditional movement pattern of caribou could have unpredictable effects on a population. Effects are dependent on the scale of an animal's environment. For example, migratory caribou require access to distant ranges which are used for portions of their seasonal life cycles, including calving grounds, post calving range, rutting areas and winter range. Non-migratory caribou select habitat at a more local scale and the distance travelled between seasonal habitats is much smaller.

Point source disturbances that are discrete and separated by large distances (e.g., mine site and ports, individual wind turbines) are unlikely to cause changes to caribou movement because caribou can use adjacent habitat to get to their target habitats. Linear infrastructure, however, could block movement or cause caribou to change movement routes. Confirming the permeability of these linear disturbances is important for maintaining migratory routes when caribou densities increase in the RSA and begin to experience the Phase 2 Proposal's potential ZOI.

During the construction phase it is expected that few caribou will occur within the RSA; currently, the caribou are thought to be in the trough (bottom) of a 70-year population cycle and few caribou occur within the RSA. The caribou that currently occupy the RSA are not migratory. The local caribou on average move less than 4 km per day during all seasons. There were very few focused directional movements and all movements were at the scale of tens of kilometres — most caribou remained within a relatively small area near the area they were collared.

In the long-term, the north Baffin Island caribou are expected to return to population highs observed during the 1980–2000 period, and migratory caribou will return to the region. If this is the case, caribou abundance/density in the RSA will substantially increase and caribou will start to make the long-distance movements observed during the last population high, which traversed linear features in the Phase 2 Proposal. According to IQ, and trail orientation and abundance, movement will predominantly be east-west in the southern extent of the RSA (e.g., as illustrated in Map 4 reflecting the "larger herd" movements), and north-south in the northern part of the RSA (as illustrated in Map 4 from the IQ information, and on Map 12 reflecting contemporary caribou knowledge).

Literature regarding caribou movement (e.g. permeability, accessibility, barrier effect, etc.) is discussed in the context of roads or pipelines, and to a lesser extent, railways, but provides additional insight into transportation infrastructure potential effects on wildlife. Horejsi (1981) documented individual and caribou group response to an approaching ¾ ton truck on the Dempster Highway. Bergerud et al. (1984) reviewed behaviour in eight different caribou herds that were exposed to industrial development or transportation corridors and found that caribou are resilient to human disturbance, and seasonal movements and range habitation are a function of population size as opposed to anthropogenic disturbance. Caribou movement and migrations have persisted across constructed railways or roads in Newfoundland, Yukon, British Columbia, and Alaska, but one example from Norway found migrations between summer and winter ranges ceased (Wolfe et al. 2000). Some recent studies using migratory caribou collar data in Alaska (Wilson et al. 2016) and a draft report from Nunavut (Kite et al. 2017) have shown that roads may change the crossing behaviour of some individuals, (e.g., take longer to cross roads on approaching them, divert around roads), but as yet the impacts of those behavioural responses at the population level are undetermined.

The height of road and rail embankments as a potential barrier to caribou movement is a widely discussed aspect of caribou movement across transportation corridors due to the visual barrier they present to caribou. Barrier threshold heights of 1.2 m, 1.43 m, and 1.0–1.5 m have been reported for Arctic caribou herds, but it is generally believed that caribou move with their learned directional orientation (Miller 1985) and simply look for crossings with the least energetic cost (Bergerud et al. 1984), as opposed to responding to barriers of a certain threshold height. Deflection from transportation-related berms or embankments is believed to be a response to other sensory disturbances (i.e. sight and noise of vehicles) rather than the height of the barrier (Bergerud et al. 1984). Miller (1985) found caribou would cross 19 m high embankments in open terrain on the Dempster Highway. In the absence of traffic, caribou may be influenced by stimuli associated with roads, such as gas, oil, and rubber odours and the visual appearance of the plowed road (Miller 1985). Caribou may also associate road corridors with elevated predation risk (see Mortality section).

Relevant to determining potential impacts on movement, one IQ participant noted that caribou in smaller groups (the current situation) will behave differently than when in large groups:

> *The caribou will follow the leading caribou. They will not make a detour. They will follow the leader. When they are travelling in a large herd they are not scared of anything. When they are not a large herd they are scared easier.* [Workshop #4 Participant]

3.2.3 MORTALITY

Caribou mortality may increase as a direct result of the Phase 2 Proposal through collisions, or indirectly through increased harvesting access. Project related activities could directly cause wildlife mortality through collisions with vehicles (trains and automobiles) or through problem animal kills (wolves and foxes); and indirectly cause higher mortality through increased hunter harvest because of easier access into hunting areas or greater knowledge about caribou in the area due to continual human presence.

Increased mortality because of infrastructure or activities would result in reduced caribou abundance in the ZOI of the Project and the north Baffin Island caribou range.

The abundance and density of caribou within the north Baffin Island caribou herd range is currently low, so any mortality could cause changes in the abundance of caribou that might be large relative to populations of animals in the herd. Therefore, avoiding caribou mortality due to project related activities is important. Baffinland has implemented a Project-wide wildlife policy that has resulted in no direct mortality of caribou. Mine related activities will increase in the short-term and medium-term compared to current conditions. Closure activities will likely be less intense and even less of a mortality risk.

3.2.4 HEALTH

Effluent, dust and air emissions released into the environment have the potential to be absorbed, ingested or inhaled by wildlife, which may have an impact on the health of individual animals and, consequently, wildlife abundance. Emissions from diesel generators and other equipment, and dust along transportation corridors and near project facilities are the project's most likely contributors to contaminants.

3.3 ASSESSMENT METHODS

The assessment of the Project's effects on caribou was based on four measurable parameters: 1) habitat, 2) movement, 3) mortality, and 4) health. Habitat and movement effects were predicted using a quantifiable procedure. Mortality and health effects were assessed qualitatively. Assessment methods are described for individual measurable parameters below.

The magnitudes of the potential impacts were determined relative to the scale of occurrence within either the RSA or within the range of the North Baffin Island Caribou Herd. The range of the herd encompasses an area from south of the Barnes Ice cap, extending north along the southern coast to the southern Brodeur Peninsula, and inland to east of Pond Inlet. Caribou are known to exist throughout this region and impacts on caribou because of the project are assessed within the entire range. The maximum extent of the herd's range is estimated at 134,308 km², and the RSA is entirely encompassed within that range. Residual effects assessments and the overall impact summary are described in the context of the North Baffin Island Caribou Herd — the caribou population that interacts with the Project.

3.3.1 HABITAT

Caribou Habitat

The methods used to determine the Phase 2 Proposal potential impacts on habitat are identical to those used for the Approved Project. The method includes calculation of the loss of habitat due to the PDA, and reduced habitat effectiveness within the Zone of Influence (ZOI) of Project activities were quantified using the seasonal RSPF models (Section 2.3.2.2). The difference between estimated baseline habitat compared to the estimated conditions at maximum disturbance during operation was used to determine the predicted magnitude of effect.

The RSPF model (Section 2.3.2.2) was used to quantify the probability of caribou using habitats within their seasonal range during the winter, calving, and summer (growing seasons). The model was used to predict the direct and indirect impacts of Phase 2 Proposal activity on caribou habitat effectiveness. Direct habitat impacts were quantified by assuming that the habitat within the PDA will become unavailable to caribou (i.e., the probability of finding caribou within the PDA is reduced to 0).

Indirect impacts were more difficult to predict because the ZOIs observed from empirical studies are often specific to the type of activity (e.g., oil and gas compared to mining) and location of the activity (e.g., forest compared to tundra). Our approach to estimating ZOIs was to consider the weight of evidence in the literature while deferring to discussions about disturbance to wildlife that have been part of the various IQ workshops.

Reduced caribou use of areas near industrial sites has generally been documented at distances ranging from 1–14 km (Table 5). The reason for large range is primarily driven by a recent article that documents a 14 km ZOI around the EKATI™ and Diavik mine sites in the Northwest Territories (Boulanger et al. 2012). The authors suspected that one of the main mechanisms causing the observed ZOI was dust deposition.

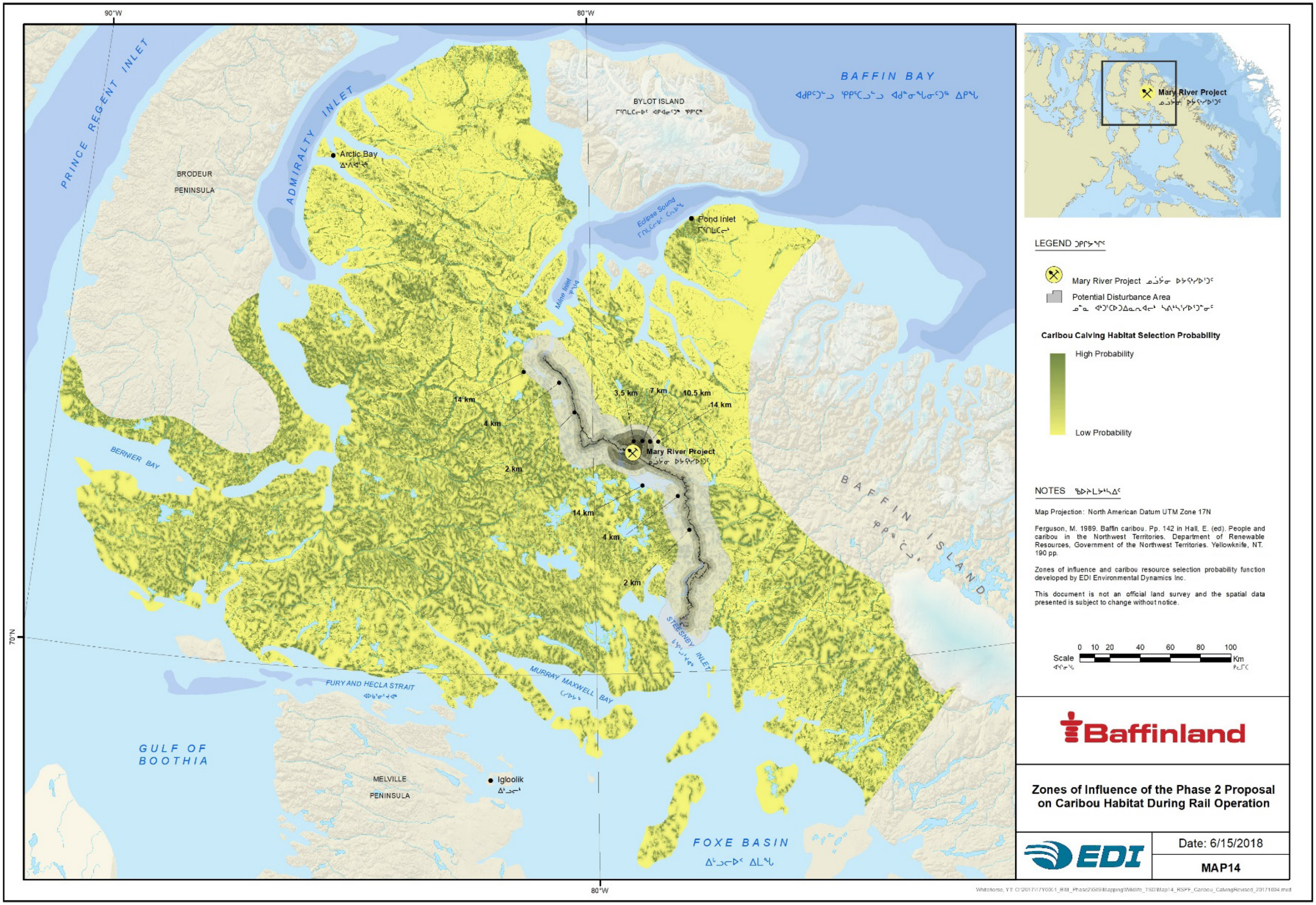
Predicted indirect habitat effects using the RSPF habitat model were quantified by reducing the probability of observing caribou within certain ZOI distances reported from empirical studies. The value of the multipliers was based on interpretations of reduced habitat use across the ZOI distances. The multipliers are provided in Table 5, and illustrated in Map 14. More conservative (i.e., biased to greater potential impact) multipliers are used during the calving season to reflect the generally held view that cows and calves during and after the calving period are most sensitive to human disturbances. The RSPF values beyond 14 km of the PDA were assumed to be unaffected, so RSPF values remained unchanged. The combined area of effect of the Phase 2 Proposal ZOI on caribou habitat (including waterbodies) is 8,133 km² (39% of the 21,053 km² RSA, and 6.1% of the 134,308 km² north Baffin Island caribou range). The Phase 2 Proposal potential ZOI is 5.7% larger than the Approved Project's ZOI (7,696 km²), mainly accounting for the slight diversion of some sections of the North Railway from the existing Tote Road, thus expanding the spatial extent of both the PDA and ZOI.

Table 5. Summary of the Factor used to Reduce RSPF Values and Calving Site Effectiveness with Distances from the PDA

Project Area	Zone of Influence (ZOI)	Habitat Selection Multiplier	Calving season multiplier	Subspecies or Herd	Source of Information
All	PDA	0.00	0.00	na	na
Milne Port, Northern and Southern Railway, Steensby Port, Milne Inlet Tote Road (after ore transport shifts to rail and traffic is reduced)	>PDA–2.0 km	0.25	0.125	Central Arctic herd (Alaska), woodland (Alberta)	Cameron et al. 1992, Dyer et al. 2001
	>2.0–4.0 km	0.75	0.375	Woodland (Newfoundland), central Arctic herd, reindeer (Norway)	Weir et al. 2007; Cameron et al. 2005; (Vistnes and Nellemann 2008)
	>4.0–14.0 km	0.90	0.45	Woodland (Ontario)	Vors et al. 2007; Mayor et al. 2007, 2009
Milne Inlet Tote Road (to peak operation and max 6 Mtpa ore haul), Mine Site	>PDA–3.5 km	0.30	0.15	Bathurst herd	Boulanger et al. 2012
	>3.5–7.0 km	0.40	0.20	Bathurst herd	Boulanger et al. 2012
	>7.0–10.5 km	0.60	0.30	Bathurst herd	Boulanger et al. 2012
	>10.5–14 km	0.80	0.40	Bathurst herd	Boulanger et al. 2012
All	>14.0 km	1.00	1.00	na	Vors et al. 2007; Mayor et al. 2007, 2009; Boulanger et al. 2012

Wolf Habitat

The assessment of Phase 2 Proposal impacts on wolves was based on assessment of potential denning habitat as a measurable parameter. That assessment was conducted specifically to address Information Request 19 of the FEIS by the Government of Nunavut. The response included an assessment of glaciofluvial cover material as potential denning habitat for wolves. The assessment is updated for the Phase 2 Proposal to quantify the expanded PDA's impact on (i.e., partial reduction in) that habitat type.


BAFFIN BAY
BYLOT ISLAND
PRINCE REGENT INLET
ADMIRALTY INLET
BRODEUR PENINSULA
Arctic Bay
Pond Inlet
Eclipse Sound
Milne Inlet
BERNIER BAY
Mary River Project
14 km
4 km
2 km
3.5 km
7 km
10.5 km
STEENSBY INLET
BAFFIN ISLAND
FURY AND HECLA STRAIT
MURRAY MAXWELL BAY
GULF OF BOOTHIA
MELVILLE PENINSULA
Igloolik
FOXE BASIN
90°W
80°W
70°N
LEGEND
Mary River Project
Potential Disturbance Area
Caribou Calving Habitat Selection Probability
High Probability
Low Probability
NOTES
Map Projection: North American Datum UTM Zone 17N
Ferguson, M. 1989. Baffin caribou. Pp. 142 in Hall, E. (ed). People and caribou in the Northwest Territories. Department of Renewable Resources, Government of the Northwest Territories. Yellowknife, NT. 190 pp.
Zones of influence and caribou resource selection probability function developed by EDI Environmental Dynamics Inc.
This document is not an official land survey and the spatial data presented is subject to change without notice.
Scale 0 10 20 40 60 80 100 Km
Baffinland
Zones of Influence of the Phase 2 Proposal on Caribou Habitat During Rail Operation
EDI
Date: 6/15/2018
MAP14

3.3.2 MOVEMENT

The methods used to determine the Phase 2 Proposal potential impacts on movement are identical to those used for the Approved Project. The quantitative method considers that the Phase 2 Proposal can either eliminate the possibility of caribou moving the through parts of the PDA (barriers), or somehow affect movement of individual caribou by either slowing or diverting (e.g., filter) their movement. Impacts on caribou movement were also qualitatively assessed by reviewing information provided in the IQ workshops, from a literature search, professional opinion, or self-evident effects.

Potential physical barriers of the Northern Transportation Corridor on caribou movement were qualitatively and quantitatively assessed. A broad scale assessment was conducted by visually inspecting each of the North Railway plan sheets while looking for specific attributes that could cause reduced movement of caribou. Draft Line Plan and Longitudinal Section drawings of the North Railway alignment provide information on rail chainage (start 0 at Milne Port), cut depth, fill height relative to existing topography (TSD 02, Project Description Appendix D5). Each sheet illustrates cut and fill details for 20 m segments, allowing estimates of areas along the North Railway that could pose barriers to caribou movement using criteria described below. Based on the criteria, each line sheet was scored for movement permeability: Nil (cuts and fills > 2 m deep/high for entire alignment); Low (most cut and fill are > 2 m, but at least 10% of the alignment is estimated as likely not physical barrier with a 4 km length; Moderate (10–50% of the alignment within a 4 km length is < 2m cut or fill; High (>50% of the alignment within a 4 km length is < 2 m cut/fill).

As a finer scale assessment, 14 trails located during the 2010 ground surveys were mapped on the individual line drawing sheets, allowing for assessment of specific areas where caribou may cross when they return to the area, or as they currently use the area in low density. This fine scale assessment determines if caribou travelling along those trails could experience a physical barrier to movement. This is the same method that was used for the Approved Project's assessment of the South Railway.

The criteria used to predict whether the North Railway infrastructure could be a physical barrier included a combination of professional opinion and a relative assessment based on surrounding landscapes in the RSA. Conservative criteria (e.g., biased towards landscape changes being a barrier) for identifying areas that could be barriers to caribou movement were identical to those used for the assessment of the South Railway. Three types of infrastructure are associated with the North Railway: cuts, fills, and bridges. It is assumed that caribou will readily pass under bridges. It is assumed that cuts (embankment below grade) and fills (embankment above grade) will act as similar barriers. The characteristics of the cuts and fills will determine the permeability of the Railway for caribou. Based on professional opinion informed by discussions in the IQ workshops, it was determined that steep and tall embankments may act as the greatest barrier to caribou movement (although participants in the IQ workshops noted that caribou movement in this region are not deterred by steep terrain). Criteria for determining if a segment of rail will be a barrier to caribou movement was to visually estimate cuts or fills that have embankments slope ratios that are greater than 1 in 2 (e.g., 1:2, 50%, 26.6° slope) and the height or depth of the embankment is greater than 2 m (Figure 1). Two metres was chosen because it seemed like a reasonable height that 1) is close to the height of caribou (caribou are about 1.5 m tall when vigilant), 2) caribou are likely to be able to see habitat on the other side of the Railway embankments that are less than 2 m high so they will have more information on the potential benefits of crossing the Railway, and 3) caribou are more able to climb small (<2 m) heights.

The Railway alignment was stratified into ~4 km segments because that was approximately the average distance travelled by caribou in one day — determined by the caribou collar data (described in (EDI Environmental Dynamics Inc. 2012).

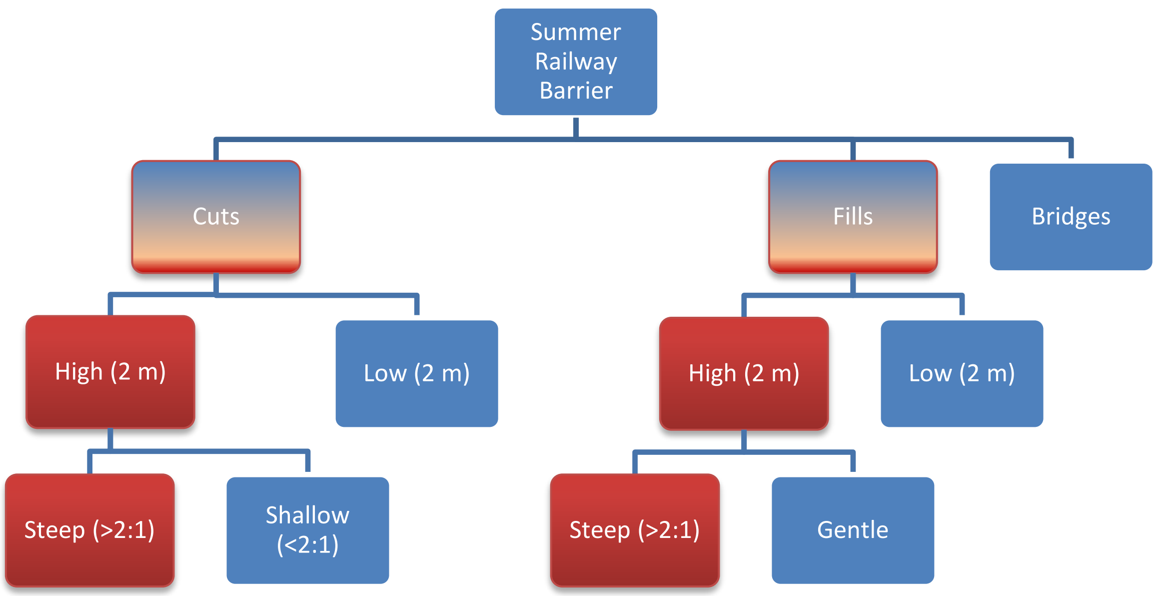


Figure 1. **Flow chart for determining the potential of the Railway or Road embankment to be a physical barrier to caribou movement.**

NOTE(S):

1. Red boxes (steep and high) represent a potential barrier to movement.

Additional to the structures that may be a barrier to movement, sensory disturbances associated with vehicle and train set movements themselves act as temporal barriers to movement. To assess the length of time that each vehicle/train set transit acts as a physical barrier to caribou movement, the length of the vehicle/train set and average speed (50 km/hr or 13.88m/sec) and the length of the vehicle/train set were considered. Identical to the assessment of traffic for the Approved Project, a 100 m buffer ahead or behind a moving vehicle/train set was presumed where a caribou would not attempt to cross the Northern Transportation Corridor. The estimated time that individual transits are a physical barrier to caribou movement are calculated in Table 6. Those results are used to display the barrier to movement as traffic levels fluctuate through the life of the Phase 2 Proposal.

There are no known thresholds upon which to determine at what level of traffic disturbance caribou will respond. An older study of caribou response to combined pipeline and road disturbance in Alaska found through observation that traffic at very high rates (e.g., > 1 vehicle/minute) likely creates a barrier to caribou movement (Murphy 1988).

Table 6. Estimate of time that traffic presents a barrier to a single point along the Northern Transportation Corridor.

Traffic type	Length (m)	Crossing "buffer" (m)	Avg. speed (km/h)	Max. barrier time (per transit) in seconds
Ore train/freight train	900	100	50	79.25
Ore truck/freight truck/service truck	35	100	50	16.93

3.3.3 MORTALITY

The Project's potential impact on caribou direct mortality risk was assessed as the probability of increased risk of activities killing caribou: collisions with caribou on the Tote Road and North Railway, and the potential interaction with infrastructure (e.g., falling into an open pit). The assessment is considered within the framework of Baffinland's wildlife policy of wildlife having the right-of-way for travel and a no-hunting policy for on-site staff.

The Project's potential impact on caribou indirect mortality was assessed as the potential for increased harvest of the regional caribou herd through increased access (e.g., an improved Tote Road) and improved knowledge of the region that could increase harvester success. However, that potential increase in mortality is considered within the context of the north Baffin Island allotment of a total allowable harvest of 250 male caribou on Baffin Island (Government of Nunavut, Department of Environment 2015).

3.3.4 HEALTH

The Phase 2 Proposal's potential impacts on caribou health are considered as it relates to potential deposition of and uptake of metals in forage because of dust and emissions from the Project. The methods used to assess that potential impact are addressed in the report *Evaluation Of Exposure Potential from Ore Dusting* (Intrinsik 2017).

The screening level assessment of caribou exposures to metals in ore dusts compares predicted future soil concentrations to ecological health-based soil quality guidelines; discussions related to bioaccumulation potential; an evaluation of potential future lichen concentrations, and discussions related to dust deposition and potential for exposure across the PDA (Section 5.1 in Intrinsik 2017).

The potential impact from sensory disturbances (e.g., traffic noise, mining) on caribou health (e.g., noise) is accommodated within the assessment of habitat effectiveness as noted above (e.g., caribou avoiding suitable habitat and resulting negative effects on health from reduced foraging).

A broader assessment on the predicted impact on the health of the North Baffin Island caribou herd is addressed in the energetics discussed in the Cumulative Impact Assessment (Section 3.5).

3.3.5 CRITERIA FOR ASSESSING SIGNIFICANCE

Significance of the Phase 2 Proposal's potential impact on wildlife and wildlife habitat is determined in consideration of one or more of the following sources of information (Canter 1999):

- Guidelines or standards outlined in Nunavut or other laws, regulations, policies, etc.
- Pre-defined thresholds
- Setting (e.g., is the Project in protected habitat, critical or sensitive habitat, land-use zone with defined land use thresholds)
- The intensity of the effect (e.g., predicted change, and whether the change is within normal variability); and
- Public concern.

Criteria including direction, magnitude, extent, frequency, reversibility, etc. (described further in Section 3.8 of the assessment methods volume, Baffinland Iron Mines Corporation (2012b)) are used to characterize the nature of the residual effects. The criteria are assessed in the context of the mitigation measures and Project design features that will be applied to eliminate or reduce the Phase 2 Proposal potential impact(s) on the wildlife and wildlife habitat KIs. Where legislation, thresholds, standards, or objectives exist to define criteria rating and are relevant to the assessment, they are used. Similarly, quantitative values, if available, are used over qualitative criteria.

Guidelines or Standards — There are no guidelines or standards outlined in Nunavut or other laws, regulations, policies, etc. that informed significance criteria or thresholds.

- The draft *Nunavut Caribou Strategy Framework* (Government of Nunavut Department of Environment 2010) does not identify any quantified thresholds of disturbance or significance to caribou.
- There are no thresholds of disturbance to wildlife reflected in known Government of Nunavut policy (Government of Nunavut, Department of Executive and Intergovernmental Affairs 2017).
- There are no Nunavut government regulations or policies constraining wind turbine development within caribou habitat (Government of Nunavut, Department of Executive and Intergovernmental Affairs 2017).

- The *Nunavut Wildlife Act* (Government of Nunavut 2005) does not identify specific thresholds of allowable disturbance to wildlife or habitat, rather it generally suggests that disturbance shall not occur without licence to do so.

Pre-defined Thresholds — The *North Baffin Land Use Plan* (Nunavut Planning Commission 2000) does not identify any land use disturbance thresholds related to wildlife and wildlife habitat that are relevant to Project impact significance determination. There are no other sources of pre-defined thresholds that may be relevant to north Baffin Island wildlife. As described in Section 2.4.5, the Government of Nunavut implemented a harvest threshold of 250 male caribou island wide, with no specific threshold identified for north Baffin Island caribou.

Setting — e.g., Critical Habitat — There is no defined North Baffin Caribou Protection area within the North Baffin Land Use Plan (Nunavut Planning Commission 2000, Qikiqtani Inuit Association and Baffinland Iron Mines Corporation 2014). No critical wildlife areas relevant to north Baffin Island wildlife are identified in the Nunavut Wildlife Act Regulations (Government of Nunavut 2015). No proposed Project activities overlap with national park boundaries.

Public concern — Public concerns related to the Phase 2 Proposal's impacts on wildlife are reflected in Section 3.1. None of the concerns expressed suggested quantifiable significance thresholds.

Where empirical knowledge, IQ, or scientific evidence is lacking, professional judgement and experiences from similar projects were used in determining if a criterion is given more or less weight in assigning impact significance. Any weighting and justification of the weighting are described. After considering the criteria, a confidence rating is determined and applied that considers the accuracy and application of analytical tools, an understanding of the effectiveness of mitigation measures, and an understanding of known responses of wildlife and habitat KIs to potential Phase 2 Proposal impacts.

Definitions and rating scales for the criteria for specific wildlife and wildlife habitat measurable parameters are described in Table 7. That table lists the upper threshold limits that have been proposed for this Project's Wildlife KIs and their respective potential impacts and measurable parameters. There was no new IQ perspective or literature suggesting updates to the thresholds used in the FEIS, so this assessment uses the same threshold levels used for the Approved Project (≤10%, >10–25%, and >25% change; Table 7) for measurable parameters.

Table 7. Potential Effects, Measurable Parameters and Significance Ratings for Wildlife Key Indicators

Effect	Measurable Parameters	Significance Criteria (Magnitude and Extent)
Habitat	Changes in the quality and availability of habitat within the RSA and seasonal range (caribou) Change in availability of denning habitat (wolf)	**Level I**: confined to the PDA, 10% available in the RSA, or 3% in the seasonal range **Level II**: >10%–25% change of available habitat in the RSA, or >3% to 5% in the seasonal range. **Level III**: >25% change to habitat available in the RSA, > 5% across seasonal range.
Movement	Project Infrastructure barriers to known caribou trails	**Level I**: Barriers on <10% of known trails **Level II**: Barriers on >10% to 25% of known trails **Level III**: Barriers on >25% of known trials
Mortality	Increased mortality risk to caribou due to Project	**Level I**: Negligible to low change (<10 %) **Level II**: Moderate change (10–25 %) **Level III**: High change (>25 %)
Health	Potential increased metals content in caribou forage and resultant potential uptake	**Level I**: No discernible change to metals in forage. **Level II**: Measurable and biologically relevant increase in metals in forage in the Zone of Influence **Level III**: Exceeds published guidelines to the point that caribou suffer from ingestion.

3.4 PHASE 2 PROPOSAL IMPACTS

3.4.1 CARIBOU

3.4.1.1 Habitat

Following the two-year construction of the North Railway and transition from truck to rail ore haul to Milne Port, caribou habitat effectiveness may be reduced by 2.4%, 4.8% and 5.0% across the North Baffin Island Caribou Herd range during the calving, growing and winter seasons, respectively (Table 8).

The Phase 2 Proposal does not interact with any additional sites known to have been used for calving, determined by either by collar data (Map 8) or identified by IQ (Map 5) that were considered for the Approved Project. The Approved Project's discussion about interaction with potential calving sites does not change for the Phase 2 Proposal — the PDA does not interact with any known additional calving habitat.

The greatest disturbance within caribou habitat is limited to the three years during construction of the North Railway while the Tote Road is being used to haul up to 6 Mtpa of ore to Milne Port. When ore transport transitions to rail, traffic on the road is substantially reduced, and thus the ZOI is reduced to that of the rail operation which is less intense due to fewer vehicle (rail car) passes, lower amounts of fugitive dust emissions, likely reduced noise, etc. Also, at the peak of disturbance during North Railway construction and Tote Road use for hauling, there are likely very low densities of caribou and little to no migratory movements in the region.

Table 8. Change in Effectiveness of Caribou Habitat within the North Baffin herd range for the Phase 2 Proposal.

Habitat Suitability Rating	Baseline sum of Probabilities — North Baffin Range	Approved Project Sum of Probabilities		Phase 2 Change — Sum of Probabilities		Total Phase 2 Proposal — Sum of Probabilities	
		Loss to PDA and ZOI	% Difference in North Baffin	Loss to PDA and ZOI	% Difference in North Baffin Range	Loss to PDA and ZOI	% Difference in North Baffin Range
Calving	2,310,306	-47,930	-2.1%	-8,407	-0.4	-56,337	-2.4
Growing	6,372,250	-226,003	-3.6%	-79,040	-1.2	-305,043	-4.8
Winter	4,741,184	-201,445	-4.2%	-35,871	-0.8	-237,316	-5.0

MITIGATION

Mitigation to reduce impacts from habitat loss are the same as those used for the Approved Project and include reclamation of disturbed areas post-construction and operation to reduce the direct loss of habitat; and dust suppression throughout the operation. Mitigation to reduce sensory disturbances are the same as those for the Approved Project, with the notable addition of the North Railway that will reduce the sensory disturbances associated with hauling ore on the Tote Road. Other sensory disturbances will be limited to those reasonably required for mining activities. Additionally, the Qikiqtani Inuit Association and Baffinland collaboratively developed Caribou Protection Measures (CPMs) for the Approved Project in January 2014 (Qikiqtani Inuit Association and Baffinland Iron Mines Corporation 2014). It was agreed between the QIA and Baffinland that the CPMs are appropriate measures to take in respect of the protection of caribou. It is unlikely that the activities proposed for the Phase 2 Proposal will require changes to those mitigation measures to reduce impacts from habitat loss. Those include caribou (wildlife) having the right of way, reducing the disturbance footprint, and controls on fugitive dust dispersion as key measures to reduce impacts on habitat loss and reduced habitat effectiveness.

3.4.1.2 Movement

Caribou movement will be affected by physical barriers created by Phase 2 Proposal infrastructure, and by sensory disturbances with the ZOI of the proposed Phase 2 Proposal activities. The effect of Phase 2 Proposal infrastructure was qualitatively assessed through information from a literature search, professional opinion, or self-evident impacts.

The Mine, Ports and point sources of potential disturbance such as wind turbines will not be substantial barriers to caribou movement. Currently, the caribou within the region are non-migratory and it is not expected that migratory caribou will return to the area until the population begins to increase, perhaps first becoming apparent as regular occurrence in the 2030s. The density of caribou in the region currently is low compared to the caribou numbers observed during the end of the twentieth century, so few caribou will encounter the mine infrastructure during construction and early years of operation, and these caribou are not expected to be migratory. When caribou start moving through the area again, the Project will be operating with rail transport of ore, and road traffic and associated sensory disturbances will be minimal.

Based on information collected from the 2008–2011 caribou collaring program, caribou exhibit movement patterns more like those of non-migratory caribou (Approved Project's FEIS Appendix 6F, Figure 14). North Baffin Island caribou currently do not show predictable long distance movements during any season, but there are some generally shorter seasonal movements noted by participants involved in the contemporary knowledge workshops (Jason Prno Consulting Services 2017)summarized in Section 2.4.2). Based on that knowledge and discussions in those workshops, it appears that the infrastructure of the Phase 2 Proposal does not intersect traditional movement corridors and therefore will not present substantial barriers to caribou movement. Based on the information provided in the 2008 IQ workshop, and the 2015/2016 contemporary knowledge workshops, much of the directional movement by caribou in the region of the Northern Transportation Corridor is generally of shorter north/south movement patterns, parallel to the direction of the existing Tote Road and proposed Northern Rail. There are no distinct routes or corridors crossing the Northern Transportation Corridor. Therefore, there was no specific area to focus where the road may impact distinct caribou movements.

The potential physical barriers that the Tote Road may present to caribou were addressed in the Approved Project's ERP assessment (Baffinland Iron Mines Corporation 2013). The barriers considered, in addition to an overall effect on habitat effectiveness addressed in the habitat section, are the road embankments and traffic transits on the road. There are short sections of the Tote Road where road embankments may pose a barrier to caribou movement, but none are in locations where the few caribou trails documented north of the Mine Site (e.g., Map 6) are known to be located, and no stretches of embankment are long enough to deter caribou from crossing the road in nearby areas. In the winter when plowed snowbanks may become a barrier, Baffinland reduces the potential for drifting by smoothing snow piles on the edges of the road or creating larger isolated piles with breaks between those piles that would allow caribou to move through unimpeded (snow bank monitoring to document this practice are included in several of the annual terrestrial monitoring reports).

All bridge crossings proposed for the North Railway are adjacent to the current bridge crossings used for the Tote Road assessed for the Approved Project. None of those areas are important water crossing areas for caribou, based on survey results conducted at the request of the QIA in 2014 as part of the Approved Project monitoring (summarized in the 2014 terrestrial annual monitoring report — EDI Environmental Dynamics Inc. 2015). The North Railway does not travel through any areas where caribou movement may otherwise be restricted.

Design details such as depth of cuts and embankment heights are noted on rail alignment sheets and reviewed to determine if crossing may be affected following the criteria noted in Figure 1. Each alignment sheet provides details for a 4–5 km section of rail from Milne Port to the Mine site.

No individual section of rail poses an absolute barrier to caribou movement (Table 9). Only two sections of rail were rated as low permeability to caribou: 1) The section at Milne Port as the railway ascends through deeper rock cuts, and a section at ~km 47 that traverses coarse undulating terrain where several cuts and fills are greater than 2 m. The remaining sections are rated moderate to high permeability to caribou movement (Table 9). Using the same design mitigation proposed for the South Rail that was reviewed in the Approved Project's FEIS should prove equally effective for the North Railway. During or after construction, the alignment can be reviewed at documented caribou trails to determine if embankment adjustments need to be made to allow for caribou crossing using best design practices indicated in the FEIS.

No water crossings were identified along the proposed North Railway, and no specific "pinch points" or areas that would limit caribou movement across water crossings were identified along both the North and South Railways in a survey conducted at the request of the QIA (EDI Environmental Dynamics Inc. 2015).

Table 9. Summary of North Railway Section Permeability to Caribou Movements

Alignment Sheet (H353004-00000-224-272-xxxx-0001)	Chainage (km)[1]	Permeability score[2]	Documented trails?	Notes
0004	0–4.8	Low	No	In Milne Inlet area, generally low-quality habitat due to high levels of disturbance. No known directional caribou movement (IQ and observations) that transects rail or road alignment.
0005	4.6–9.4	Moderate	One ~km 4.6	Deep (> 2m) cuts to ~km 6, but then generally low (< 2 m) fill. The one observed trail located at Tote Road is not deeply incised, suggesting moderate to low historical use.
0006	9.4–14.1	High	No	Generally level terrain with low raised rail bed.
0007	14.1–18.7	High	No	Generally level terrain with low raised rail bed.
0008	18.7–23.4	Moderate	One ~km 21.0	Some cuts and fill > 2 m, but several lengths of < 2 m. Observed trail on level terrain with rail bed < 2.0 m.
0009	23.4–28.0	Moderate	No	Some cuts and fill > 2 m, but several lengths of < 2 m.
0010	28.0–32.6	Moderate	One ~km 28.0, two ~km 30.0	Undulating terrain with few cuts and fill > 2 m, but many lengths with <2 m
0011	32.6–37.3	High	No	Generally level terrain with low raised rail bed, some cut and fill > 2 m.
0012	37.3–41.9	Moderate	One ~km 39.5	Undulating terrain with several cut/fill > 2 m. Documented trail at cut ~2.1 m. Several alternative spots to consider for creating crossing during rail build.
0013	41.9–46.6	High	No	Undulating terrain, but generally cut/fill ~2 m

Table 9. Summary of North Railway Section Permeability to Caribou Movements

Alignment Sheet (H353004-00000-224-272-xxxx-0001)	Chainage (km)[1]	Permeability score[2]	Documented trails?	Notes
0014	46.6–51.2	Low	No	Coarse undulating terrain with many cut/fill >2 m, but several points with embankment < 2 m
0015	51.2–55.8	Moderate	No	Several sections where terrain is leveled for rail bed < 2 m
0016	55.8–60.5	Moderate	No	Km 55.8 –~59 on level terrain, then cut and fill in undulating terrain.
0017	60.5–65.1	Moderate	No	Variable undulating terrain with cut and fill > 2 m to ~km 62.5, then terrain generally levels with many areas < 2 m fill/cut
0018	65.1–69.8	Moderate	No	Gradual undulating terrain, many lengths of suitable crossing areas.
0019	69.8–74.4	High	No	Gradual undulating terrain, many lengths suitable crossing areas.
0020	74.4–79.0	Moderate	No	Gradual undulating terrain, some embankment > 2 m, but many lengths suitable crossing areas.
0021	79.0–83.7	High	Two ~km 80.5, one ~km 81, one ~ km 83	All noted trails on low to no embankment. Rest of alignment on gently undulating terrain, many lengths suitable crossing areas.
0022	83.7–88.3	High	No	Level terrain with minor fill for embankment
0023	88.3–93.0	Moderate	One ~km 87.3	Undulating terrain > km 90, but many lengths suitable crossing areas.
0024	93.0–97.6	Moderate	Two ~km 94.5	Two trails in area with shallow cut < 2 m, trails are parallel to rail route.
0025	97.6–102.2	High	One ~km 99.7	Known trail in area with shallow cut or fill < 2 m
0026	102.2–106.9	High	No	Some undulating terrain with deeper fill required, but most length suitable crossing areas.
0027	106.9–109.6	High	No	At Mine Site. Most length suitable crossing area. All located in mine PDA.

[1] km 0 is at Milne Inlet

[2] Permeability scores: Nil (cuts and fills > 2 m deep/high for entire alignment); Low (most cut and fill are > 2m, but at least 10% of the alignment is estimated as likely not physical barrier with a 4 km length; Moderate (10–50% of the alignment within a 4 km length is < 2m cut or fill; High (>50% of the alignment within a 4 km length is < 2 m cut/fill).

Traffic as a barrier to caribou movement was quantified as a proportion of day that individual animals may experience vehicle passes (train sets, trucks, etc.). Localized, intensive construction-based traffic used along sections of the Northern Transportation Corridor to construct the railway was not considered because of the limited duration in specific areas only during construction. Estimated traffic volumes (transits) vary through the years of development and operation of the Phase 2 Proposal, as described in TSD 02, Appendix C —Key Project Facts Table. During the life of the Phase 2 Proposal activities, minutes between transits of combined vehicles or train set passes varies from as few as 1.5 minutes at peak levels of activities during construction of the North Railway while using the Tote

Road to haul up to 12 Mtpa for four years, to as many as 18 minutes when both the North and South Railways are in full operation (Figure 2).

Those projected number of vehicle transits were used to characterize the moving physical barriers to caribou movement through the life of the Phase 2 proposal activities. The proportion of a day that individual animals could be encountering vehicle transits while attempting to cross the Northern Transportation Corridor ranges from as high as ~16% of the day during peak North Railway Construction and Tote Road haul to 12 Mtpa for four years, to as low as ~2.5% of a day during full rail operation (Figure 3).

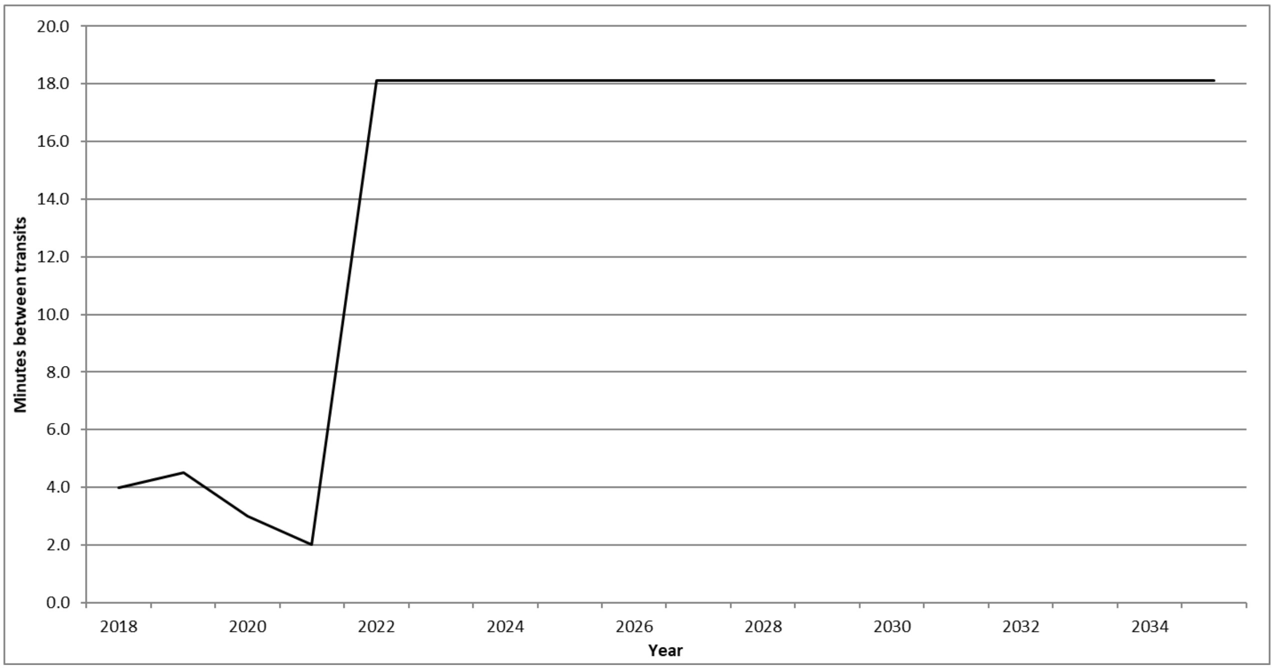


Figure 2. Estimated minutes between vehicle or rail transits on the Northern Transportation Corridor for the Life of the Phase 2 Proposal.

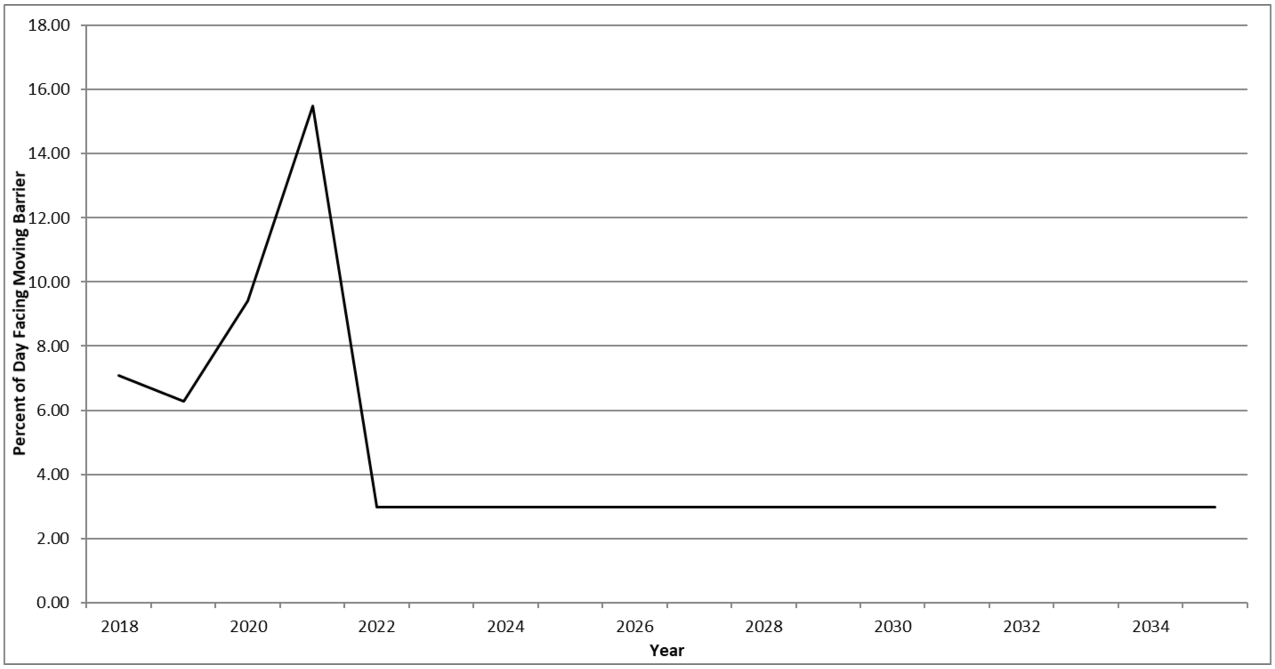


Figure 3. Percent of day that a caribou could face a physical barrier to movement because of train-set or vehicle transits in the Northern Transportation Corridor for the life of the Phase 2 Proposal.

MITIGATION

Project effects on the movement of migratory caribou are possible; however, the migratory caribou will not suddenly appear in the area, there will likely be a gradual increase in the number of caribou in the area during two or three decades, so monitoring of the non-migratory caribou and early migratory caribou during operation of the mine will provide some insight into potential mitigation requirements.

There are no suggested changes to the mitigation for caribou movement that is already part of the Approved Project. By design, the North Rail presents few physical barriers to movement. Physical barriers if they are identified will be modified as necessary using the same techniques as described in the FEIS and summarized below. Traffic, albeit predicted to be of greater frequency and volume at times during the Phase 2 Proposal, will be managed as presented in the FEIS and as summarized below.

Physical Barriers — IQ knowledge of caribou movement and crossing areas was incorporated indirectly into the design and directly into the operation of the South Railway for the Approved Project. Those same principles are applied to the Phase 2 Proposal's North Railway. Trails that cross or approach the Northern Transportation Corridor will have modified embankments (if necessary) to confirm the height and slope do not present a barrier to caribou moving through the landscape (i.e., > 2 m high and > 1V:2H). If the regional caribou population increases and caribou start to move through the RSA more frequently, as expected based on IQ, these areas will become more heavily used and monitoring of caribou movement will become increasingly important. Operation of the Northern Transportation Corridor will incorporate IQ into activity planning, particularly in movement areas, and future monitoring. Operators on the Tote Road are required to report any caribou sighting along the route, and this practice will be in place for all transport along the Northern Transportation Corridor. Furthermore, different configurations on a limited number of potential crossings will be considered to see if caribou behaviour indicates the need to alter the engineering of the embankment. The fill material used for all railway embankments will be a fine mixture of gravel and sand, preventing possible caribou leg entrapment, and will be of sufficient width to facilitate caribou movement across broad sections of the railway. A relatively wide crossing structure has been correlated with successful crossings by other ungulates (e.g., elk and deer), but that was for highway overpasses in Banff (Clevenger and Waltho 2005). Other crossing structures (underpasses, overpasses, fencing, etc.) were investigated for effectiveness in the Project landscape; however, it was determined that these structures are not feasible in this environment and will not be effective to facilitate caribou movement.

Snow Management — Current snow conditions in winter are hard packed snow cover. These snow conditions allow easy movement across the landscape. In years with poor snow conditions (e.g., deep snow and fall icing), caribou may use the railway as a travel corridor to decrease energy costs, especially if they are already in poor physical condition (Klein 1971). An analysis of climatic data conducted for the FEIS showed that the months with the greatest snow depths are April and May, with a maximum annual snow depth of 0.68 m and a maximum average annual depth of 0.46 m; both of which occur in April. There is little that can be done to prevent caribou from traveling on the railway; however, Baffinland's TEMMP (Baffinland Iron Mines Corporation 2016a) contain measures to reduce the risk of vehicle/caribou collisions.

Elevating the railway reduces snow accumulation on the tracks by exposing them to a wind flow. To avoid snow drifting on roads, Baffinland smoothes the snow piles on the edges of the roadways (e.g., Photo 1). Similar snow management will be required along the Railway, reducing the possibility of caribou encountering large artificial snow drifts. This will be achieved using the locomotive at the front of the trains. Snow accumulation along the railway will likely facilitate caribou movement across the landscape and reduce any barrier that was potentially caused by the embankment — snow will fill voids and slopes will become more gradual). Snow management along the railway will not result in a barrier to caribou movement during the winters. Some crossings that are in embankment cuts will be cleared during operations which should enable caribou to easily move off the tracks (i.e., an escape route) if a train is approaching. As caribou numbers increase, as is predicted by IQ and harvest data, monitoring of caribou movement across the Northern Transportation Corridor and Southern Rail will be implemented.

Photo 1. Example of snowbank management on east and west sides of Tote Road to reduce snow drifting and confirm that snowbanks do not exceed the maximum snow depth (km 28, April 21, 2017).

Traffic — Traffic volumes at the peak of traffic activity along the Northern Transportation Corridor (when hauling up to 6 Mtpa and the North Railway is being constructed) are high and approaching what has been documented to be a barrier to barren-ground caribou movement (e.g., > 1 truck transit/minute, (Murphy 1988). However, that traffic peak is likely to occur many years before caribou are found in large numbers interacting with that portion of the Project, when the number of vehicle transits will drop substantially as ore haul is converted to transport by the North Railway.

Regardless of the number of caribou expected to be interacting with the Northern Transportation Corridor, measures are in place to confirm that all caribou and wildlife near and/or attempting to cross the corridor will be allowed to do so, and operations will continue with the Approved Project's "wildlife have the right-of-way" policy, reflected in the Caribou Decision Tree (Figure 4) and the detailed mitigation described in (particularly Section 3.3.3 Movement, and 3.3.4 Mortality) the Terrestrial Environment Mitigation and Monitoring Plan (Baffinland Iron Mines Corporation 2016a). Those practices will not change.

North Railway operations will follow the practices for the Approved Project's South Railway operations. Recognizing that stopping a train is not as simple as described in the Caribou Decision Tree (Figure 4), different practices apply to rail operations and are based on earlier warning mechanisms to better plan for rail transits when caribou may be present and trying to cross the transportation corridor. As stated above, the caribou are not expected to suddenly appear in the RSA, rather they will slowly start using the area again as the numbers increase. This gradual increase will be observed by on-site personnel, and continual transits to Milne Port will information operators where and when transits will have to be limited to confirm that caribou continue to have the right-of-way through the RSA.

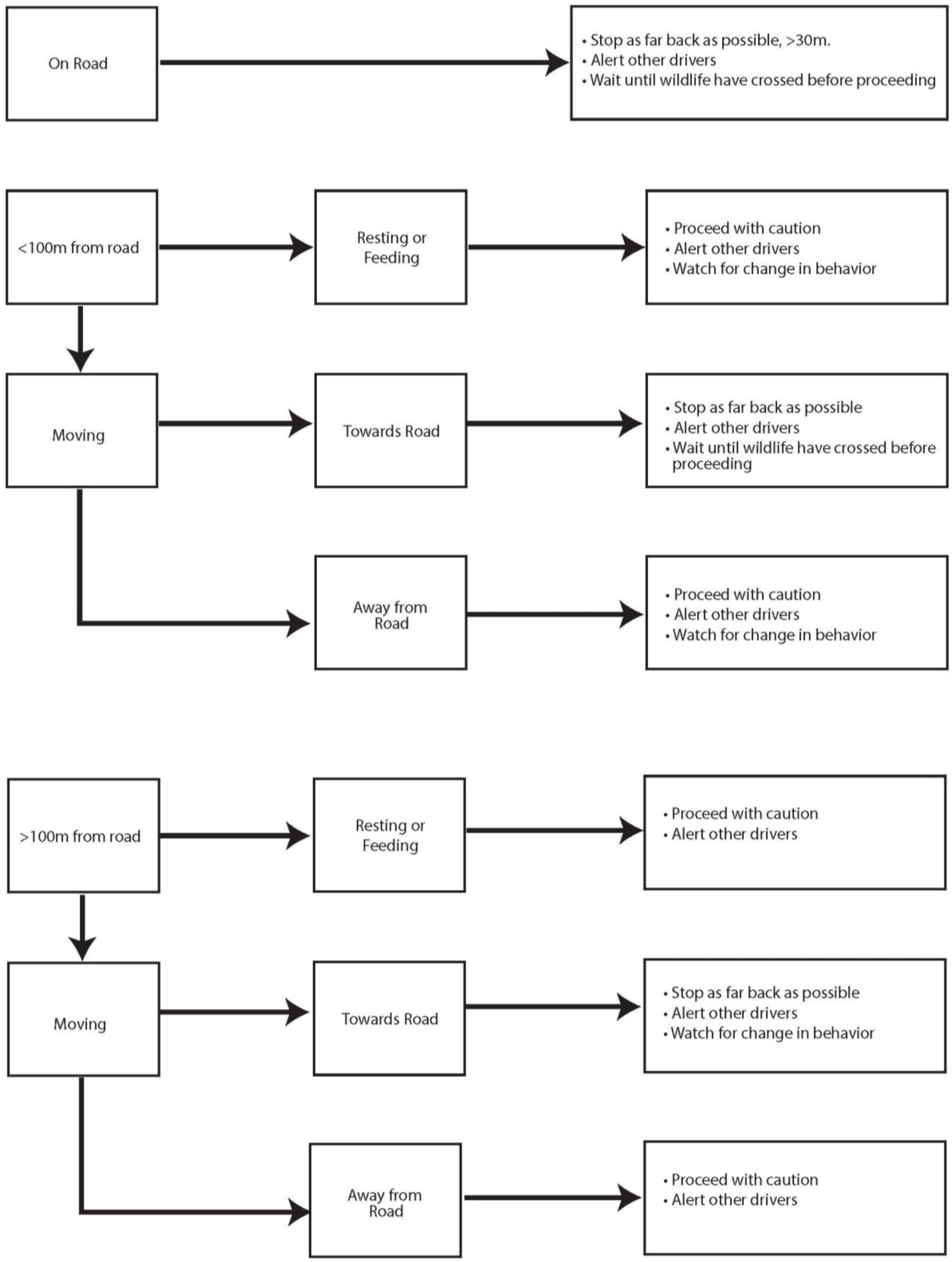


Figure 4. Caribou collision avoidance Decision Tree.

3.4.1.3 Mortality

The Phase 2 Proposal slightly increases the risk of collisions with caribou with short-term increased traffic on the Tote Road, and continual vehicle (either truck or rail) transits to Milne and Steensby Port through the life of the Phase 2 Proposal proposed activities. There will also be continual human presence in the PDA that will inform personnel and related harvesters about the presence of caribou near the PDA. That continual presence and knowledge may lead to increased harvest pressure on caribou near the Project. The potential magnitude of these effects is unknown but is assumed to be capped at the harvest limit set for the area.

MITIGATION

Project related caribou mortality risk may increase, but that risk is readily mitigated. To date there have been no Project-related caribou mortality. Project-related direct mortality risk is readily managed by traffic controls (e.g., speed limits, seasonal traffic limits, regular monitoring of caribou numbers and proximity to transportation corridors) and a no-hunting policy for Project personnel while on-site. There are no known features of the Phase 2 Proposal that will reduce health to a level of increased mortality for the north Baffin Island caribou herd. An outstanding concern of communities related to mortality is how north Baffin Island caribou will react to the trains and steady traffic on the Tote Road, should caribou begin interacting with the Project again before the transition of ore haul to rail. It is generally an unknown among the knowledge holders involved in workshops whether caribou will be aware of moving locomotives and be capable of getting off the rail tracks. However, regardless of that uncertainty, mitigation is possible because 1) caribou currently are in very low numbers and are seldom expected to be encountered along the rail routes, and 2) when the large numbers of caribou return, seasonal shut downs are possible to allow caribou to pass during migratory movements, should they occur. Additionally, the temporary increase in traffic in the Northern Transportation Corridor and the concomitant increase in mortality risk will be partially mitigated by the shorter-term transition to rail for transport of ore to Milne Inlet.

The Phase 2 Proposal's transportation infrastructure will not provide improved access to the RSA. The Tote Road has existed for several decades and was used before the Approved Project's existence. Although caribou harvest in the region is a year-round activity with both summer and winter access by all terrain vehicle/snow machine (Map 12), harvest in the area is primarily a winter activity by hunters using snow machines. Snow machine access is not improved by presence of the Tote Road because travel is usually following smoothly frozen waterbodies and areas covered by hard-packed snow.

Employment with Baffinland will improve local people's knowledge of the area. Most employees will be working at the Mine Site or the Milne Port facility where most of the mining and shipping activity will occur, so increased knowledge of the RSA will be primarily within these areas. Hunter access and knowledge of the RSA will not substantially change from baseline conditions, so no specific mitigation is required.

An increase in indirect mortality risk due to increased human presence is likely in the RSA, but that impact can be mitigated by wildlife management initiatives. Outside of the period where there was a moratorium on caribou harvest on Baffin Island (01 January 2015 to 26 August 2015; Government of Nunavut, Department of Environment 2014, 2015), caribou harvesting has continued in the RSA, as it has since before the Mary River Project began. Harvesters have been accessing the north Baffin Island region both before the Mary River Project existed. Hunter continued to access the area during the Approved Project construction and operation and will continue to use the area during the life of the Phase 2 Proposal. The harvest distribution will likely continue to be reflective of where caribou are found, and that has been shown to vary on a longer-term basis related to the north Baffin Island caribou population cycle.

Harvest management, the mandated responsibility of Nunavut's wildlife co-management partners, will mitigate the potential indirect effect of increased human presence, or knowledge, and concomitant increased mortality (harvest) risk to caribou in the RSA. The potential indirect Project effect of over harvest is outside of the control of Baffinland. To address the reduced caribou population on Baffin Island and the potential for over-harvest, the Government of Nunavut accepted a recommendation by the Nunavut Wildlife Management Board to set a total allowable harvest of 250 male caribou on Baffin Island. The Qikiqtaaluk Wildlife Board has the responsibility for allocating the Total Allowable Harvest (TAH) among the community hunter and trapper organizations for that harvest (Government of Nunavut, Department of Environment 2015).

3.4.1.4 Health

Metals in soils and vegetation from aerial deposition potentially effecting caribou health is assessed in the Evaluation of Exposure Potential from Ore Dusting report (Intrinsik 2017). In summary, caribou exposure to metals in soil and vegetation is expected to be low due to the relatively small area outside the various PDAs where dust deposition is predicted to be high enough to affect plant/forage health. As a result, the likelihood of substantial increases in metals loading to caribou (and hence, to local people eating caribou), is predicted to be low.

Based on the limited size of the areas affected by deposition rates of 55 g/m^2/year or greater, and the fact that these areas, and areas exhibiting higher dust deposition rates, are largely within the active PDAs, the likelihood of metals exposures to caribou is considered to be low, particularly in light of their currently low rates of occurrence and movement through the study area (Intrinsik 2017).

MITIGATION

Dust effects on forage food will be addressed by those measures used to mitigate effects on air quality as described in the Air Quality and Noise Abatement Management Plan (Baffinland Iron Mines Corporation 2016b). Potential impacts of dust fall within the PDA are not considered further since vegetation removal is predicted for the entire PDA and is encompassed within the expected area of caribou habitat loss.

3.4.1.5 Significance of Residual Effects on Caribou

Habitat — Loss of habitat within the PDA will be a residual effect. The direct habitat loss to the PDA is a small proportion of the overall habitat effect. Baffinland does not expect that directly affected habitat will be reclaimed (re-vegetated) within a generation of caribou, and the effects are therefore long-term and semi-reversible. Sensory disturbances that reduce habitat effectiveness within a ZOI can only be partially mitigated. Caribou will find some Project activities disturbing. It is uncertain to what degree caribou will habituate to those disturbances. However, over the entire range of the north Baffin Island caribou, habitat effectiveness is predicted to be reduced by 2.4% during the calving season, 4.8% during the growing (summer) season, and by 5.0% during the winter season. This effect will last for the duration of the Phase 2 Proposal's activities or until caribou adapt to the disturbances.

The loss of calving habitat will be entirely from disturbance associated with the mine, and therefore is reversible. The greatest disturbance to calving caribou habitat will be during the two-year period of the north railway construction while the Tote Road is still active for hauling ore. However, actual effects during that period are expected to be negligible because the area is not currently occupied by caribou. Railway construction will not impact the entire railway route simultaneously; therefore, the largest magnitude effect will be reduced because of the small spatial extent (e.g., section of rail being constructed at any one time) and shorter duration (e.g., the construction period). Given the broad distribution of calving sites within the RSA, the assumed availability of alternative calving areas, and the minimal competition for calving areas, Baffinland is moderately confident that after mitigation the Project will have a not significant effect on calving caribou.

There is medium confidence in the predicted Phase 2 Proposal impacts on caribou habitat over the life of the Project. Under current caribou distribution and abundance, there is high confidence that the Project will have negligible effects on the North Baffin Island Caribou Herd. If the population begins to expand in abundance and distribution, there is uncertainty about the extent of a potential ZOI and the impact that that ZOI may have on caribou. The ZOI is based primarily on work from EKATI™ and Diavik mines in the Northwest Territories (e.g., Boulanger et al. 2012b). Although caribou in general were four times more likely to be found >14 km from the mine, there were still observations of large numbers of caribou within the 14 km ZOI. Habitat will still be available, and it is possible that caribou will habituate to mine disturbances and forage in areas close to Project activities. Although that study had high quality empirical evidence, it was limited to an assessment of migratory caribou from the central Arctic from only mid-July to mid-October. The 14 km ZOI found in that paper was not replicated by Golder (2017) using alternate analyses and more years of data. The more recent analysis did not detect a discernible ZOI for that project and those caribou. The mechanisms behind the 14 km ZOI (Boulanger et al. 2012b) attributed to dust and potential effects on vegetation was also questioned by Chen et al (2017) that found dust only affected vegetation to 1,000 m from the Ekati diamond mine complex. Based on the findings of Golder (2017) and Chen (2017) it appears likely that the patterns described by Boulanger et al. (2012b) were short term in nature and may not have been entirely attributable to mining activities. If that is the case, application of the 14 km ZOI in this assessment represents a very conservative ZOI.

The caribou in this Project's RSA are not migratory and use the same range and habitat year-round. If caribou avoid habitat within the predicted ZOI, then a future RSPF model may show that there could be increased probabilities of caribou outside of the ZOI. A pre-development and post-development RSPF study in Wyoming found that mule deer response to well pad development resulted in increased probabilities of occurrence further away from the well pads (Sawyer et al. 2006). However, it is not possible to quantitatively predict increased probabilities of habitat use outside of the ZOI. This prediction will require follow-up monitoring.

The predicted levels of habitat effects based on the evaluation criteria and qualifiers are summarised in Table 10, and a summary of significance is provided in Table 11.

Movement — At the broad scale, there are few sections of the Northern Transportation Corridor that create a physical barrier to caribou movement, and most of the 5 km alignment sheets were rated as moderate to high for permeability. At a finer scale, there was only one of the known trails (~ km 39.5) where the corridor may present a barrier (a cut > 2 m deep) to movement.

Alterations to the landscape that will remain post-closure are consistent with the surrounding environment and will be immeasurable features on the landscape given the rough terrain in the RSA. Transportation embankments and building foundations do not exceed the characteristics of the current landscape. The caribou population is expected to rebound and large numbers of migratory caribou, relative to current levels, are expected to return to the area. Trails that were altered because of transportation infrastructure will be re-established as caribou return to and start to move through the region again.

The overall residual effect of the Phase 2 Proposal on caribou movement may be that caribou travelling on five of 52 (9.6%) known trails along the South Railway, and one of 14 trials along the Northern Transportation Corridor (7.1%) may experience a barrier to their movement on those trails. This will be a not significant impact on the movement of North Baffin caribou.

The traffic occurs along the transportation corridors at varying frequencies, and for short time periods approaching what may be barrier to caribou movement. Traffic transits decrease when there is full rail operation to the north and south, when transits decrease to regular rail transits.

Three is medium confidence in the predicted Phase 2 Proposal impacts on caribou movement. It was not possible to monitor caribou reaction to sensory disturbance in the Project area (densities were too low). The assessment of potential Project impacts relies on literature reporting impacts of transportation infrastructure, including railroads, on caribou movement and habitat use. It is unclear exactly what characteristics of the railway embankment may be a physical barrier, and how behaviour of caribou in low numbers (current) differs from caribou at high numbers (future). During the construction and early stages of operation the caribou population is expected to remain low and the regional caribou are expected to remain sedentary. Therefore, there is moderate confidence in our prediction of effects. As the North Baffin caribou herd population increases, IQ and the abundance of trails suggests that caribou will start to move across the PDA. Caribou movement reaction to infrastructure could be readily monitored and assessed to confirm that the project has a not significant effect to caribou movement. Future mitigation options available to mitigate unforeseen effects on a larger caribou population (e.g., seasonal traffic limitations when caribou start moving through the RSA). This prediction will require follow-up monitoring.

The actual impact of a ZOI on caribou movement is also questioned. While a ZOI certainly exists, it is not yet certain, regardless of numerous years of research, what the impacts of a ZOI on a caribou population area. There are many caribou herds in North America that interact with roads and traffic levels at or near the busiest numbers of transits proposed for this Project. Those populations have persisted and many have been stable or growing regardless of the interaction and potential impacts similar to what were assessed for the Phase 2 Proposal (e.g., Central Arctic Herd — National Research Council (U.S.) and Committee on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope 2003; or the Fortymile caribou herd in east central Alaska — Boertje et al. 2012). A recent draft publication by the Government of Nunavut documented what may be changing movement patterns of caribou approaching the Meadowbank Road outside of Baker Lake (Kite et al. 2017). However, those changing patterns have not yet been determined to cause an impact at a population level.

The predicted levels of movement impacts based on the evaluation criteria are summarised in Table 10, and a summary of significance is provided in Table 11.

Mortality — Project-related direct mortality on caribou is readily reduced by adjusting speed limits, seasonal traffic limits, regular monitoring of caribou numbers and proximity to transportation corridors, and a no-hunting policy for staff while on-site. There are no known features of the Phase 2 Proposal that will reduce health to a level of increased mortality for the north Baffin Island caribou herd. An outstanding concern of communities related to mortality is how north Baffin Island caribou will react to the trains, and whether they will be aware of moving locomotives and be capable of getting off the rail tracks. This is mitigable; caribou currently are in very low numbers and are seldom expected to be encountered along the rail route, and when the large numbers of caribou return, seasonal shut downs are possible to allow caribou to pass during migratory movements. The Project will not significantly increase caribou harvest in the RSA because of increased human access or improved knowledge of the area; no mitigation is required.

There are no expected residual effects of the Phase 2 Proposal on caribou mortality. Mortality, if it occurs, will be limited to individuals within the PDA. The effect of the Project on North Baffin caribou mortality is not significant.

There is high confidence in the predicted Phase 2 Proposal impacts on caribou mortality risk. There are few caribou in the area. Mitigation is readily enacted (e.g., speed limits, seasonal traffic limitations). No hunting is allowed by mine staff. General project activity monitoring will include a component tracking Project-related animal mortality.

The predicted levels of mortality effects based on the evaluation criteria are summarised in Table 10, and a summary of significance is provided in Table 11.

Health — The potential effect of the Phase 2 Proposal's dust fall and potential metals uptake by caribou and resulting impact on health is assessed in the *Evaluation of Exposure Potential from Ore Dusting Report* (Intrinsik 2017). No residual effects of the Project on caribou health are anticipated due to metal exposure from dust fall. The summary conclusions in that report are the following:

- Future predicted soil concentrations of all metals considered in the assessment were either within baseline concentration ranges, or below agricultural land use soil quality guidelines, and therefore are unlikely to pose a significant risk to caribou.
- The spatial extent of dust deposition and impact to soil is predicted to rapidly decline with distance from the PDA.
- Based on the estimated future soil concentrations of all metals considered, some accumulation within vegetation and other terrestrial organisms' tissues is anticipated to occur but would likely be localized to areas most affected by dust loadings which are generally limited in their spatial extent.
- Based on the limited size of the areas affected by deposition rates of 55 g/m²/year or greater, and the fact that these areas, and areas exhibiting higher dust deposition rates, are limited in size and largely within the active PDAs, the likelihood of significant metals exposures to caribou is low, particularly considering their limited exposure to impact areas due to movement through the RSA.
- Based on the lack of exceedance over ecologically-based soil quality guidelines, and the limited change to vegetation predicted in this assessment, other terrestrial wildlife species with smaller home ranges would not be anticipated to be adversely affected by the predicted levels of dust fall.

Three is medium confidence in the predicted Phase 2 Proposal impacts on caribou health. There is a reasonable degree of confidence in this assessment, albeit lichen predictions have a high degree of uncertainty associated with them (Intrinsik 2017). Most dust fall will be associated with the Mine Site and the primary metals are relatively innocuous to caribou. Standard operating protocols to reduce dust dispersal in the ZOI will be implemented (e.g., Baffinland Iron Mines Corporation 2016b) and transportation of ore and freight using railway infrastructure will reduce dust deposition (compared to truck transport).

The predicted levels of mortality effects based on the evaluation criteria are summarised in Table 10, and a summary of significance is provided in Table 11.

Table 10. Effects Assessment Summary of Phase 2 Proposal Residual Effects on Caribou

Effect	Residual Effect Evaluation Criteria					Significance of Residual Effect
	Magnitude	Extent	Frequency	Duration	Reversibility	
Habitat (winter, calving, growing)	Level II % difference in North Baffin caribou range from -2.4 (Level I) to -5.0 (Level II).	Level I: The ZOI occurs outside of the PDA but remains within the RSA.	Level III: Habitat loss occurs gradually through the construction stage, but the ZOI is continuous through to closure.	Level II: The effect will occur through operation stage.	Level I: The effect is fully reversible (ZOI diminished following operation).	Not significant
Movement	Level I: There may be a barrier at 1 of 14 known trails (7.1%).	Level I: Effects on movement are likely confined to the PDA when caribou encounter Project activities and infrastructure.	Level III: Physical barriers and traffic will be continuous.	Level II: The effect will occur through the operation stage of Phase 2	Level I: The effect is fully reversible – barriers can be removed, and traffic will stop.	Not significant
Mortality	Level I: minor to no impact, and undetectable at the population scale.	Level I: The impact will occur within the PDA.	Level I: The potential for the impact will be continuous, but occurrence of events are predicted to be very rare, once mitigated	Level II: The potential for the impact will occur through construction and operation of Phase 2.	Level I: The potential for the impact is reversible (e.g., stop traffic, reduce hazards)	Not significant
Health	Level I: minor to no impact, and undetectable at population scale.	Level I: The impact will occur if animals are exposed to emissions and dust deposition near the PDA.	Level III: The impact will be continuous	Level II: The potential impact will occur through the operations phase.	Level I: Fully reversible at closure.	Not significant

Table 11 Significance of Potential Residual Effects on Caribou

Effect	Significance of Predicted Residual Environmental Effect		Likelihood[a]	
	Significance Rating	Level of Confidence	Probability	Certainty
Habitat	N	2 (Medium): Caribou habitat is well studied and modelled with site-specific data. Habitat will clearly be lost to the PDA for the long-term, but caribou response to potential ZOI and overall impact on population is not certain. Baseline data and IQ are comprehensive, interaction understood, but ultimately caribou response to reduced effectiveness in the predicted ZOI is not clear.	na	na
Movement	N	2 (Medium): Caribou will respond to disturbance and adjust movement, but unclear how that behavioural response on individuals equates to a population-level effect.	na	na
Mortality	N	3 (High): There is no way that individual project-related mortality on an infrequent basis could have a measurable impact on the north Baffin Island caribou population Over the life of the Phase 2 Proposal there is likely to be infrequent Project-related mortality of caribou. Based on experience at other Nunavut mine sites, this is most likely to occur during periods of reduced visibility (e.g., fog).	na	na
Health	N	2 (Medium): Dust fall is generally predictable, and highest dust fall is limited to the PDA where there will be no foraging habitat. Risk of uptake of metals in caribou is low and unlikely due to limited project-related impact pathways. There is a reasonable degree of confidence in this assessment, albeit lichen predictions have a high degree of uncertainty associated with them (Intrinsik 2017).	na	na

Key

Significance Rating: S = Significant, N = not Significant, P = Positive

Level of Confidence[1]: 1 = Low; 2 = Medium; 3 = High

[a]Likelihood — only applicable to significant effects

Probability: 1 = Unlikely; 2 = Moderate; 3 = Likely

Certainty[2]: 1 = Low; 2 = Medium; 3 = High

Notes

1. Level of confidence in the assignment of significance
2. Certainty around the assignment of likelihood

COMBINED PROJECT EFFECTS ON CARIBOU — ENERGETICS

The combined Project effects are quantified and assessed using an energy-protein model updated to include protein dynamics (Russell 2014, Attachment 1). This is the third iteration of the model, initially developed for the Approved Project's FEIS, then revised twice in consultation with the QIA. The objective of the energetics model was to predict how varying potential impacts of the Mary River Project affects the long-term productivity of the North Baffin caribou herd. While the model did not consider a North Railway per se, the level of disturbance associated with that part of the Phase 2 Proposal is included within the range of conditions of the existing model (D. Russell, pers. comm.).

Model inputs were obtained to best reflect the conditions in the north Baffin region. The model assumes that the North Baffin caribou population is cyclical, so it incorporates the predicted caribou population increase during the life of the Phase 2 Proposal. The model simulated food intake based on the seasonal quantity and quality of forage available, followed energy and protein kinetics through the rumen and allocated the resultant metabolizable energy intake and metabolizable nitrogen intake into maintenance, activity, growth, lactation and gestation.

Model inputs were obtained to best reflect the conditions in the north Baffin region. Distribution of cover types were compiled separately for the north Baffin caribou range, the Regional Study Area (RSA), and the Zone of Influence (ZOI). Five scenarios were developed to be tested in the model. All five scenarios are considered conservative predictions of Project effects. The scenarios are as follows:

Scenario 1: The baseline condition, with no development but with an expanding and thus increasingly dense caribou population.

Scenario 2: The impact of caribou abandoning the ZOI completely. The negative effect of caribou abandoning the ZOI was an increased density on the rest of the range, thus reducing the effective biomass per individual.

Scenario 3: The impact of the potential for caribou to be unable to cross transportation corridors in key places, thus abandoning a portion of the RSA over and above the ZOI. In this scenario it is assumed that caribou would abandon 35% of the RSA, which includes all of the ZOI (representing about 25% of the RSA) and an additional 25% of the RSA north and west of the development. The same source of impact was modeled: increased density outside the abandoned zone with a proportional decrease in biomass per individual.

Scenario 4: The same as Scenario 3, except it is assumed caribou would abandon the entire RSA north and west of the infrastructure, including the ZOI on the south and east side of the Mine and railway (65% of the RSA).

Scenario 5: The impact of caribou being in the Zone of Influence (ZOI) for the whole year. Impacts were modeled based on a reduction in foraging time and eating intensity (the proportion of foraging time spent eating) and an increase in walking and running time.

To assess overall Project effects on an expanding north Baffin caribou population, scenarios were modeled over a 50-year period (at 5-year intervals). The initial population could grow and thus with each iteration (time step) the biomass per individual was reduced as a response to increasing density and for Scenarios 2, 3, and 4 with increased density due to abandoning portions of the range. Output body condition variables that link directly to rates of herd productivity were used to compare the outcomes of the scenarios.

In all runs, cows did better with no development. With the Scenario 2, Scenario 3, and Scenario 4, cows did progressively worse in terms of the key variables. The least severe impact modeled, abandoning the entire ZOI (Scenario 2), reflects an unlikely impact of the Project, but is used to show the result of what would be considered a severe Project impact on the North Baffin caribou herd. Under Scenario 2 conditions, the changes to the key variables from baseline values at the highest caribou densities (largest population) when project impacts are expected to act with natural stressors associated with an oversized population range from a -1.7% to -6.4% change in body condition variables. These changes are likely not distinguished from natural variability.

This analysis allows for better understanding of the impacts of human activity on the energy-protein relations of caribou. When new North Baffin specific data become available, more monitoring of impacts on activity and distribution is conducted, and a better understanding of the population dynamics of this population is achieved, this modeling approach can be used to re-assess impacts of the Mary River Project and others as cumulative effects may occur in the future. As discussed with the QIA, this modeling approach did not assess the role of climate in exacerbating or ameliorating the projected impacts of development.

The Project is expected to result in not significant changes to factors that could act to influence caribou population dynamics. Population dynamics of the North Baffin Island caribou herd can be influenced if Project activities that significantly change the numbers of births, deaths, emigration, or immigration. The Project is expected to cause not significant changes north Baffin Island caribou habitat loss, mortality, or reduced health; therefore, there is no pathway to an impact on caribou population dynamics from Project effects. Consequently, changes to caribou population dynamics are not anticipated due to the Project.

3.4.2 WOLF

3.4.2.1 Habitat

The RSA includes approximately 945 km² of glaciofluvial terrain that may provide suitable denning habitat for wolves. Phase 2 proposed infrastructure require disturbance in an additional 3.95 km² of a total 26.20 km² of glacio-fluvial habitat within the PDA. The result is a potential loss of 2.77% of the glacio-fluvial wolf denning habitat in the RSA (Table 12).

Table 12. Direct effects on potential wolf denning habitat in the Mary River RSA.

Habitat	Baseline RSA		Approved Project		Phase 2 Change		Phase 2 Total	
	Area (km²)	% RSA	PDA (km²)	% Habitat Available in RSA	PDA (km²)	% Habitat Available in RSA	PDA (km²)	% Habitat Available in RSA
Glacio-fluvial	942	4.48	-20.87	-2.35	-4.74	-0.42	-26.20	-2.77

MITIGATION

No new mitigation than that suggested for the Approved Project is suggested. Active wolf dens will be avoided as they are discovered. It is likely that wolf den monitoring will be re-initiated when caribou return to the area and wolves are again observed in the RSA.

3.4.2.2 Significance of Residual Effects on Wolf

Habitat — Loss of habitat within the PDA is a residual effect — Baffinland does not expect that habitat will be reclaimed (re-vegetated) within a generation of wolf. Within the RSA, there will likely be a long-term loss of 2.7% of the potential denning habitat for wolves. That affect is limited to the PDA and is a not significant loss of potential denning habitat in the RSA.

The predicted levels of habitat impacts based on the evaluation criteria are summarised in Table 13, and a summary of significance is provided in Table 14.

Table 13. Effects Assessment Summary of Phase 2 Proposal Residual Effects on Wolf

Residual Effect	Residual Effect Evaluation Criteria					Significance of Residual Effect
	Magnitude	Extent	Frequency	Duration	Reversibility	
Habitat	Level I: Habitat loss is 2.7% of available habitat in RSA	Level I: Loss is limited to the PDA	Level II: Habitat loss occurs gradually but through the construction stage, then no loss at operation	Level II: The habitat loss will occur for the life of the Phase 2 proposed operation.	Level I: Fully reversible when operations cease.	Not significant

Table 14 Significance of Potential Residual Effects on Wolf

Effect	Significance of Predicted Residual Environmental Effect		Likelihood[a]	
	Significance Rating	Level of Confidence	Probability	Certainty
Habitat	N	2 (Medium): Habitat will clearly be lost to the PDA for the long-term. While the loss of habitat to PDA is likely, it is unlikely that wolf denning is potential is limited to that area. Baseline data and IQ are comprehensive, interaction understood. Ultimately wolves are dependent on return of caribou.	na	na

Key

Significance Rating: S = Significant, N = not Significant, P = Positive
Level of Confidence[1]: 1 = Low; 2 = Medium; 3 = High
[a]Likelihood — only applicable to significant effects
Probability: 1 = Unlikely; 2 = Moderate; 3 = Likely
Certainty[2]: 1 = Low; 2 = Medium; 3 = High

Notes

1. Level of confidence in the assignment of significance
2. Certainty around the assignment of likelihood

3.5 POTENTIAL CLIMATE CHANGE EFFECTS

Potential effects from climate change are not traditionally considered within a cumulative effects assessment, but the pathways are similar. Global emissions of greenhouse gases are expected to cause an overall warming trend, with more rapid changes in polar latitudes such as the Arctic (Larsen et al. 2014). Over time, effects to species and ecosystems are likely to be widespread but will vary relative to realized emissions pathways (Field et al. 2014). Potential climate change effects interact with the Phase 2 Proposal at a level like cumulative effects: they result largely from external activities that are beyond control of the Project but that have the potential to interact with direct and indirect Phase 2 Proposal effects.

Vulnerability to climate change varies broadly by species. Understanding key sources of vulnerability for each species can be facilitated by assessing interactions between climate change and key factors such as habitat, physiology, phenology, and biotic interactions. This helps to rank the relative importance of each of the key factors, assess the uncertainty of existing knowledge and provide an estimate of both the vulnerability of a species as well as the uncertainty associated with that estimate. After conducting these assessments on multiple species, it is then possible to consider the potential effects on birds in a broader ecological context. In this Section, we present a broad overview of this assessment on wildlife for each key factor.

Habitat vulnerability refers to potential changes in habitat quantity or quality that may affect survival or reproduction. It is largely differentiated into non-breeding habitat components associated with a species' survival, and breeding habitat components that are primarily associated with reproductive success.

Summer forage habitat is expected to increase slightly in both duration and area. An increase in duration would result from longer ice-free seasons. This may confer some resilience to herbivores, especially those able to vary behaviour to adapt, for example by breeding earlier or by increasing fat reserves for winter survival. Greater summer snowmelt and a decrease in the area of freshwater (Prowse et al. 2006) would cause a small increase in forage habitat area. This is not expected to benefit most herbivore species for which winter, rather than summer, forage area is more likely a limiting factor. No significant changes to predator habitat affecting survival or reproduction are anticipated.

Winter forage availability is a limiting factor for many herbivores, including caribou. Changes to snow conditions may reduce access to forage and have strong negative effects on caribou populations (Post and Forchhammer 2008, Miller and Barry 2009, Stien et al. 2010, Hansen et al. 2011). Population die-offs such as those recorded in the Queen Elizabeth Islands (Miller and Barry 2009) may occur more frequently. Snow conditions in the winter affect both growth rate and demographic structure of caribou populations (Berteaux et al. 2017). Rain-on-snow events and freeze-thaw cycling increases snow thermal conductivity and hardness and decrease snowpack thickness (Sturm and Benson 1997), creating areas of hard snow and ice where forage is inaccessible (Hansen et al. 2011). Areas of suitable habitat are diminished, requiring greater travel (Berteaux et al. 2017) increasing associated energetic costs (Loe et al. 2016) and potentially increasing vulnerability to predators.

Physiological vulnerabilities are related to direct effects on survival and reproduction, including the potential for exceedances of physiological thresholds, exposure to weather-related disturbance, survival during resource fluctuations and energy requirements. Overall, the greatest physiological vulnerabilities to climate change are primarily associated with exposure to extreme weather events such as increased frequency of heavy rain. These can have both direct and indirect effects on reproductive and foraging success. Behavioural plasticity may confer an advantage to species that can take advantage of warmer temperatures to alter breeding timing and changes in prey sources.

A key physiological vulnerability to herbivores such as caribou is the potential for more frequent rain-on-snow events. Extreme weather events from unseasonal warm spells and rain-on-snow events can cause changes in snow pack properties, including ground icing, increases in snow thermal conductivity and hardness and decreases in snowpack thickness (Sturm and Benson 1997, Loe et al. 2016). Areas of suitable habitat are diminished, requiring greater travel in more difficult conditions; in extreme cases, forage can become inaccessible (Berteaux et al. 2017). The most extreme rain-on-snow events have caused massive reindeer mortality in Norway, Siberia and Canada (Miller and Barry 2009, Hansen et al. 2014, Sokolov et al. 2016). An increase in the frequency of rain-on-snow events could also cause energetic costs to species such as the Baffin Island wolf by making travel on snow more difficult.

Phenological vulnerabilities can result from mismatches in timing between species' behaviour and biology and critical resources. This can occur where species rely on an environmental cue to initiate activities such as migration or breeding, or where a species' fitness is tied to a discrete resource peak that is expected to change. Phenological processes may be a substantial source of vulnerability, particularly for migratory species and those that time activities to environmental cues or discrete resource peaks. Migratory wildlife can adapt if environmental cues are present; however, the lag time of behavioural change compared to environmental change may be a concern for some species. Climate change interactions with phenology are not expected to be an important factor conferring vulnerability or resilience to wildlife on Baffin Island.

Vulnerabilities relating to biotic interactions stem from changes in interactions with food sources, predators, diseases, symbionts and competitors. Overall, vulnerability associated with changes in biotic interactions mainly relate to food sources. Primarily, terrestrial species may see an increase in the abundance of food sources but food quality for some species may diminish. For caribou, forage quality depends mainly on plant species composition in the diet (Heggberget et al. 2002). Caribou diet is dominated by sedges, willows, grasses and forbs (Parker 1978, Miller 1991) but lichen is an important fodder (Thomas et al. 1999, Ferguson et al. 2001, Larsen et al. 2014) and legumes provide important winter protein (Larter and Nagy 2004). Changes in forage species abundance, distribution and cover are a likely response to climate change; shrubs are expected to increase at the expense of other plant functional types. Shrub biomass, cover and distribution have expanded in many areas of the Arctic over recent decades, likely as a result of climate change (Sturm et al. 2001, 2005, Tape et al. 2006, Myers-Smith et al. 2011, Ropars and Boudreau 2012). This could decrease the quality of available forage for caribou and other herbivores.

Predator species that are not flexible in their prey selection will be vulnerable to fluctuations in prey composition and availability. Other biotic interactions such as predators, symbionts, disease and competitors are either not expected to have a large influence on vulnerability or the results are highly uncertain.

Changes in environmental processes because of climate change will occur independently of the Phase 2 Proposal. Therefore, potential interactions of climate change with the Project and their effects on wildlife are limited and likely not measurable. Changes in vegetation composition and distribution will affect the balance of direct and indirect habitat loss. It would be difficult at best to predict and quantify these changes at the scale of the RSA, North Baffin Island Caribou Herd range, or at any scale. However, assessments of changes in habitat along with their effects on the habitats of key indicator species can be conducted periodically through the life of the Project. Adaptive management plans could then be implemented if necessary. The current suite of mitigation presented in the Terrestrial Environment Mitigation and Monitoring Plan (Baffinland Iron Mines Corporation 2016a) to alleviate disturbance to wildlife will prevent exacerbating the effects of physiological vulnerabilities. Vulnerabilities related to phenology and biotic interactions are completely independent of the Project and as a result cannot be mitigated. Their effects on wildlife species will depend mainly on the plasticity of individual species and their ability to adapt timing of activities (e.g., migration, breeding) through their life cycle. Baffinland will integrate climate change considerations into project planning and operations by continuously seeking to use energy, raw materials and natural resources more efficiently and effectively, and striving to develop new processes and more sustainable practices.

3.6 MITIGATION AND MONITORING PLAN UPDATES

No material changes are required to existing mitigation and monitoring plans for wildlife. There is no new information, survey methods, or material changes in Project interactions associated with the Phase 2 Proposal that suggest the need for any substantial changes to the current monitoring program for wildlife and wildlife habitat.

All on-going monitoring relevant to the Approved Project will continue. The geographic scope of some of the programs, such as the dust fall collection and height-of-land surveys, may be adjusted to accommodate the increased PDA, particularly in the section of the northern rail that diverts from the existing tote road corridor. Those changes will be discussed in detail among the Terrestrial Environment Working Group (TEWG) either during the review of the Phase 2 Proposal or when the Project Certificate is amended.

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ATTACHMENT 1. CARIBOU ENERGETICS

Energy-protein modeling of North Baffin Island caribou in relation to the Mary River Project: a reassessment from Russell (2012)

PREPARED FOR:

EDI Environmental Dynamics Inc.
2195 2nd Avenue
Whitehorse, YT Y1A 5T8
867.393.4882

PREPARED BY:

Don Russell
Shadow Lake Environmental Consultants
Box 10038
Whitehorse, YT Y1A 7A1
867.456.2695

May 2, 2014

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INTRODUCTION

This report builds on a similar report that used an existing energy-protein model to assess effects of the proposed Mary River iron mine and railway infrastructure on North Baffin Island caribou (Russell 2012). An amendment to the Project, relying initially on transporting ore north along the existing tote road and a delay in the construction of the rail option, offered an opportunity to update our assessment of the effects of the Project on the energy-protein dynamics of the North Baffin Island caribou. Further, refinements to our models allow us to extend those effect predictions to the population scale.

General Approach

For a general description of how we previously employed the energy-protein model to assess effects of the Mary River project see Russell (2012). Since that time we improved our approach to energetics modeling by incorporating three modifications:

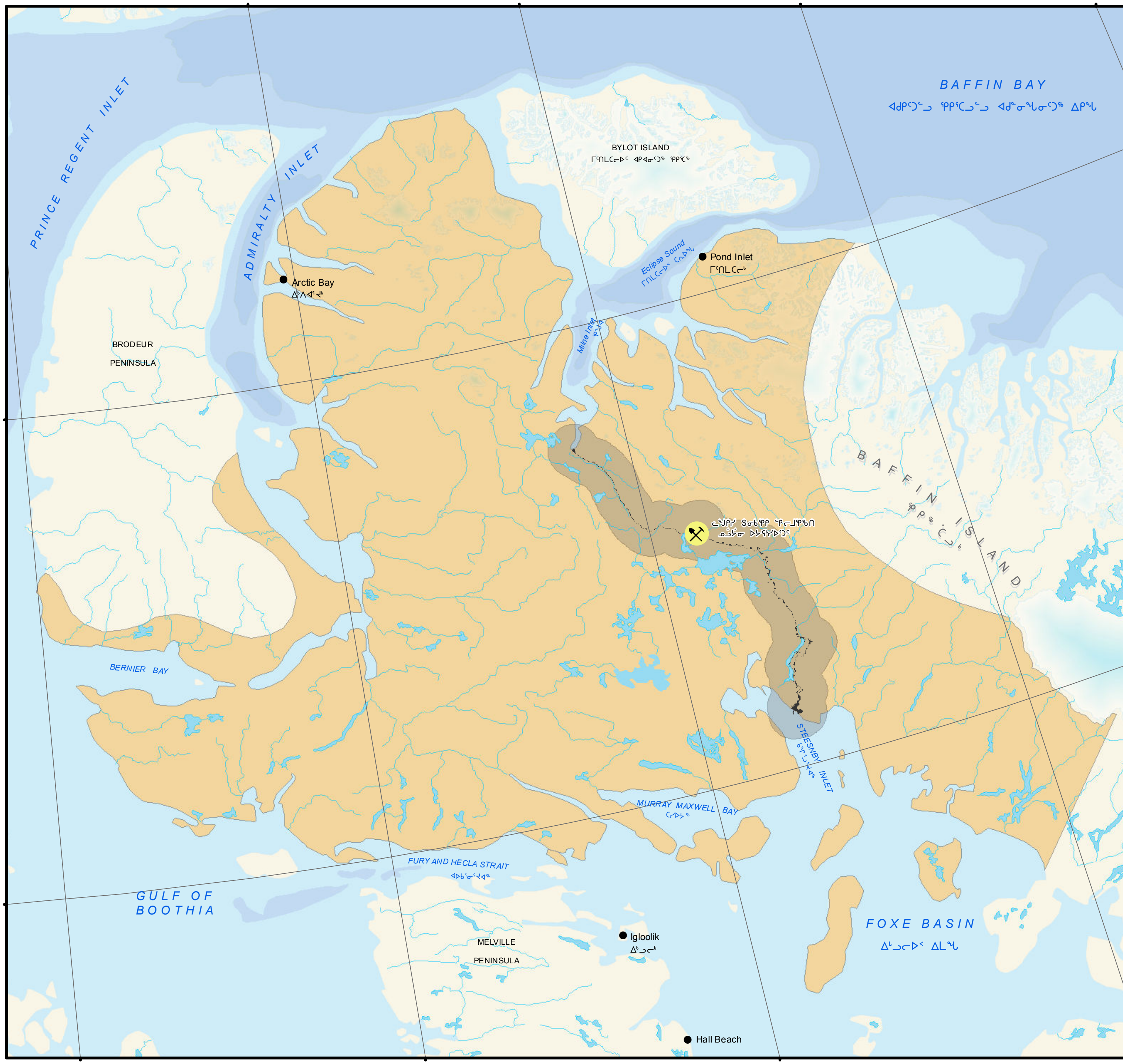
1. The model will determine weaning strategy where lactating caribou can now wean calves early to ensure they are in better fall physical condition to improve their chances of winter survival;
2. The model will run 100 animals through the model simultaneously to better represent effects at the population level (*i.e.,* effects on a cross section of the population are assessed rather than on a single individual); and
3. Model output can be used to drive a population model to predict Project effects at the population scale.

In this exercise, we have run the energy-protein model to integrate two development effects:

1. disturbance to caribou within the Zone of Influence (ZOI) (Figure 1) and
2. displacement of caribou from the ZOI.

Disturbance to caribou is defined as sensory stressors resulting from Project activities or infrastructure that may temporarily reduce the effectiveness of adjacent habitats, filter movement among habitat patches, and/or increase overall energy expenditures (change in activity budgets) near sources of sensory disturbance. Displacement is defined as the temporary (long-term, not permanent) avoidance of areas near the source of disturbance.

Output indicators (weaning strategy and fall body weight of cows and calves) from the energy-protein model runs are linked to the population model through changes in pregnancy rates and calf mortality. One objective of our assessment is to determine Project-related effects throughout the cycle of abundance of North Baffin Island caribou. Thus we modeled the hypothetical future recovery of the herd under two scenarios: an unharvested population and a harvested population. For both the unharvested and the harvested population projections, we then integrated the two Project development effects (displacement and disturbance) into three scenarios: 1) moderate disturbance and displacement, 2) moderate displacement and high disturbance, and 4) high disturbance and displacement. We then determined how a reduction and/or sex selection of the harvest would have to be altered to offset the demographic effects of the Project. The output from this can then be used to compare Project-related and harvest-related effects to population projections (Figure 2).



LEGEND

- Mary River Project
- Potential Development Area
- Zone of Influence Area
- North Baffin Caribou Herd Range

NOTES

Map Projection: Canada Albers Equal Area Conic.

Updated PDA provided by Hatch (25 April 2013).

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Scale 0 10 20 40 60 80 100 Km

Baffinland Iron Mines Corporation

The Mary River Project's Zone of Influence relative to the Project & the North Baffin Island caribou herd range.

EDI

Date: 22/01/2014

FIGURE 1

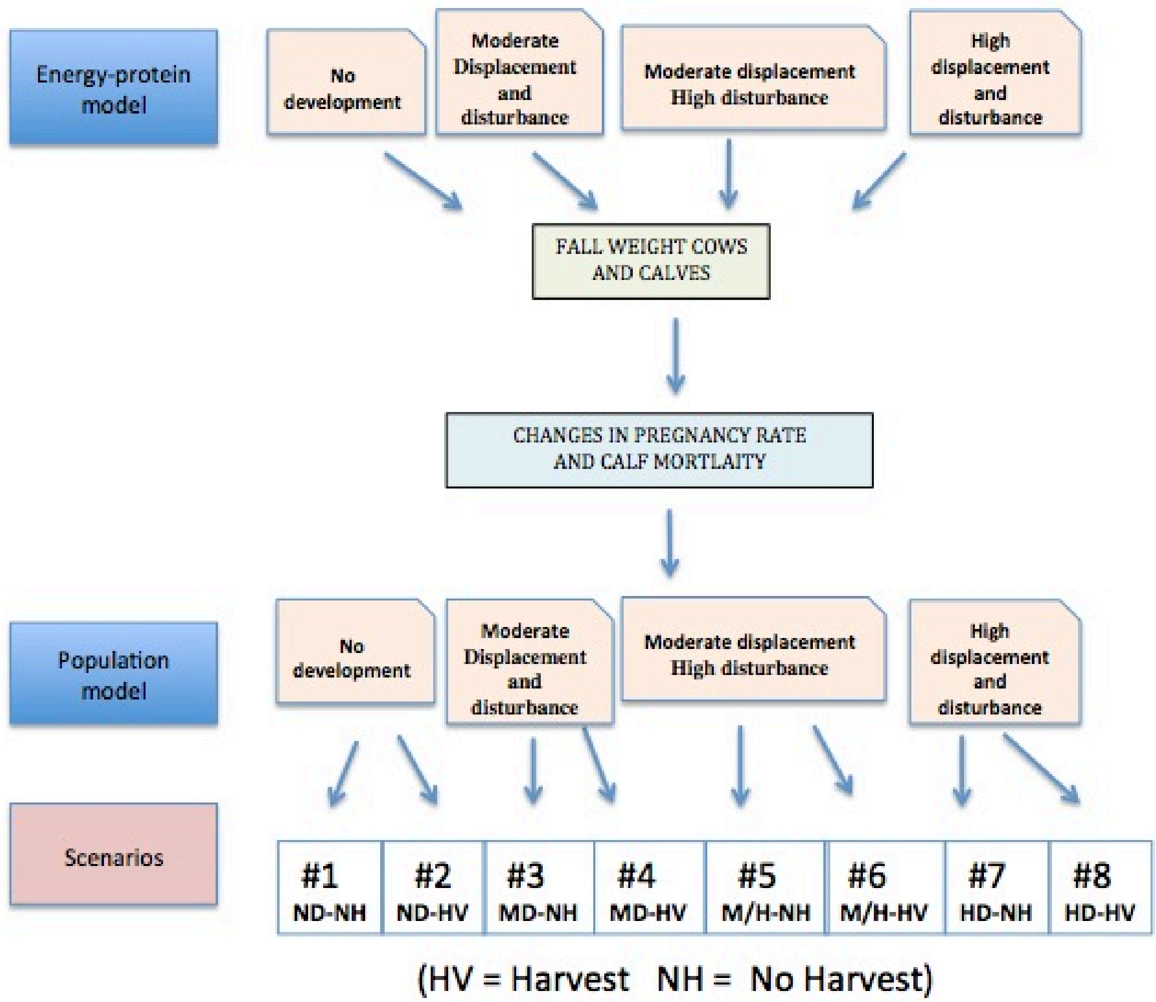

Figure 2. **Modeling approach used to assess the cumulative effects of the Mary River Project and harvest on North Baffin Island caribou.**

MODELING EFFECTS

DISPLACEMENT

Moderate

- The use of the Zone of Influence (ZOI) was determined from collared caribou described in Jenkins and Goorts (2011) and summarized in respect to use of the ZOI by Baffinland (2013), Figure 6-5.8 page 51. Based on Figure 6-5.8, 70% of collared animals use the ZOI 25% of the time. If we assume that the collared sample is indicative of all North Baffin caribou, then 70*.25 = **17.5% of caribou use days would occur in the ZOI**.
- Caribou were collared more or less randomly based on linear transects covering much of North Baffin caribou range. However Jenkins and Goorts (2011) indicate that they also collared caribou opportunistically travelling to and from their base (the Mary River Mine site). Thus it may be argued that the collared animals may be biased to have more of their home range in the ZOI.
- Recent assessments of mine development effects on caribou indicate a measureable reduction in caribou occupation (yet still occupied) within a ZOI of 14 km (Boulanger et al. 2012).
- Boulanger et al (2012) derived a 14 km ZOI with an "odds ratio" of 4 times relative increase in habitat selection at distances further than the ZOI relative to the disturbance site and increasing from 1 to 4 more or less linearly out to 14 km (Figure 3)
- If we assume Figure 3 is synonymous with displacement then there is potentially 14*4=56 caribou "units" in the ZOI. The amount displaced is the area of the displaced triangle = .5*14*3=21 caribou or 21/56*100= 37.5% displacement
- So given all the assumptions above displacement is 17.5% use of ZOI * 37.5% displaced = **6.6%** caribou use days displaced from ZOI. In this report we refer to this as "moderate" displacement.
- Displacement effects will begin to occur when the population exceeds 15,000 animals
    - Rationale: At low population densities, displaced animals would have no effect at the herd scale and would merely result in normal range expansion. As densities increase, feedbacks on biomass (*i.e.,* a reduction in food available per individual) would increase. Population estimates for North Baffin Island caribou have ranged from 30,000 in 1985 (Williams and Heard 1986) to 50,000–150,000 in 1991 (Ferguson and Gauthier 1992). For our modeling we conservatively assumed a peak abundance of 50,000 animals with displacement effects beginning as the population exceeds 15,000 animals and maximizing (*i.e.,* a percent reduction in biomass per individual equal to the percent of the range abandoned by displaced caribou) at 50,000 animals.
    - We consider 15,000 quite low to see the effects of displacement. Typically, with a sigmoidal growth curve indicative of density-dependent growth, productivity is expected begin declining at the inflection point (near 50% of the peak population size), which for this case would be 25,000 caribou.

High

- Although we do not think caribou would absolutely avoid the area within the ZOI, and there is no precedent for this in the literature for either roads or railway, high displacement assumes that 100% of animals are displaced from the ZOI, thus 17.5% (from above) of North Baffin caribou use days would be displaced from the ZOI.

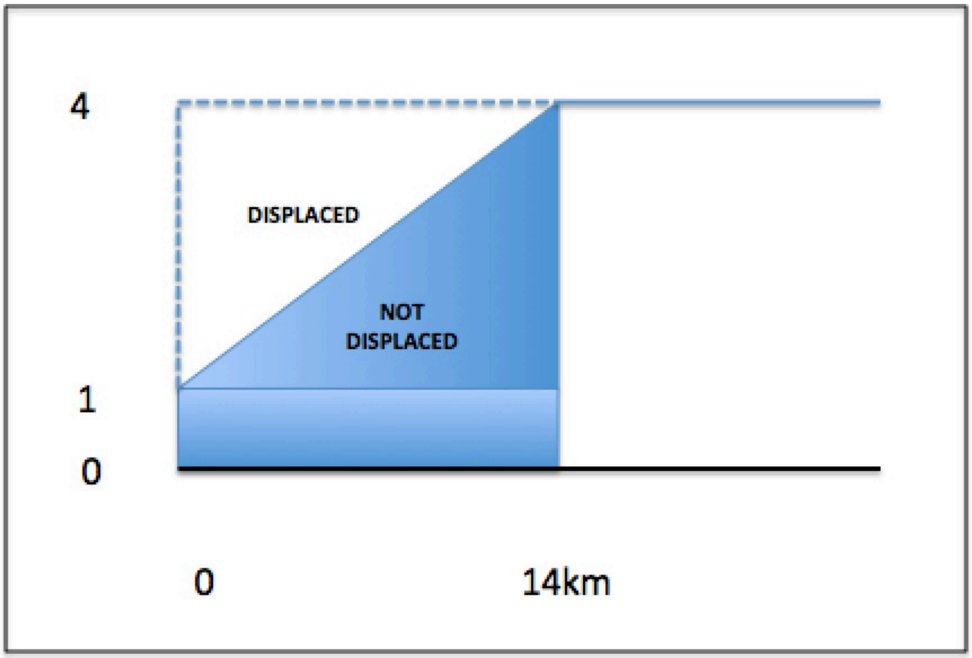

Figure 3. Schematic of Boulanger's et al (2012) "odds ratio" and how the proportion of caribou displaced was calculated

DISTURBANCE

Moderate

- From above, 70% of animals use ZOI 25% of time.
- Literature and opinion varies on if there is a measureable difference in behavior in the ZOI. However for those that do measure a difference, the distance caribou are affected are generally no more than 500 m from the source of disturbance.
- If we assume that disturbance will occur out to 1 km, especially with heavy traffic from the source, than our **"moderate"** percent of time an animal is disturbed in the ZOI (assume evenly distributed in the ZOI, i.e. no displacement from the source of disturbance) = 25% of time/14 (only disturbed 1 km of the 14 km ZOI) = **1.7%** of their time.
- For those caribou disturbed, behavioural activity is affected: 6% decrease in feeding; 3% increase in walking and running
    - Rationale: literature estimates vary considerably, however for paired studies (simultaneously monitoring activity of caribou inside and outside a ZOI) the effect on caribou activity was not consistently different. Thus this is a liberal application of disturbance effects on activity.

High

- Although we do not think caribou would be disturbed throughout the entire 14km ZOI, our **high disturbance** scenario assumes all caribou in the ZOI are disturbed.

HARVEST

1. We modeled the recovery of the North Baffin Island caribou from 2013 to 2050 with a) no harvest, and b) at a constant harvest equivalent to 5% of initial population size. We started the population at 1,500 animals and thus the constant harvest was 1,500*0.05 = 75 caribou per year. It was not our intent to try to model realistic harvest throughout the recovery of the herd but rather to simply illustrate the effects of the Project in the context of harvested and non-harvested populations.
2. Harvested animals were assumed to be taken in proportion (by age and sex) to their occurrence in the population. The Nunavut harvest study determined that North Baffin Island caribou harvest from Pond Inlet is ~63% females, relative in proportion to female abundance in the population (Priest and Usher 2004).
3. We then determined how much of a reduction and/or sex selection of the harvest that would have to be altered to offset the demographic effects of the Project.

MARY RIVER MODELING SCENARIOS

Scenario #1 (**ND-NH):**

- No development, no harvest; initial population size 1,500 animals (see Initial population size section below)

Scenario #2 (**ND-HV):**

- Same as #1 above, with harvest of 75 animals per year (see Harvest section below for rationale)

Scenario #3 (**MD-NH**):

- Development, moderate disturbance and displacement, no harvest
  - <u>Displacement:</u> 6.6% caribou use days in ZOI that could potentially be displaced
  - <u>Disturbance</u>: caribou disturbed out to 1 km from infrastructure 7% of caribou use in ZOI that could potentially be disturbed

Scenario #4 (**MD-HV):**

- Development, moderate disturbance and displacement, with harvest
  - Same as #3 but with harvest

Scenario #5 (**M/H-NH**):

- Development, moderate displacement, high disturbance, no harvest
  - <u>Displacement:</u> same as in #3
  - <u>Disturbance</u>: caribou disturbed throughout the ZOI =100% of caribou use in ZOI that could potentially be disturbed

Scenario #6 (**M/H-HV**):

- Development, moderate displacement high disturbance, with harvest
  - Same as #5 but with harvest

Scenario #7(**HD-NH):**

- Development, High disturbance and displacement, no harvest
  - <u>Displacement</u>: 17.5% that could potentially be displaced
  - <u>Disturbance</u>: no disturbance because no animals in ZOI

Scenario #8 (**HD-HV**):

- Development, High disturbance and displacement, with harvest
  - Same as #7 but with harvest

INPUT DATA — ENERGY-PROTEIN MODEL

Model inputs for our energy-protein model were the same as reported in Russell (2012), except we expanded the ZOI to 5.7% of the range of the North Baffin Island caribou herd to include the road, ports, mine site, and railway. In the initial modeling, only the mine and railway were included. The expansion of the ZOI resulted in a slight shift in the relative abundance in the vegetation types accounted for within the ZOI (Figure 4).

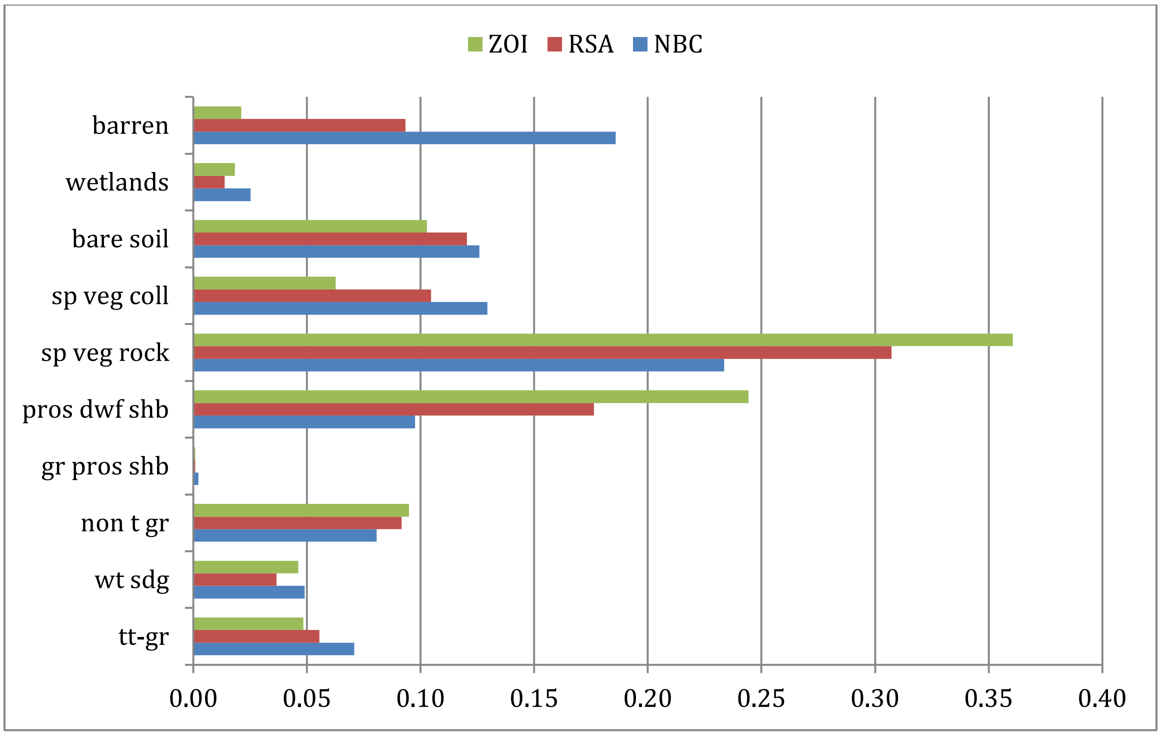

Figure 4. Relative abundance of vegetation types in the North Baffin Island caribou range (NBC), the Regional Study Area (RSA), and the Zone of Influence (ZOI) of the Mary River Project.

INPUT DATA – POPULATION MODEL

Initial population size: There is currently no reliable population estimate for North Baffin Island caribou. We have assumed that population density in the north is similar to conditions in south Baffin Island. Jenkins et al. (2012) surveyed south Baffin Island and recorded a mean population density (without calves) of 0.0054 caribou km^{-2}. Regions surveyed varied from 0.02558 to 0.00094 caribou km^{-2}. The area for the North Baffin Island caribou herd range is 133,656 km^2 and thus if densities were similar there would be a current population of 721 caribou. Our intention was to run the population model to 2050; however, with this low population size, even in the absence of harvest, the population never exceeds 27,000 by 2050. We know that population estimates were closer to 70,000 animals in the early 1990s (Ferguson and Gauthier 1992), so to account for the noted population decline since the 1990s and reflect effects through the entire expected levels of abundance, we started the population at 1,500 caribou in 2013, approximately twice what we suspect may be in the population.

Population structure: We used the population structure determined for south Baffin Island (Jenkins et al. 2012), namely 63 males per 100 females, and allocated the 1500 individuals among sex and age class (Figure 5). Age structure allocation was derived from animals collected on Baffin Island by Elkin in the 1990s (unpublished data).

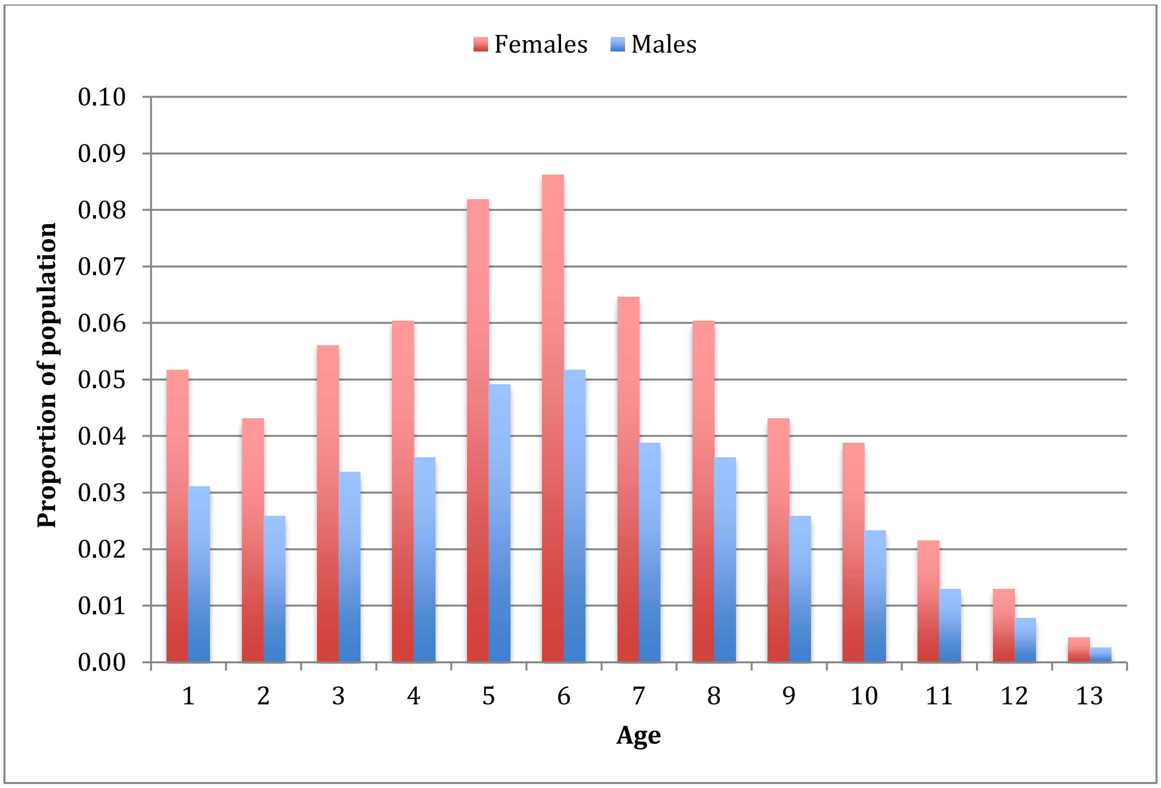

Figure 5. Estimated proportion of North Baffin Island caribou population by age and sex.

Offspring per female: Our population model allows the user to input productivity data for any time of year. Input at peak of calving would represent parturition rates, while input during fall and/or spring would represent calf:cow ratios during composition surveys. Because data for North Baffin Island caribou are absent for any of these time periods, we examined data from Elkin taken in the mid to late 1990s — a period when the population had peaked or began to decline. From 46 adult cows collected in the spring, 76% were pregnant. We adjusted that value upward to 82% to reflect expanding populations (Bergerud 1980).

Annual mortality rate: As there are virtually no data on North Baffin Island caribou mortality rates, we applied mortality rates indicative of an expanding population (Figure 6). Recent recovery of the Porcupine caribou herd was associated with a reduction in mortality rates for adult cows from 17% in the 1990s to 6.7% in the mid-2000s (Alaska Dept. Fish and Game, unpublished data). To account for the differential proportion of males to females in the population, we assigned 5% higher age-specific mortality rates to males than females.

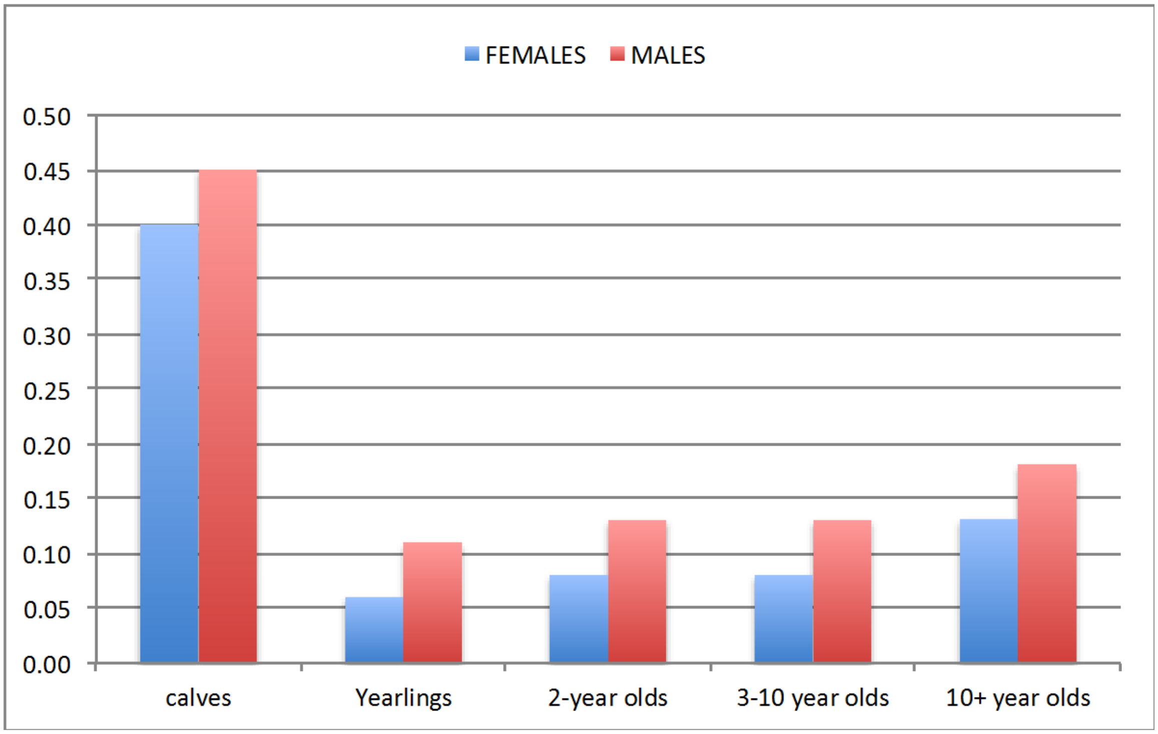

Figure 6. Modeled mortality rates of the North Baffin Island caribou herd by age and sex

Harvest: We assumed harvest was additive to the natural mortality rates and that harvest by age and sex was proportional to occurrence in the population. We did not attempt to model current or historic harvest levels, even though data do exist. Our intention was to demonstrate the relative effect at the population level of development scenarios from unharvested and harvested populations. Although we realize that harvest would increase as populations grow, our harvest scenario (75 animals or 5% of the initial population size) was used to illustrate the relative impact of harvest versus development and form the baseline scenario for us to determine harvest reductions required to offset the effects of development. A constant harvest of 75 animals is likely an underestimate of actual harvest as the population recovers.

RESULTS

ENERGY-PROTEIN MODEL: Development Scenarios

We assumed that displacement of caribou from the ZOI would result in higher densities outside of the ZOI and thus a reduction in the forage per animal available. However, we assumed that at lower population levels (0–15,000 animals) displacing caribou from the ZOI would have no effect because the extra animals could be accommodated within the existing range. We assumed that when the caribou population is between 15,000 and 50,000 animals that there was a linear increase from 0% biomass reduction at 15,000 caribou to maximum reduction, depending on the scenario, at 50,000 caribou. Disturbance effects were incorporated by calculating the number of days exposed under moderate displacement and disturbance (1.7% = 6 days) and high displacement and disturbance (25% = 91 days) conditions. Exposure days were dispersed throughout the year in 5 time periods. The set up to run the Energy-Protein model is summarized in Table 1.

Table 1. Parameters used to run Energy-Protein model to assess effects of development from the Mary River Project on the North Baffin Island caribou herd.

Reaction	Effect	Population size	Percent biomass reduction	# days disturbed in ZOI
None	none	n/a	0	
Moderate	displacement	25,000	1.9	
Moderate	displacement	35,000	3.8	
Moderate	displacement	50,000	6.6[a]	
Moderate	disturbance	n/a	0	6[b]
High	displacement	25,000	5	
High	displacement	35,000	10	
High	displacement	50,000	17.5[c]	
High	disturbance	n/a	0	91[d]

Notes:

[a] 6.6% moderate displacement (in terms of percent caribou use days)

[b] 17.6% high displacement (in terms of percent caribou use days)

[c] based on 25% time in 14 km ZOI and disturbance occurring in only 1/14 of ZOI

[d] based on 25% time in 14 km ZOI and disturbance throughout ZOI

To relate fall body weight of cows and calves to vital rates we:

1. Calculated the pregnancy rate change associated with the change in relative body size of adult cows. This change was then applied to annual rates in the population model throughout the simulation for disturbance and in association with population size for displacement.
2. Increased calf mortality in proportion to weight change compared to the baseline mortality (from the no harvest, no development scenario). Results indicated that under the most severe scenario (high displacement at high population densities) we determined a maximum reduction in fall body weights of calves of 2.5 kg (Table 2). In the absence of any studies that provide implications of such small body changes on overwinter mortality of North Baffin Island caribou, we conservatively assumed that a 1 kg change on calf body weight was equivalent to a 2% increase in overwinter mortality.
3. To account for additional calf mortality from the proportion of cows that weaned early, we assumed that a proportion of those calves were already accounted for in the base mortality rate (our population run assumed a base mortality of female calves of 45%). For this analysis therefore we assumed a 70% compensatory mortality and the remaining mortality was added to the overwinter mortality already calculated from average fall calf weights.

The results of the effects on pregnancy rates and calf mortality for our development scenarios compared to baseline (no development) conditions are summarized in Table 3.

Table 2. Energy-Protein model results for weight change of cows and calves for development scenarios relative to baseline (no development).

Reaction	Effect	Population size	Cow weight (kg)	Number post-natal and summer weaners	Calf weight (kg)	Change calf from base
None	none	n/a	79.75	0	49.25	0.00
Moderate	displacement	25,000	79.28	0	48.89	-0.36
Moderate	displacement	35,000	78.80	0	48.53	-0.72
Moderate	displacement	50,000	78.21	1	47.93	-1.32
Moderate	disturbance	n/a	79.53	0	49.19	-0.06
High	displacement	25,000	78.63	1	48.21	-1.04
High	displacement	35,000	77.73	12	47.45	-1.80
High	displacement	50,000	76.62	37	46.75	-2.50
High	disturbance	n/a	76.45	1	49.21	-0.04

Table 3 Calculated pregnancy rate and calf mortality for displacement and disturbance effects.

Reaction	Effect	Population size	Pregnancy rate	Female calf mortality rate
None	none	n/a	0.82	0.40
Moderate	displacement	25,000	0.81	0.41
Moderate	displacement	35,000	0.81	0.41
Moderate	displacement	50,000	0.80	0.43
Moderate	disturbance	n/a	0.82	0.40
High	displacement	25,000	0.80	0.42
High	displacement	35,000	0.79	0.47
High	displacement	50,000	0.76	0.56
High	disturbance	n/a	0.76	0.40

POPULATION MODEL SCENARIOS

North Baffin Island caribou population projections were modeled from 2013 to 2050 for all the scenarios. Final population estimates varied from 21,330 (harvest and high disturbance/moderate displacement [M/H-HV]) to 49,839 (no harvest and no development scenario [ND-NH], Figure 7). There is a clear separation in population projections when harvest is included as a variable. In all scenarios, harvest consistently results in slower population recovery and lower population estimates by 2050.

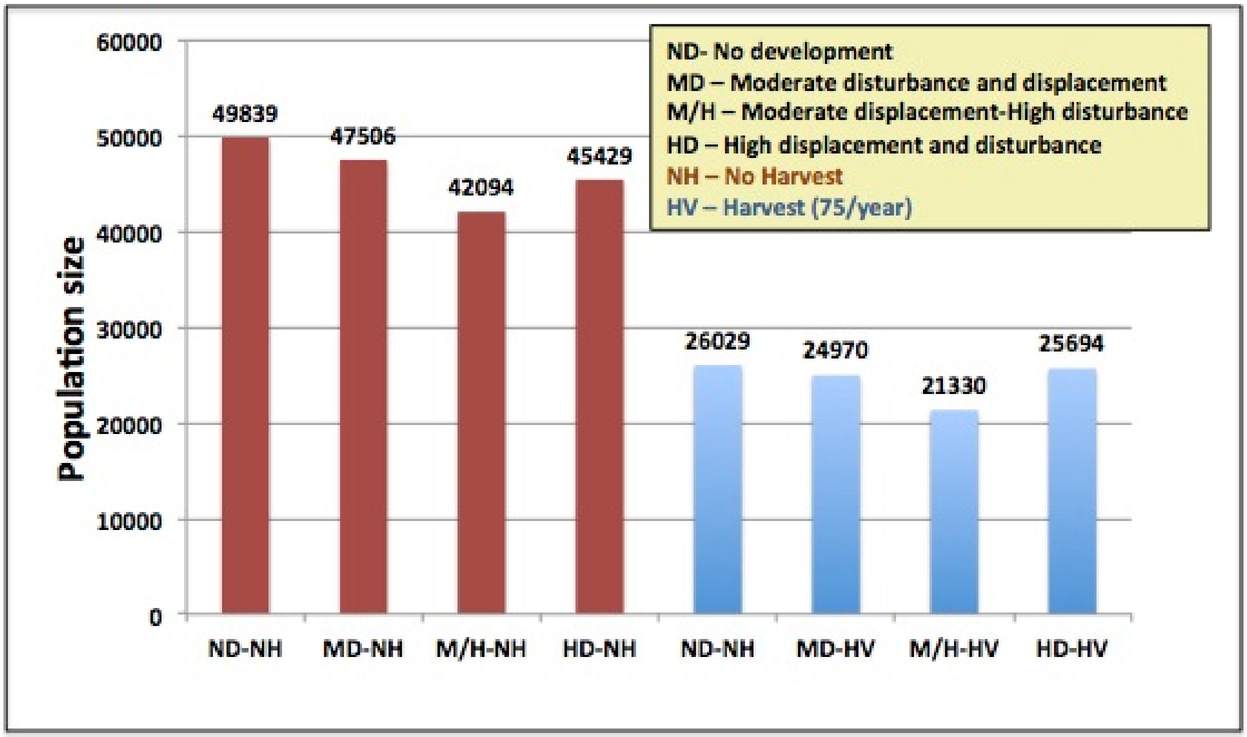

Figure 7 Summary of final population size for all harvest and development scenarios modeled for the North Baffin Island caribou population

No harvest scenarios: In the absence of development and harvest (ND-NH) scenario, the population recovered from 1,500 to 49,839 animals by 2050 (Figure 7). The moderate disturbance and displacement, No Harvest (MD-NH) scenario resulted in a 5% lower final population size by 2050; Moderate displacement/high disturbance, No Harvest (M/H-NH) scenario resulted in a 16% reduction, and the High development, No harvest (HD-NH) scenario resulted in a 9% lower final population size.

Harvest scenarios: Compared to the no harvest no development (ND-NH) scenario, modelled final population size of a harvested (ND-HV) scenario was 48% lower by 2050 (Figure 7). When we introduce the effects of development in the harvested scenarios, final population size for the MD-HV scenario resulted in a 4% lower final population size by 2050; the M/H-HV scenario resulted in an 18% reduction, and the HD-HV scenario resulted in a 1.2% reduction.

The relative effect of development was greater for the unharvested scenarios because the effect of displacement was operating seven years longer in the unharvested scenarios as displacement only took effect when the population reached 15,000 caribou.

Ironically the HD scenario did not produce the lower final population values because in our HD scenarios all caribou were displaced and therefore were not subjected to disturbance effects. Because of the few years that displacement had any effects in our harvested scenarios, our HD scenario resulted in the lower development effect compared to both the M/H and the MD scenarios.

HARVEST OFFSET

We determined the harvest reduction required to offset the effects of development for our 3 harvested and 3 unharvested population projections. Determining the harvest reduction required to offset the effects of development is largely dependent on the composition of the harvest. We assumed if a reduction in harvest were implemented, a reduction in cows would be the focus. Currently we assume that 63% of the harvest is females from the North Baffin Island herd. Co-management organizations during the current population lows have primarily developed a two-prong approach to halt population declines, reduce recovery times and enhance population growth: 1) to reduce overall harvest and 2) to focus more on bulls compared to cows (Porcupine Caribou Management Board 2010). These prescriptions were implemented for the Porcupine, Cape Bathurst, Bluenose West, Bluenose East and Bathurst herds. To determine the harvest reduction associated with our harvest scenarios, we iteratively reduced the number of cows in the harvest until the final population size equalled or exceeded the final population size for our harvested, no development scenario (26,029 caribou). Our analysis indicated that to offset development we would need to reduce cow harvest by: 2 cows (MD), 10 cows (M/H) and 1 cow (HD). For the unharvested scenarios, because there is no harvest to reduce in our development scenarios, we iteratively added harvest to the base run until the final population size equalized with the development scenario. Our analysis indicated that to offset development we would need to reduce cow harvest by: 5 cows (MD), 14 cows (M/H) and 10 cows (HD, Figure 8).

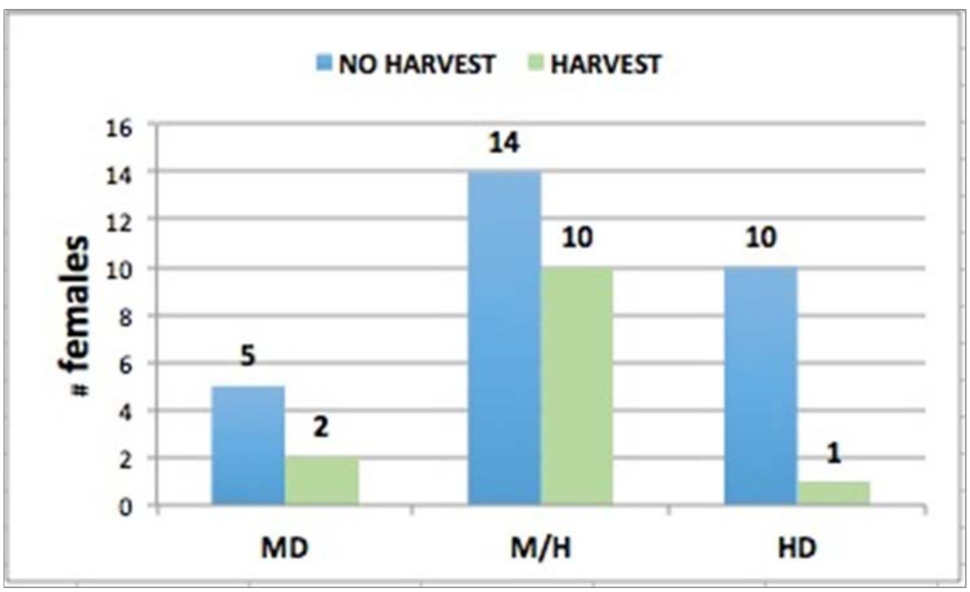

Figure 8 Model results to determine the required reduction in cow harvest to offset population effects of development for no harvest and harvest scenarios.

DISCUSSION

We realize that because of the lack of appropriate demographic data, our population recovery model should only be assessed with respect to the relative effects of development and harvest rather than being considered a projection of how the current North Baffin Island caribou population will recover. We modeled recovery in the absence of development and harvest and compared how that baseline scenario would change if caribou were harvested and/or if ZOI displacement or ZOI disturbance of caribou due to the Project were to occur. Our approach was to illustrate a range of possibilities of how caribou would react to development infrastructure and associated human activity.

We initially modeled a suspected current base population of 800 caribou; however, even with optimistic pregnancy rates and mortality rates, the model could not get the population to recover much beyond 10,000 caribou by 2050. Starting the population at 1,500 caribou allowed the population to expand close to historic levels and thus enable us to assess the development effects over the full range of abundance.

We linked energy-protein modeling to population modeling through effects on pregnancy rates and calf mortality. Although the effect on pregnancy rates is reasonably well documented, the effects of a 1 kg smaller fall calf are unknown. We could model a number of assumptions; however, we decided to simply assume a 1 kg drop in fall body weight is equivalent to a 2% increase in overwinter mortality.

The ZOI does contain significantly higher cover of prostrate dwarf shrub communities and lower cover of barrens than the North Baffin Island caribou range as a whole (Figure 4). Thus it is reasonable to expect that the ZOI would be selected more than it's percentage of a whole range (5.7%). However, that 70% of the North Baffin Island caribou use the ZOI 25% of their time is based on the assumption that the collared samples used in the analysis are representative of all North Baffin caribou and not biased toward use of the ZOI. There are two possible ways that the sample is not representative 1) placement of collars were not random, and 2) caribou harvested by hunters, and/or caribou collared only for a portion of a year were not random in respect to use of the ZOI.

Jenkins and Goorts (2011) dispersed collars both along survey lines, opportunistically between lines and opportunistically in transit from base camp, which was at the Mary River mine site. Further, Jenkins and Goorts (2011) indicated that the Borden Peninsula was not surveyed for the 2008 collaring program, but was included in the 2009 program but no collars deployed, although caribou were sighted. In fact Jenkins and Goorts (2011) state that the 2008 survey "centered on Mary River" (their Figure 3). Flight lines and thus deployment of collars did not extend to the known home range of the North Baffin Island caribou. With the exception of the Borden Peninsula survey in 2009, the area searched did not extend far enough north or west to encompass the full range of the herd and even within the surveyed area collars were not randomly deployed given the opportunity to collar leaving and returning to the Mary River area.

Of the 32 animals collared, 10 caribou remained active throughout the study period, 13 were harvested, 5 died of natural causes and 4 of unknown causes (Jenkins and Goorts (2011). Based on all collar analysis, 70% of caribou used the ZOI and of these 25% of their time was in the ZOI. These values were the basis of our analysis. However of the 22 (70%) collars using the ZOI, 6 were never tracked for a full annual cycle and these 6 collars were in the ZOI for on average 38% of their time. Those in the ZOI that were harvested before providing a full year of data, spent on average 44% of their time in the ZOI. If we simply eliminated collars that were not tracked for a full annual cycle then they represent 65% of animals and 19% of their time. However even these values may be biased given our concern for the non-random deployment of collars.

Our analysis relied heavily on studies that showed a 14 km ZOI where effects of human activity could be detected. These studies were for the Bathurst herd in the presence of Mines and road infrastructure (Boulanger et al 2012). No similar analysis has been done in the Mary River area and no studies have been done with respect to railroads. Of the 22 collars that used the ZOI only one collar was primarily associated with the tote road where a large number of trucks may elicit a higher disturbance and displacement response than the less frequently travelled railway option. Thus applying a displacement and disturbance response to 70% of caribou for 25% of their time that is more appropriately associated with high truck traffic and dust conditions is likely an overestimate. Caribou reactions associated with high truck traffic should only be appropriately applied to 1 collar out of 32 collars = 3% of the herd.

High displacement scenario assumes that 100% of caribou are displaced from the 14 km ZOI and High disturbance assumes caribou are equally disturbed throughout the 14 km ZOI. Both these extremes have no precedence in the literature; however modeling these scenarios allows us to explore the extremes in caribou reaction. Ironically because no caribou can be disturbed in the ZOI if all caribou are displaced for the ZOI, the High displacement/disturbance, harvesting scenario (HD-HV) resulted in a higher final population size than our MD and M/H scenarios because there were no caribou to disturb in the ZOI and displacement effects were not applied until the population reached 15,000 caribou, relatively late in the simulation.

Although we present target harvest reductions to offset the effects of development, composition of the ongoing harvest could more painlessly offset development. For example the scenario with the largest percentage impact was the M/H-HV scenario, which was 18% lower than our ND-HV scenario. Instead of reducing annual harvest by 10 cows the effects of development could be offset by changing the composition of the harvest from 63% cows to 50% cows without reducing the harvest at all.

We believe that our modeling should be a baseline attempt at assessing potential development effects. It will be important however to continue to monitor the use of the region with respect to the ZOI if the project proceeds. The analysis can be updated easily as more information becomes available and/or as the herd recovers to historic numbers. It will also be important to monitor and assess the role of harvest, both quantity and composition to better understand the role of harvest on the recovering population. From our analysis the growth rate of the herd is most sensitive to harvest.

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